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# Earth Reserve Assurance (ERA): A Framework for Sound Money

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## Abstract

This paper presents a novel approach to achieving sound money. The design can be incrementally retrofitted to any conventional currency in a multi-currency system without a central reference unit of account. Drawing upon monetary theory and elements of monetary system designs of ancient Sumer and modern Hungary, a new tradable deposit receipt security would be introduced that is indexed to changes in the capacity of ecosystems within the currency zone to produce primary commodities, relative to a base year, weighted by currency of invoicing data across jurisdictions. This would establish a grounded 'Money-of-Account' referent for that currency. New money creation involves a second new tradable deposit receipt security to be issued by corporations and communities that have verifiably improved the primary productive capacity of ecosystems in their currency zone. Central banks would be invited to redeem the securities with a special series of commemorative banknotes, to serve as Money-in-Trade valued in accordance with the Money-of-Account. With this auxiliary method, relative currency worth reflects changes in the core ecological co-determinants of economic activity. Instead of expressing ecosystem productive capacity in terms of money, this framework expresses money in terms of ecosystem productive capacity.

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## 1. Introduction: The Essential Attributes and Functions of Money

In the opening paragraphs of the first chapter of *A Treatise on Money*, John Maynard Keynes clearly prioritized the *accounting* attribute over the *exchange* attribute of money, to introduce the topic:<sup>1</sup>

“Money-of-Account, namely that in which Debts and Prices and General Purchasing Power are *expressed*, is the primary concept of a Theory of Money. ... Something which is merely used as [J1] a convenient medium of exchange ... may represent [J2] a means of holding General Purchasing Power. But if this is all, we have scarcely emerged from the stage of Barter. Money-Proper in the full sense of the term can only exist in relation to [J3] a Money-of-Account. ... Perhaps we may elucidate the distinction between *money[-in-trade]* and *money-of-account* by saying that the money-of-account is the *description* ... and the money[-in-trade] is the *thing* which answers to the description. Now if the same thing always answered to the same description, the distinction would have no practical interest. But [J4] if the thing can change, whilst the description remains the same, then the distinction can be highly significant. (Keynes, 1958, First published 1930, pp. 1-4; Enumeration and [-in-Trade] added; Other italics are in the original.)

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<sup>1</sup> This paper uses relatively long quotations to spare the reader the need to chase sources that are not freely available online. The extensive footnotes avoid burdening the main text with context intended for an interdisciplinary readership.

This excerpt in which Keynes' distinguishes Money-of-Account and Money-in-Trade contains references [J1], [J2], [J3], and [J4] inserted by the present author to identify the four functions of money described a half-century earlier in *Money and the Mechanism of Exchange* by William Stanley Jevons (1876):

*Table 1: Attributes and Functions of "Money Proper in the Full Sense of the Term"*

<p><i>Things: Money-in-Trade</i></p> <p>[J1] Trade: "A medium of exchange" among all persons in all regions;</p> <p>[J2] Accumulation: "A store of value" for any person in any region;</p> <p><i>Descriptions: Money-of-Account</i></p> <p>[J3] Quantification: "A common measure of value" at any given time;</p> <p>[J4] Stability: "A standard for value" through time.</p>
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These four functions grouped by the two attributes constitute the axiomatic premises of archetypal 'Money', upon which is contingent any currency's status in that regard. To the extent the design or operation of a currency fails these axioms, it is not Money in the full sense of the term. This is not unique to the 'Keynesian' school of thought. When Frederick Hayek set aside the: "usual assumptions of monetary theory, that there is only one kind of currency, the money, and that there is no sharp distinction between full money and mere money substitutes", he clearly held there to be an archetype of Money in the full sense of the term. (Hayek, 1990, p. 81) Robert Mundell also stepped through each of Jevons' four functions (Mundell, 1968, p. 45-52) when outlining his concept of Money.

Keynes' *Treatise on Money* (1930) paradoxically reached publication just after the market crash of 1929. In the same year he presented a lecture in Spain entitled "Economic Possibilities for Our Grandchildren" to confront the prevailing pessimism and to examine: "What can we reasonably anticipate the standard of our economic life to be a century hence? What are the economic prospects for our descendants?" (Keynes, 1930, p. 322) In a similar spirit the present paper challenges the pessimism of the 2020s with an approach to sound money that looks forward 200 years, yet begins with the origins of money over 6,000 years ago.

## 2. Ancient Money In the Full Sense: A Simple Money-of-Account Reference Model

The axioms which were given definitive expression by Jevons are so elemental to the nature of Money that their functional presence is evident in interpretations of the archaeological evidence of ancient Sumerian civilization from approximately 4500 to 1900 BCE in the Fertile Crescent between the Mediterranean Sea and the Persian Gulf. (Oppenheim, 1959) (Sterba, 1976) (Schmandt-Besserat, 1996) (Schmandt-Besserat, 2009) (Schøyen, 2007) (Hudson, 2004b) (Papadopoulos & Urton, 2012) (Ouyang, 2013) (Goetzmann, 2016) (Finné, 2011) Despite the vastly different circumstances, cognitive schemas and social norms of such an ancient civilization, it is useful in the present to consider a monetary system that predates all the 'schools of thought' and operational mechanisms of the past 500 years.<sup>2</sup>

<sup>2</sup> This assertion is accompanied with my acknowledgement of the inherent paradox of attempting to grasp elements of fundamentally different cultures by viewing them through the blurred lens of one's own biases and assumptions. As Karl Polanyi warned, when academics today reflect on the economic concepts and methods of ancient civilizations:

"We are bound to locate every economic situation within the traditional coordinates of money, market, price, etc., as these have been defined and have found acceptance within the last hundred years of our civilization. We constantly apply this frame of reference without even realizing that we distort the Mesopotamian picture in its most essential aspects, by basing our analysis on a set of assumptions which we take for granted are universally applicable." (Polanyi, 1957, p. 28)

Reference is made here to a half dozen works by prominent career archaeologist and economic historians of the Sumerian civilization upon which I have based the following summary of a monetary system, mainly reflecting selected arrangements in place during the Sumerian Ur III Period, c. 2112-2004 BCE. Of course, its gradual emergence between 8,000 and 3,350 BCE involved many variants and steps as Late Neolithic hunter-gatherers (Natufian, Halaf, Hassuna and

In ancient Sumer, anyone unable to pay a debt in silver *Money-in-Trade* could instead settle the obligation in barley seed<sup>3</sup> *Money-of-Account* at a pre-published proportion. This formal substitution was the inverse of what is today considered redeemability, since instead of a central monetary authority committing to redeem cash with the reference commodity, it authorizes the decentralized settling of payments with the reference commodity in lieu of cash. Economic historian Michael Hudson explains the utility of what I propose to call the ‘Inverse Redeemability Rule’:

“[S]cheduled payments denominated in silver could be made in barley at the official price equivalence. This meant that it was not necessary to get silver into the hands of the population in order for transactions to take place. Stabilizing the barley-silver conversion rate enabled exchange to occur without a monetary deflation when families lacked silver to pay debts or buy ... products needed for their daily life.” (Hudson, 2004b, p. 315)

In Sumer, the assigned worth of silver in terms of tangible barley in each region was adjusted occasionally under the authority of the city temple’s Chief Steward (the *Nubanda*), taking into account crop yield per unit of land relative to transaction demand for standard units of silver.

- *Money-in-Trade* involved pieces of precious silver the size of an average grain of barley called 1 silver *gerah*, declared at the temple to be worth an average handful of barley seed.<sup>4</sup> A piece of silver equivalent to 20 silver *gerahs* was 1 *shekel* of silver, deemed to be worth 1 standard sack (1 *gur*) containing 20 handfuls of barley seed (20 *gerahs*). The value of 60 silver *shekels* was referred to as 1 silver *mina*. These silver units were used in trade.
- *Money-of-Account* records were tallied with non-precious clay tokens in standardized shapes to represent various categories of basic goods and services. The worth of a *gur* (a sack of barley) was represented with a spherical clay token, and a *gerah* (a handful of barley) by a conical token. An ovoid shape recorded the worth of a standard jar of olive oil. A tetrahedral piece represented the worth of a day of labour. The worth of livestock, such as cow or goat, was accounted for with a cylinder. These units were used in record-keeping.

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Samarra cultures) transitioned to settled agriculturalists (Uruk and Ubaid cultures), proceeding into the Early Bronze Age (Sumerians, Akkadians, Assyrians, Amorites and others). Denise Schmandt-Besserat comments:

“Tokens appeared .. about 8000 BC, coinciding with the first signs of agriculture. ... In fact, in each of the five sites which yielded the earliest tokens, the invention of clay counters was consistently related to evidence that grain was harvested or hoarded. ... Silos were an important feature at Mureybet III, Cheikh Hassan and Tell Aswad.” (Schmandt-Besserat, 1996, p. 102)

- 3 The emergence of agriculture generally, and the monetary role of barley in particular owes much to this crop’s versatility and resilience. Barley is relatively more tolerant of temperature variations, drought and salinity, it has a shorter growing season, and it produces more grain per unit water, compared with wheat. Barley seed and straw provide excellent feed for cattle and goats, while the seeds are useful as flour for baked goods, sprouts for greens, syrup for sweetener, and malt for beer. Barley straw is useful for strengthening clay bricks, starting fires, weaving into baskets and mats, providing animal bedding, and aerating compost.
- 4 Whereas the Sumerian monetary system relied on the *size* or the *weight* of an average barley seed to measure an amount of silver, some later monetary systems such as in Medieval England used the *weight* of an average seed (wheat or barley) to measure silver only by that factor. In a chapter entitled “The Babylonian Mina, the Egyptian Kat, the Lydian Mina and the Roman Pound”, Keynes noted that in the ancient Babylonian system: “The primitive metrological fact may have been that 13 wheat grains were the same weight as 10 barley grains and the primitive monetary fact that 10 barley grains weight of silver were worth 1 wheat grain weight of gold.” (Keynes, 1978, 238) Commenting on medieval England he explained: “The legal definition of the grain a voidupois [dry, loose wheat seed] in the reign of Henry III (1267) is given by ‘An English penny, called a sterling, round and without clipping, shall weigh 32 wheat corns [seeds] in the midst of the ear’. The penny contained 24 Troy grains [dry loose barley seed], thus giving the 3 to 4 ratio for wheat to barley.” (Keynes, 1978, p. 236, 238) See also: (Naismith, 2011, p. 168-180) The units given in this paragraph are based on the several archaeological sources cited at the beginning of this section, which do not refer to the “gin-tur” or “she” units that appear in Keynes’ summary (p. 245). However the proportions are consistent when referring to the same units.

Ranging in worth from small to large values, the various clay token shapes could be combined to maintain precise and scalable records for the *Money-of-Account* function. The clay tokens themselves represented entitlements (credit), whereas their negative impressions pressed into clay containers or tablets represented corresponding obligations (debit)—a precursor to double-entry book-keeping. As barley seed could be used to settle a debt in lieu of silver, the proportion of tangible seed assigned to silver was administratively anchored to the underlying productive capacity of barley fields:

“The way in which the Sumerians set up an equivalency between silver-money (the shekel), the crop yield of land rented out (and hence, a land area that would yield a given crop of barley as rations) ... enabled accounts to be translated readily into monetary equivalency ... It is the overall set of proportions that represent the monetary system, not the commodity silver, copper or whatever. In the beginning this set of proportions had to be administered, at least within the large institutions. The key was the overall system, not merely the phenomenon of money as a metallic commodity. There needed to be some unit or units of account against which to value other commodities, as well as labor time and land.” (Hudson, 2004a, p. 352, Emphasis added)

Cultivators who deposited barley in the temple granaries were given clay tokens as 'deposit receipts' corresponding to about 80% of what they deposited, while the temple retained ownership of the surplus as a fee. A team of records management and compliance specialists ('scribes') would update the clay tablet registries. Later, when cultivators presented those clay tokens, temple officials would validate each request against their own registry records, and upon confirmation, release the corresponding amount of barley, and update the records.

The monetary system of ancient Sumer merits reflection today precisely because it embodied all the essential attributes and functions of Money with an easily-understood relation between the standardized silver Money-in-Trade and standardized barley Money-of-Account. Keynes concluded that:

"[F]or most important social and economic purposes what matters is ... the money of account which is the subject of contract and of customary obligation. ... When we turn to the actual records of antiquity, we find in the earliest Greek history a community very primitive in its use of money, but in the earliest Babylonian history a community very advanced indeed in all these matters even in the remotest records of the third millennium B.C. ... Recent discoveries have ... thrown back the genesis of organized economic life to a date so much earlier than was previously supposed, that weights must have existed centuries and, perhaps, even millennia before Dungi [a King of the third dynasty of Ur circa 2456 BCE], in whose reign money, prices, interest, contracts, and receipts are fully established, the archaic civilization of the Sumerians being far more fully developed in these respects than those which succeeded it. ... Individualistic capitalism and the economic practices pertaining to that system were undoubtedly invented in Babylonia and carried to a high degree of development in epochs more distant than the archaeologists have yet explored. ... The first important innovation on Babylonian practices is essentially a modern one, namely the invention of representative money. ... The introduction of a money, in terms of which loans and contracts with a time element can be expressed, is what really changes the economic status of a primitive society; and money in this sense already existed in Babylonia in a highly developed form. (Keynes, 1978, p. 231, 244, 253, 255)

The resilient monetary design of the Sumerians assigned neither static nor floating valuation of their silver currency disconnected from the tangible biogeophysical productive capacity. They achieved *monetary system stability* lasting several millennia, while also dynamically moderating price and the supply of a strategic crop amidst seasonal fluctuations and multi-year productivity trends. Granted, after numerous periods of development and retrenchment spanning two and a half millennia between 4500 and 2000 BCE, the Sumerian civilization finally succumbed to a combination of institutional weakness and ecological degradation, internally and externally driven. Yet elements of ideas and methods originating in

Sumer were adapted by other civilizations in the region and beyond, apparently beginning to spread out as far back as 3,000 BCE.<sup>5</sup> (Christian, 2000, p. 12) (Abdullah, 2020)

Between 1920 and 1926 while preparing the *Treatise on Money*, Keynes conducted an in-depth exploration of the operational aspects of ancient currencies calibrated to barley and wheat. He came to the unexpected conclusion that heirloom varieties of those seeds evidently provided a more stable foundation of weights and measures for money than metals such as gold, silver and copper:

“It may help the reader if I mention at this point a possible conclusion which my argument may suggest. I believe that, apart from a possible movement of the conventional wheat-barley weight ratio from 077 (i.e. 13:10) to 075 (i.e. 4:3), and a slow, slight increase in the absolute weight of these grains, the fundamental weight standards of Western civilization have *never* been altered from the earliest beginnings up to the introduction of the metric system, which was the first real revolution in these matters away from the Sumerian and Egyptian ideas. All weight standards of the ancient and also of the medieval world in Babylonia, the Mediterranean Basin and Europe have been based on either the wheat grain or the barley grain ... The conservatism which I attribute to the ancient world in this matter is no matter for surprise. Prior to the introduction of modern strains ... the weights of the wheat and barley grains were physical facts stable within a fairly narrow range. ... When, however, we come to currency questions it is a different matter. The copper-silver value ratio and the silver-gold value ratio were very far from stable physical facts but depended on the varying relative abundance or desirability of the three metals. The tendency of these ratios to change over a period of time may have been, therefore, at the root of the currency difficulties in the ancient days of trimetallism and a cause of the complications of currency standards which perplex numismatists. ... The stamping of pieces of metal with a local trademark was just a piece of bold vanity, patriotism or advertisement with no far-reaching importance. (Keynes, 1978, p. 239, 254)

- 5 In 1889 Hungarian-British archaeologist Aurel Stein observed that “the system of reckoning incomes in grain is widely spread throughout Asia”. For example he reports early records of pricing in standardized units of rice in Kashmir dating back to the reign of Avantivarman from 855 to 883 CE. In particular, Stein’s detailed “Notes On Monetary System Of Ancient Kashmir” document the complementary operation of copper coins as *Money-in-Trade* with rice as *Money-of-Account*.

“In these forms the use of the word *dhndra* in the general sense of “money,” “cash,” is extremely common. ... The true meaning of the term *dhndra* is brought out prominently by passages where it is used in evident contrast to *dhndya*. Grain, in particular rice, has formed practically to the present day a regular medium of currency in Kashmir... It is, therefore, characteristic that we find *dhndrojdmacirikd* side by side with *dhndvojdmacirikd*, the first term denoting a “bond of debt for cash”, the other one for grain. ... By far the greatest portion of the land revenue being assessed and collected in Kharis of grain, the consequences in respect of the currency must have been similar to those observed in modern times. ... Its existence in old Kashmir, which we conclude from the evidence above indicated, greatly helps us to understand the facts we have ascertained regarding the cash currency of the country. A monetary system based on the cowrie unit, and represented in its main bulk by a copper coinage, becomes far more intelligible if we realise that it was supplemented in all important transactions of public business and private life by the ample stores of another circulating medium, the Khari of rice.” (Stein, 1899, p. 172-174)

Similarly, the *Leviticus* (27:16) chapter of the Jewish Torah, composed in Sinai/Canaan (c.1400-400 BCE) discusses ethical and agricultural laws, and states, “If anyone consecrates to the Lord any land that he holds, its assessment shall be in accordance with its seed requirement: fifty shekels of silver to a homer of barley seed.” (Foer & Lockspeiser, 2020)

Rather different types of monetary designs anchored to primary agricultural commodities in ancient China illustrate decentralized and centralized variants. These might have been influenced by innovations originating in the Fertile Crescent, passed along via traders along the ancient Silk Road caravans. China’s early forms of commodity price management though coordinated storage operations were first described to Western academia in a 1911 doctoral dissertation at Harvard University by Confucianist scholar Chen Huan-Chang (Chen, 1911, pp. 571–580). I learned of his work from the opening page of the 1937 book “*Storage and Stability*” by Wall Street ‘value investment’ legend Ben Graham, (Graham, 1937, p. 3, also 30-31, 40, 237 and 241) as he explicitly adapted this operational design into his proposed commodity reserve currency for industrial open market economies of the 20<sup>th</sup> Century. Chen’s doctoral thesis (available today via *The Internet Archive*) outlines a centralized monetary system based on essential grains during the Han Dynasty. In 54 BCE assistant minister of agriculture Keng Shou-ch’ang oversaw the operation of a ‘constantly normal granary’ which, while ensuring security of the food supply, also provided a tangible Money-of-Account standard upon which to anchor Money-in-Trade silver for trade. Chen also described a decentralized voluntary cultivator-operated variant he referred to as “free granaries”, which were initiated by Ch’ang-sun P’ing during the Sui Dynasty a half millennium later in the year 585 CE. Under both the centrally mandated and voluntary producer-managed models, when supply exceeded demand for the listed commodities, the granaries would buy the *Money-of-Account* commodities with at pre-published stable prices (distributing silver); and when demand exceeded supply, the granary would sell them at those prices (receiving silver).

“This twofold mechanism of storage and price control was formally set up some five centuries after Confucius under the name of the ‘Constantly Normal Granary’. With considerable variations as to price policy, and with more or less serious interruptions due to political conditions, the system of the Ever-normal Granary has existed in China ‘in nearly all the ages from 54 B.c. to the present time.’ There have also been other storage arrangements of a local character, known as the ‘free granary’ and the ‘village granary’, and involving both gifts and loans of grain to the people.” (Graham, 1937, p. 30-31)

Michael Hudson has also commented on the complications that came with the introduction of coins compared with the simpler Money-in-Trade metal quantity anchored to a Money-of-Account commodity:

“I also should add that when coinage was developed, it did not simplify matters and reduce costs. It actually introduced new complications as it made possible seignorage (issuing coins whose nominal face value exceeded that of their bullion content), clipping, depreciation and hence price inflation. So that idea that each monetary innovation has saved transaction costs does not hold up.” (Hudson, 2004a, p. 353)

### 3. A Modern ‘Special Purpose’ Money-of-Account Benchmark

A striking similarity can be observed in the monetary systems of ancient Sumer and present-day Hungary, despite their vast and obvious differences. In the Sumerian system, the productive capacity of barley fields formed the basis of a *general-purpose* Money-of-Account; in contemporary Hungary, the productive capacity of agricultural and forestry lands provides a *special-purpose* Money-of-Account benchmark.

The Hungarian Golden Crown (*Arany Koroná: AK*) is calibrated to the 10-year rolling average yield of a cadastral hectare (10,000 square meters) of agricultural land, with a 15-year average for vineyards and a 25-year average for timber lands, adapting for their longer growth cycles. The assessment methodology and baselines used in Hungary are in need of an update,<sup>6</sup> but in principle they accommodate natural variations in productive capacity through baseline adjustments for underlying factors such as soil fertility, climate, topography, and fresh water accessibility. The AK is not a physical Money-in-Trade currency, rather it is strictly a Money-of-Account for the purpose of pricing agricultural and forestry lands. The actual buying and selling of those lands is conducted with the Hungarian Forint (HUF) Money-in-Trade, like all other market exchange. (Paczolay, 1992) (Hungary, 1997) (Tógyer, 2012) (Takács et al., 2020)

Whereas the worth of the HUF general-purpose currency floats subject to the diverse forces of regional and global foreign exchange markets, the special-purpose AK is anchored to the ground. There is no direct mechanism relating to the quantity or worth of the HUF relative to the AK. The buying and selling of agricultural land requires multiplying the stable AK Money-of-Account land assessments by the current domestic average price of wheat denominated in the unstable HUF Money-in-Trade currency.<sup>7</sup>

Between 2012 and 2022 the floating HUF has dropped to a third of its value, relative to the grounded AK (HCSO, 2023) (Magro, 2015). The result is that farmers have had the worth of their agricultural land protected by the AK Money-of-Account. and both have fallen significantly in terms of the Euro. This complexity clearly presents socio-economic challenges, but issues are addressed through fiscal policy.

In 2019 average regional AK rates for agricultural land in Hungary ranged from 3 to 30 AK per hectare, and the assessed value for the typical farm was between 10 and 20 AK. (Takács et al., 2020) Magro Inc., an online agricultural marketplace and data services provider in Hungary, offers the following summary:

“Lower quality land is considered to be worth between 0 and 17 gold crowns, good land is between 17 and 25 gold crowns, and excellent land is worth more than 25 gold crowns. The classification of a given area is recorded in the land registry, and is also indicated on the property's title.” (Magro, 2015, translated)

6 In the late 1980s a more precise 100-point system was designed for assessing land quality, but it was not adopted due to administrative and data integration difficulties, so the earlier outdated methodology persists despite its inaccuracies and inability to reflect supply and demand factors, which cause distortions and anomalies in land valuations. (Mandula, 2021)

7 Money-in-Trade has elsewhere been issued directly upon agricultural land. For example in 1769 David Hume wrote: “[I]n our colony of Pennsylvania, the land itself, which is the chief commodity, is coined, and passes in circulation. The manner of conducting this affair is as follows :—A planter, immediately after he purchases any land, can go to a public office and receive notes to the amount of half the value of his land; which notes he employs in all payments, and they circulate through the whole colony, by convention. To prevent the public from being overwhelmed by this fictitious money, there are two means employed—first, the notes issued to any one planter, must not exceed a certain sum, whatever may be the value of his land; secondly, every planter is obliged to pay back into the public office every year one tenth part of his notes; the whole, of course, is annihilated in ten years; after which, it is again allowed him to take out new notes to half the value of his land. An account of this curious operation would enrich your dictionary; and you may have a more particular detail of it, if you please, from Dr Franklin, who will be in Paris about this time, and will be glad to see you. (Hume, Letter to Morellet, 10 July 1769, cited in Rotwein 1970, p. 215)

The ancient Sumerian and modern Hungarian examples of monetary linkage to agricultural productive capacity illustrate how a Money-of-Account can operate alongside a Money-in-Trade currency, to fulfill all four of Jevons' axiomatic functions. The Sumerian model stands out for its completeness and simplicity in relation to the productive capacity of barley cultivation as the tangible referent, and for its decentralized 'Inverse Redeemability Rule'. The partial hybrid Hungarian model operating today is also useful because it demonstrates how a floating Money-in-Trade can operate concurrently with a Money-of-Account grounded in the productive capacity of the country's agricultural and forestry lands, and how at any time the price of grain can be used to convert between the two. All of these aspects will appear in a new form in Section 6 below.

#### 4. Most Present-Day Currency is Not Money in the Full Sense of the Term

In the past half century, influential economists in government, academia, and banking have transformed the Money-of-Account concept from a relatively simple *anchor* that passively prevents drift, into a *rudder* for active steering in complex currents. John Taylor succinctly explained responsive monetary management:

“The preferred policy rules that have emerged from this research have not generally involved fixed settings for the instruments of monetary policy... The rules are responsive, calling for changes in the money supply, the monetary base, or the short-term interest rate in response to changes of the price level or real income.” (Taylor, 1993, p. 196)

Central banks have adapted the so-called “Taylor Rule”, each in their own way, to serve as a sort of dynamic Money-of-Account wheelhouse with access to the following three controls, among other techniques:

- *Ongoing inflation rate targeting to a standard profile of consumer spending*,<sup>8</sup> performed by buying and selling government and corporate bonds which, in effect, injects currency into markets, or extracts currency out of them; (Since 2008 these actions have included other types of financial securities, as well as market equities);
- *Occasional base lending rate*<sup>9</sup> adjustments, by increasing or decreasing the ‘bank rate’ or ‘credit fee’ at which commercial banks borrow from central banks; and
- *Infrequent regulatory changes to the reserve ratio*,<sup>10</sup> which sets the proportion of central bank cash, precious metals or government securities that commercial banks must hold when extending credit to their customers.

However just as a ship's captain must prioritize two of the triple set LOAD—SAFETY—SPEED, the admirals of responsive monetary management have to triage two-out-of-three objectives. In the early 1960s Robert Mundell and Marcus Fleming independently described a “trilemma” (“impossible trilogy”) involving the policy objectives of [X] maintaining a fixed exchange rate; [C] allowing capital to flow freely across borders; and [M] controlling the money supply and lending rates. Their conceptual and empirical analyses led to a widely accepted conclusion, albeit with some dissenters, that a government can pursue any two of these three policies simultaneously, but must inevitably sacrifice the third. (Mundell, 1963) (Fleming, 1962)

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8 Notwithstanding official policy, economist Arthur Laffer has asserted that the US Federal Reserve, in fact, unofficially anchored the US dollar to a benchmark of 25 primary exchange-traded commodities:

“In the early 1980s under gifted Federal Reserve chairman Paul Volcker (1979-87), the United States once again returned to a price rule, only this time the dollar wasn't pegged to gold. Following a meeting I had with Chairman Volcker in 1982, I co-wrote an article for the editorial page of the Wall Street Journal. In this article Charles Kadlec and I outlined in detail Chairman Volcker's vision of a price rule”. (Laffer & Kadlec, 1982)

“In short, what Chairman Volcker did was to base monetary policy on the secular pattern of spot commodity prices (the market price of a commodity for current delivery). ... It's very similar to a gold standard, except that Chairman Volcker was using twenty-five commodities instead of just one. ... If spot commodity prices rose above their cyclically adjusted long-term level—outside a band, of course—the Fed would then start selling bonds in the open market... if spot commodity prices fell below the cyclically adjusted lower bank the Fed would buy bonds. Following Volker, this policy has been meticulously adhered to by Alan Greenspan (Laffer & Moore, 2010, p. 230).”

9 The rate at which commercial banks borrow from central banks.

10 The proportion of central bank cash, precious metals or government securities that commercial banks must hold when extending credit to their customers.

(Obstfeld et al., 2005) Some economists reject the system-level assumptions underlying this trilemma,<sup>11</sup> and others extend it to four policy objectives.<sup>12</sup>

If the Mundell-Fleming trilemma holds, however, it presents a paradox concerning Money in the full sense of the term. Central banks and national governments sacrificing one of their three monetary policy objectives will almost surely compromise one or more of Jevons' four core functions of money. Using the variables {X, C, M} from the previous paragraph, and the {J1, J2, J3, J4} notation from Table 1, let us consider the Mundell-Fleming logic in conjunction with Jevons' core functions. In standard logic notation,  $\wedge$  means “and”;  $\neg$  means “not”, and  $\rightarrow$  means “implies”:

- Scenario (i): A country's pursuit of a fixed exchange rate (X) and free capital flows (C), requires sacrificing its ability to independently control its money supply and lending rates ( $\neg M$ ), leaving it vulnerable to domestic inflation/deflation from internal forces, and fluctuations of the external referent to which they are fixed, thus weakening the currency's function as "a store of value" for accumulation ( $\neg J2$ ) and weakening its function as a quantitative valuation standard through time ( $\neg J4$ ).

$$(X \wedge C) \rightarrow ((\neg M) \rightarrow (\neg J2 \wedge \neg J4))$$

- Scenario (ii): A country's pursuit of a fixed exchange rate (X), and independent central bank control over money supply and lending rates (M) requires sacrificing free capital flows ( $\neg C$ ), which can impact the currency's function as "a store of value" for accumulation by anyone using the currency ( $\neg J2$ ), and thus compromise its utility as "a medium of exchange" for cross-border trade ( $\neg J1$ ).

$$(X \wedge M) \rightarrow ((\neg C) \rightarrow (\neg J1 \wedge \neg J2))$$

- Scenario (iii): A country's pursuit of free capital flows (C), and independent control over the money supply and lending rates (M) requires sacrificing a fixed exchange rate ( $\neg X$ ), which compromises its function as "a medium of exchange" for cross-border trade ( $\neg J1$ ) and its function as a quantitative "common measure of value" at a given time ( $\neg J3$ ), and weaken its function as a quantitative valuation standard through time ( $\neg J4$ ).<sup>13</sup>

$$(C \wedge M) \rightarrow ((\neg X) \rightarrow (\neg J1 \wedge \neg J3 \wedge \neg J4))$$

Accepting the Mundell-Fleming trilemma leads to what we shall refer to here as the Jevons-Mundell-Fleming Inferable Paradox: *No monetary system can be expected which fulfills the axiomatic functions of Money*. The trilemma doesn't fall, but economists have to endlessly think up economic stress management techniques for coping with it. Below we consider four:

- Reduce the axiomatic functions of money;
- Replace central banks with currency boards;
- Recast Jevons' axioms as suggestions;
- Root monetary worth in fundamental determinants of supply and demand.

11 For example, Franklin Serrano and Ricardo Summa challenge the assumptions that money supply is directly manageable; that global capital markets are free and fair; and, that exchange rate expectations are not easily adjusted. (Serrano & Summa, 2015)

12 Thibault Laurentjoye adds *access of foreign exchange reserves* to the Mundell-Fleming trilemma involving fixed exchange rates, absence of capital controls, autonomous money supply and lending rates. (Laurentjoye, 2022)

13 The most common scenario to which central bankers and governments have acquiesced in the past 50 years has been Scenario (iii). As evidence, we may consider an interview with Robert Mundell conducted in 2010. Economist Judy Shelton opens with the observation:

"Global monetary relations are in disarray. Exchange rates fluctuate wildly among the world's major trade partners, spawning talk of protectionism and a currency war. Gold is soaring as the dollar slides, and economists debate whether the biggest threat ... is deflation or inflation."

At one point in their discussion, Shelton asks:

"What do you think about the rise in currency trading by banks, with some \$4 trillion now turning over daily in global currency markets?"

Mr. Mundell thrusts out his arms:

"It's part of the sickness of the system! These currencies should be fixed, as they were under Bretton Woods or the gold standard. All this unnecessary noise, unnecessary uncertainty; it just confuses the ability to evaluate market prices." (Shelton, 2010)



## 5. Some Responses to the Jevons-Mundell-Fleming Inferable Paradox

### *Response (a): Reduce the Axiomatic Functions of Money*

W. Stanley Jevons first put forward the definitive and generally-memorized expression of the functions of money in the pages of *Money and the Mechanism of Exchange*, but he immediately cautioned:

“It is in the highest degree important that the reader should discriminate carefully and constantly between the four functions which money fulfills, at least in modern societies. We are so accustomed to use the one same substance in all the four different ways, that they tend to become confused together in thought.” (Jevons, 1876, p. 16)

Notwithstanding this explicit advice, today some economists suggest that [J3] and [J4] are the same thing. That’s to say, "a common measure of value" at any given time [J3] is deemed to mean the same thing as "a standard for value" through time [J4], since the latter [J4] measures the former [J3] over time.<sup>14</sup> And other economists conflate or overlook the distinctions between [J2] "store of value" for accumulation [J2] and "standard of value" for stability [J4].<sup>15</sup> The Bank for International Settlements' *Annual Report 2022*, for example, opens a section on the "future monetary system" citing only the first three of Jevons' axioms. (BIS, 2022a) Institutions like the St. Louis Federal Reserve, the Riksbank of Sweden, and the Bank of Canada cite only the first three functions of money in their public outreach publications, while conflating J2 and J4 in their explanatory texts. (Walla, 2020) (Riksbank, 2023) (Bank of Canada, 2020) The IMF has been inconsistent on this basic point, citing only Jevons' first three functions in its articles for the general public (e.g. Asmundson & Oner, 2012), even though all four functions appear in its online glossary. (IMF, 2022)

Such ‘scope retreat’ by central banking institutions, the inverse of ‘scope creep’, has both short-term and enduring implications for governments, industries, and households. When the ‘store of value’ function, crucial for accumulation [J2], is misconstrued as fostering stability [J4], yet genuine stability is neglected, this can result in uncertainty surrounding the future value of money, which disrupts investment and spending decisions made by businesses, households and governments, while ongoing accumulation, driven by distorted prices, culminates in asset bubbles. Conversely, when the stability-enabling ‘standard of value’ function [J4] is misinterpreted as facilitating accumulation [J2], yet actual accumulation is not effectively enabled, this can lead to economic stagnation due to reduced savings, increased debt, and limited investment opportunities.

Generally speaking, by conflating the distinct accumulation [J2] and stability [J4] functions, central banks undermine Money, and jeopardize both investment and stability. The complexity of the whole thing provides them effective cover.

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14 In my opinion, "consistency at any given time" and "consistency through time" are independent, as illustrated with an analogy.

1. If a person's statements within a conversation are related and don't contradict each other, they exhibit consistency at that time.
2. If a person can learn, then it is logical that some of their statements in later conversations may contradict their earlier statements, so long as the set of statements within any specific period don't contradict.

Reframing these observations in terms of monetary worth:

1a. Consistency throughout a market in the worth of a currency allows buyers and sellers to negotiate numeric prices without contradictions caused by inconsistencies in the currency's value at that time.

2a. As an economy evolves, yet the worth of the currency used to express numeric prices remains stable in relation to the evolving fundamentals, then even though the currency's worth exhibits consistency within any specific period, it is logical for the prices of various goods, services, assets, and permissions to change.

15 It is noteworthy that the US Corporate Finance Institute (CFI), which trains finance and banking professionals, clearly explains all four functions in its article *Functions of Money*. (CFI, 2015)

## Response (b): Replace Central Banks with Currency Boards

Some economists respond to the Jevons-Mundell-Fleming Inferable Paradox by electing to sacrifice monetary autonomy in order to prioritize fixed exchange rates. A ‘currency board’ model is the opposite of an autonomous central bank model.<sup>16</sup>

A currency board is a system that displays fixed exchange rates determined by an established rule, as if on a bulletin board or notice board, to inform all buyers and sellers of the worth of the currency in terms of a reference unit ‘anchor’. The anchor could be one or more other currencies; one or more financial instruments; or one or more commodities. The currency is freely convertible to and from this anchor at any time, which means the amount of currency issued must be fully backed by reserves of the anchor. (Hanke, 2002) (Ghosh, 1998)

Currency boards have been put in place in a small number of countries to anchor their national currencies to the US dollar or to the Euro.<sup>17</sup> (Kovacevic, 2003) A currency board operates with passive rules and does not possess the discretionary powers of central banks. It is unable to alter its currency’s exchange rate to pursue policy objectives, nor can it issue new funds without increasing reserves of the anchor. It cannot provide loans to the government, nor bail out financial institutions in times of crisis. These intended ‘features’ are why few politicians or central bankers have adopted this model—a currency board would eliminate their monetary policy autonomy and flexibility. (Hawkins & Masson, 2003)

There have been many proposals over the years to reframe elements of the currency board concept from the individual country context to a comprehensive and stress-managed multilateral arrangement. This would require an anchor that is not just another currency. Keynes used the phrase “*currency union*” to refer to his internationalization of the “*currency board*” concept in various memoranda written in 1941. The essential characteristics were the same.<sup>18</sup> Having considered various referents, he proposed that it

16 The antithetical nature of a ‘*currency board*’ versus a central bank ‘*board of governors*’ was emphasized in 1967 by John Hicks:

“On strict Ricardian principles, there should have been no need for Central Banks. A Currency Board, working on a rule, should have been enough; but in fact, during this period, there was a growth of Central Banks. There was quite odd double-talk about it. The Bank of England itself was supposed to be Ricardianized by the Bank Charter Act of 1844, which divided it into an Issue Department, that was just to be a Currency Board, and a Banking Department that was to differ little from an ordinary bank. But that was not in fact what happened. The Banking Department became a Central Bank, which, at least to a limited extent, did exercise monetary policy. It had to be cautious about it, since it was not in accordance with official doctrine that it should do so. I think nevertheless that there is no doubt that that is what it did. This was indeed an odd situation; why did it persist? I think it suited the bankers very well to represent themselves, and even to think of themselves, as passive—just keeping to the ‘rules’. For if it had been suspected that they were actively controlling, people would have asked: what right have they to control? Their actions are affecting everyone, affecting everyone (on occasion) very deeply. What right have they, who have not come up through the regular channels of democratic government, to arrogate to themselves such power? So it was useful to them to keep a screen in front of them. Once it was suspected that they were exercising control, their right to control was bound to be called in question. And so, in the end, it proved. ... That Anti-Banker revolution was one aspect of the ‘Keynesian Revolution’ as it worked out in practice.” (Hicks, 1967, p. 168)

17 About a dozen countries operate their currencies through currency boards, most anchored to the US dollar, a few to the Euro. The largest country to implement a currency board has been Argentina (1991-2001) However that system collapsed after just a decade. The failure has been attributed to the US dollar being an inappropriate anchor currency, as it was too small a proportion of Argentina’s trade profile. Increases in the international worth of the dollar led to major distortions in pricing throughout the Argentinian economy. An equally significant reason given for the failure was the government’s many fiscal workarounds to the ‘*live within your means*’ discipline that a currency board presumes. (Bleaney, 2004)

18 Some of the characteristics of a *currency board* are underlined below in Keynes’ description of a *currency union*:  
 “Each national currency to have a fixed value (subject to what follows about provisions for change) determined when the Currency Union is set up in terms of the bank money of the Clearing Bank, which would be itself expressed in terms of a unit of gold.” ... “In only one important respect must an International Bank differ from the model suitable to a national bank within a closed system, namely that much more must be settled by rules and by general principles agreed beforehand and much less by day-to-day discretion.” ... “The fundamental provision of the scheme is the establishment of a Currency Union based on international bank-money, called (let us say), bancor, fixed (but not unalterable) in terms of gold and accepted as the equivalent of gold by the British Commonwealth and the United States and all members of the Union for the purpose of settling international balances. The central banks of all member states (and also of non-members) would keep accounts with an International Clearing Bank through which they would be entitled to settle their exchange balances with one another at their par value as defined in terms of bancor. (Keynes, 1941 (1980), pp. 34, 45, 72; Emphasis added)

In Keynes’s plan, the value of exports of a country would generate new bancors in their ICB account, whereas imports would subtract bancors from their account. These would be maintained within policy boundaries to prevent an excessive

be anchored to gold which he named the ‘bancor’—evidently a multilingual play on words (*banco*:bank, *cor*:heart or:gold, *bancor*:anchor). Other prominent economists have proposed international anchors in terms of a ‘basket’ of primary commodities,<sup>19</sup> financial instruments (Coats, 2011) (Coats, 2015) and equities (Engels, 1982) (Brown & Pringle, 2022).

In any multilateral arrangement, to determine the relative values of the various currencies is more complex than to determine absolute purchasing power within individual countries. An anchor basket combining multiple currencies, securities or commodities requires that weights be assigned to each component based on its importance, stability, and other characteristics. Occasional re-balancing of these weights would be needed to account for changes in these factors in each economy over time and across regions. This entails a governance structure, ongoing auditable analyses, quarterly multilateral negotiation, and ‘discretionary’ accommodations—not much like a currency board, and more akin to the coordination and cooperation undertaken through institutions such as the Bank for International Settlements and the International Monetary Fund.

### **Response (c): Recast Jevons’ Axioms as Suggestions**

Reframing Jevons’ *axioms* to the status of *suggestions* liberates one to assert that Money can be whatever a community of people choose to design and use for payments. The first step on this path is to invoke the intellectual weight of philosopher David Hume, who explained:

“Money is not, properly speaking, one of the subjects of commerce; but only the instrument which men have agreed upon to facilitate the exchange of one commodity for another. It is none of the wheels of trade : It is the oil which renders the motion of the wheels more smooth and easy. ... Money having chiefly a fictitious value (i.e. arising from the agreement and convention of men), the greater or less plenty of it is of no consequence, if we consider a nation within itself; and the quantity of specie, when once fixed, though ever so large, has no other effect, than to oblige every one to tell out a greater number of those shining bits of metal, for clothes, furniture or equipage, without increasing any one convenience of life.” (Rotwein, 1955, ‘Of Money’ p. 33; ‘Of Interest, p. 48)

One may then strengthen this perspective with Thomas Kuhn’s *Structure of Scientific Revolutions*, in which he describes a ‘*paradigm*’ as a shared cognitive framework of interpretation, explanation, validation and expectation that affords a society a degree of underlying consensus about structures, processes, know-how and rules that guide behaviour and shape the future, (Kuhn, 1962), albeit without any particular normative direction. (Feyerabend, 1970, p. 200) Additional conceptual rigour can be found in Charles Taylor’s work formalizing the ‘*social imaginary*’ as a shared understanding across a large population, or a whole society, which enables common practices and enhances them with a sense of legitimacy. (Taylor, 2004) (Strauss, 2006)

Eventually along this route, one arrives to the post-modern ‘*simulacrum*’, defined by Jean Baudrillard as an imaginary commodity that seems real enough. While familiar, it is “a copy without an original”. (Baudrillard,

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trade surplus or trade deficit, and also these policy boundaries would be proportional to a country’s share of world trade. Beyond the policy boundaries, a trade deficit country’s currency would be lowered in value relative to the bancor and to other currencies; while an excess trade surplus would cause the relative value of that country’s currency to be increased.

19 Many monetary economists have sought to design a workable method to anchor currency units to primary commodities. Prominent contributors to this effort in the past century included Dutch economists Jan Goudriaan (1932) and Jan Tinbergen (Kaldor et al., 1964), Americans Ben Graham (1937, 1944), Frank Graham (1942), Albert Hart (1976) and Paul Volker (according to Arthur Laffer and Charles Kadlec (1982)), Austrian Frederick Hayek (1943), Jean de Largentaye (J. de Largentaye, 1967) (H. de Largentaye, 2023) in France, as well as Nicolas Kaldor et.al. (1964) and to some extent John Maynard Keynes (Keynes, 1944) in the UK (summarized and updated by Leanne Ussher (2009, 2016). The ‘tabular standard’ foundations for these European designs were laid in the previous century by British economist W. Stanley Jevons (1876), who traced the roots of his own concept to the description of a primary commodity index to guide money that was proposed by British Parliamentarian George Poulett-Scrope (1833), as well as to the earlier purchasing power index for money of Scottish economist Joseph Lowe (1822). The 18th Century French economist François Quesnay’s “Tableau Économique” (1758) was a type of tabular standard of economic value based on agricultural commodities.

2005) (Andrew Wernick, in Smith, 2010, p. 199) Conveniently, one imaginary leads to another.

Baudrillard describes money since the 1970s, no longer grounded on tangible metals nor commodities, as characterized entirely by “the floating and generalized convertibility of currencies amongst themselves”.<sup>20</sup> (Baudrillard, 2016, pp. 22–23) Money becomes a sort of financial instrument barter (fib) arrangement that ‘exists’ because it works virtually in peoples’ minds.<sup>21</sup> In this monetary framework, currencies are ‘derivatives’ of other derivative currencies, amidst a self-fulfilling network of higher order “successive simulacra”. (Baudrillard, 2001, pp. 120–121, 135) Michel Foucault describes this view of money in his ‘*Lectures on the Will to Know*’:

“At this point, money ... should be understood as a fixed series of superimposed substitutions... These substitutions are superimposed on and replace each other. This is the simulacrum: real operations, indefinite series—creating fixation (not representation). Whereas the sign ‘represents’, the simulacrum replaces one substitution for another.” (Foucault, 2013, p. 141).

As money, banking, finance and payments proceed along this route: “All that we see or seem, Is but a dream within a dream.” (Poe, 1849) The monetary paradox we inferred from the Mundell-Fleming trilemma in conjunction with Jevons' core functions is rendered no longer a problem.<sup>22</sup>

### **Response (d): Root Monetary Worth in Co-Determinants of Supply and Demand**

Jevons' four axioms constitute the essence of Money—they are not policy suggestions. Any well-conceived monetary framework ensures the integrity and effectiveness of Money in its full sense.

The “standard of value” function [J4] requires stabilization through time, but this does not mean it must be static. The requirement can be met with a sort of ‘walking base’<sup>23</sup> which moves slowly and predictably. Such responsiveness would let currency exchange values and purchasing power respond dynamically but predictably to shifts tangible drivers of currency markets, in particular the underlying co-determinants of

<sup>20</sup> This is well illustrated in the *Bank for International Settlements Quarterly Review*

“The total value of all transactions involving the exchange of different currencies (spot transactions, forwards, swaps, and options) last year “averaged \$7.5 trillion per day in April 2022 – a volume 30 times greater than daily global GDP” (BIS, 2022b, p. 16)

“A typical day sees almost \$4 trillion in new FX [foreign exchange] swap contracts ... [while] the full attendant payment obligations arising from FX swaps are not reported on a balance sheet. ... In an FX swap, two parties exchange currencies (the spot leg) and agree to reverse the trade at a future date at a pre-agreed exchange rate (the forward leg). ... These FX derivatives create huge payment obligations. The BIS ... put the global total at \$97 trillion in mid-2022. Almost 90% involved the payment of US dollars. The total exceeded global GDP in 2021 (\$96 trillion) as well as outstanding global external portfolio investment (\$81 trillion) and international bank claims (\$40 trillion) at end-2021.” (BIS, 2023, p. 17, 19)

<sup>21</sup> Coincidentally while writing this paragraph, the following text arrived to my Inbox via the *Blockworks Newsletter*:

“Money ... is imaginary—a shared fiction that only exists in our collective consciousness. But it’s important that we all act as if that fiction is real because, without the shared belief in some means of exchange, how would we coordinate economic activity? Metallic coins, for example, are subject to gravity, but it’s only our collective imagination (i.e. social consensus) that makes them money—metal is real, but money is not. What, then, should we collectively imagine about crypto? It’s good to use your imagination. There’s an argument to be made that code is the one exception to the gravity rule. Code exists as bits recorded magnetically or electronically on physical hardware and, in moving around, those bits are subject to the laws of physics (like gravity). ... Crypto protocols, however, are more than just code. ... A protocol’s code might run on its own, but the protocol itself won’t function unless all of the people involved believe that protocols are real. ... It may be strictly correct to say that a protocol is just an accounting exercise or that blockchains cannot have a perspective, but if we don’t think about them as being real entities, we won’t ever get whatever it is we’re hoping they create. ... But this is more than just a mental exercise. To cooperate on a large scale we need a shared sense of identity, which, per Leo Ferre, requires a shared belief in history, even if it’s wrong. ... Similarly, for crypto to make any sense—and achieve any of the things we hope it achieves — we have to believe that protocols are real, too. Even if they’re not.” (Gilliam, 2023)

<sup>22</sup> It has been said that the post-modernist ‘mind-over-matter’ quip becomes: “*If you don’t mind, it doesn’t matter!*”.

<sup>23</sup> The metaphorical pun used here, though not from established scholarship, offers a useful way to imagine the proposed method. An improvisational jazz musician playing a ‘walking bass’ responds dynamically to the emerging melodic and rhythmic elements contributed by the other band members, without being rigidly tied to the melody or to any particular pattern. The bassist provides a confident step-wise progression of notes moving across the lower octaves, incorporating various off-beat rhythms, rests, dissonant notes, and a variety of other stylistic elements, to create a cohesive, harmonic sound. (Friedland, 1995)

supply and demand for goods, services and infrastructure.<sup>24</sup>

Table 2 summarizes generally how an auxiliary ‘walking base’ could support both policy-oriented ‘board of governors’ monetary systems, and rule-oriented ‘currency board’ systems.

Such a method would enable trilemma-bounded economists who prefer unrestricted cross-border capital flows, and domestic control of money supply and lending rates, to leave exchange rates to self-adjust to the co-determinants of market supply and demand in a predictable, consistent and transparent manner. Exchange rate flexibility no longer implies volatility. Economists who reject the assumptions of the trilemma would also find relief from the notional constraints it has imposed for a half century on monetary discourse, theory, and practice.

Table 2: An auxiliary ‘walking base’ could operate with central bank or currency board frameworks

<b>Framework</b>	<b>Incumbent ‘Floating’ Method</b>	<b>+ Auxiliary ‘Walking Base’ Method</b>
<p><b>Central Bank Money-of-Account</b> <i>A rudder to actively steer</i></p>	Central banks let <u>exchange rates</u> fluctuate in response to supply and demand for each currency, and attempt to <i>steer</i> changes in <u>purchasing power</u> in alignment to a target set of reference policies.	Supply and demand for each currency are influenced by relative shifts in the productive capacity of primary infrastructure in their respective currency zones, affecting market <u>exchange rates</u> and <u>purchasing power</u> .
<p><b>Currency Board Money-of-Account</b> <i>An anchor to passively prevent drift</i></p>	Currency boards <i>anchor</i> <u>exchange rates</u> to one or a set of reference currencies. This causes <u>purchasing power</u> of all currencies to track supply and demand dynamics within the reference currency zone(s).	Market <u>exchange rate</u> and <u>purchasing power</u> of the domestic and reference currencies adapt to relative shifts in the primary infrastructural capacity to produce commodities within their respective currency zones.

## 6. A Framework for Sound Money

The Earth Reserve Assurance (ERA) framework offers an incremental path to a more efficient and effective system of worth for currencies, embodying all four of Jevons’ core functions. Instead of rigid stability or volatile fluctuation, this design has a ‘walking base’ that enables the relative values of currencies to migrate with gradual shifts in the capacity for primary commodity production in each currency zone, as a percentage shift from the most recent base year, to the relative to ‘best’ and ‘worst’ case scenarios.<sup>25</sup>

24 In “*The Case for Flexible Exchange Rates*” Milton Friedman advised the United States Economic Cooperation Administration to pursue a method that would enable exchange rates to adapt to underlying economic change without volatility. He opposed rigid rates because they would exacerbate the eventual, inevitable corrections:

“I should perhaps emphasize two points to avoid misunderstanding. First, advocacy of flexible exchange rates is not equivalent to advocacy of unstable exchange rates. The ultimate objective is a world in which exchange rates, while free to vary, are in fact highly stable. Instability of exchange rates is a symptom of instability in the underlying economic structure. Elimination of this symptom by administrative freezing of exchange rates cures none of the underlying difficulties and only makes adjustment to them more painful.” (Friedman, 1953, p. 158)

25 The technical methods employed for the Earth Reserve Assurance framework (Potvin, Forthcoming 2024) are beyond the scope of this paper, but it will be useful to provide a summary. The multivariate Earth Reserve Index (ERi) employs a diverse set of globally standardized and independently verifiable bio-geophysical indicators of change in long-term ecosystem integrity across all four ‘core realms’ (terrestrial, marine, freshwater and subterranean) of IUCN’s Global Ecosystem Typology, as well as some of the more complex ‘Transitional Realms’. (Keith et al., 2022) Satellite data can be used to interpret 50-year trends and anomalies of temperature, vegetation vigor, biomass density, soil metabolism, soil depth, soil moisture, water turbidity, and many other factors. (e.g. NASA, 2013) The index compares each present quantitative indicator in its original units of measure to a base year, and also to realistic ‘best’ and ‘worst’ scenarios within each ecosystem. (Inevitably, normative considerations are both scientifically and socio-economically determined). A mandatory criterion for indicator selection is that the raw data can be independently validated from free public sources (e.g. NASA Landsat, ESA Sentinel satellite data), or that the synthesized data, such as for estimates of recoverable reserves, are published in freely-available submissions to regulators by publicly traded and independently audited mining and energy companies. All data used for the ERi must allow for reproduction, adaptation and redistribution by anyone via 100% free/libre/open licensing. The Generalized Earth Reserve Index of a Currency (GenERiC) is derived from the distribution of changes in the selected indicators, geographically weighted by invoicing currency data during the same period (i.e. the currency in which a transaction is actually paid). (Boz et al., 2020) This method associates the volume of use of each currency with observed and verifiable biogeophysical changes in ecosystem integrity and resource availability data. This correlation provides the basis for the GenERiC ‘walking base’ Money-of-Account’ without the implication or assumption of causality.

The ERA framework involves two operational parts: an auxiliary Money-of-Account function for each currency; and a subset of each Money-in-Trade currency. This is a market-driven incremental initiative designed to be achieved through *decentralized* initiative and *distributed* resources, involving autonomous self-selected and differentiated corporations and communities, large and small, across for-profit, not-for-profit, and regional governance entities. There is also a well-defined and feasible role within the parameters of existing law, to which central banks and national governments are invited. The practical elements are summarize below in *Annex 1: An Operational Summary of GenERiC and ERA Deposit Receipts based on the Earth Reserve Assurance (ERA) Specification*.

The purpose of this unconventional 'grassroots' and step-wise approach to monetary system revision is to provide a gradual, non-disruptive path for experimentation, reflection, discussion and adjustment. The design is intended to conform with the existing laws of each jurisdiction, and to proceed in full view of its central bank which holds the constitutional prerogative for operating, regulating and controlling their respective monetary and financial systems, as well as government policy-makers and securities regulators.

One would expect that the change of a monetary anchor or supply rule at a national or international level should involve a scheduled shift from old to now at a point in time. However it is unlikely that a Bretton Woods-style global agreement will emerge in the near or medium future. The political climate of the 2020s, as deeply polarized as it was in the 1930s, is also more decentralized and complex. Also, a disruptive shock in financial markets, driven by chaotic forces that are detached from tangible trade in goods, services and infrastructure would involve too much risk now that they have ventured into a trillionsque dimension. Any major system correction will need to be incremental, and should include an extended period of coherent parallel operation of the incumbent scheme with the new auxiliary methods.

It can be useful to consider monetary and payments systems as a special class of data storage and transmission network. The decentralized, distributed path by which 'The TCP/IP Internet' emerged, developed and proliferated (as opposed to "The Internet that Wasn't" (Russell, 2013)) provides a useful model. The Internet we have had reflects principles and standardized infrastructures that foster direct, indirect and even unconnected or inadvertent collaboration among disparate parties spanning cultures and ideologies, pursuing loosely complementary objectives, due to interdependent concepts and methods.

Gradual implementation of ERA through existing currencies accommodates the evident global shift towards diversification of Money-in-Trade, as it is a multi-currency system with no requirement for a central reference unit. The valuation methodology compares each currency zone's own capacity for the production of primary commodities to itself in a base year, and to other currency zones, through time, relative to 'best' and 'worst' case scenarios.

## **7. An Auxiliary "Money-of-Account" for Any Currency**

A simple method has been designed to incrementally retrofit any existing Money-in-Trade currency with an auxiliary 'walking base' Money-of-Account. This approach generalizes the ancient Sumerian method of seasonally re-calibrating the proportion of Money-in-Trade silver to Money-of-Account barley in response to changes in yield of the region's barley fields. The present design instead adjusts to changes in the underlying productive capacity of the currency zone's ecosystems. Our approach also resembles the general intent of the Hungarian AK, although again, generalizing from agricultural and forestry lands to all ecosystems of the currency zone. The ERA design also differs from these two systems in that it is not an institutionally mandated or managed arrangement under a specialized set of laws. Instead, the ERA design puts forward a decentralized, market-driven initiative among for-profit, not-for-profit and local or regional governmental entities, operating under existing conventional securities and contract law.

To initiate ERA Money-of-Account operations, communities of various types—perhaps characterized by factors such as region, supply chain, industry, or culture—self-organize through a contractual agreement, each signatory on par with all other signatories<sup>26</sup> to store a specified amount of conventional banknotes of their intended currency(ies) in physical ‘warehouses’. The facilities can be any secure retail vault or safe deposit service, overseen by any notary retained by the community(ies) of participants. Durable deposit receipts for these stored banknotes, in the form of specialized steel tags,<sup>27</sup> bear an alphanumeric code that refers to the registry where the serial numbers of the banknotes are recorded along with their current ownership. Upon startup, the value of each deposit receipt related to a set of stored banknotes is *at par* with the face-value of the floating Money-in-Trade, but this will diverge because the warehouse receipt’s value is thereafter anchored to the Earth Reserve Index of the Currency (ERiC). This remains in effect so long as those banknotes are stored in the designated warehouse.

The historical and ongoing significance of the most common grains—wheat, rice, corn, barley and sorghum, is relied upon to provide workable default reference for the cash amount to be stored by each participant. The face value amount of the deposited banknotes is arbitrarily set to the price of 1 metric tonne of grain, composed of 1/2 tonne of each of the two most-traded grains (by tonnage from among the global top five grains) in the currency-issuing jurisdiction, averaging the most recently published 5-year price data, in domestic currency, obtained from the largest-volume commodity exchange in that country. Once the initial amounts of cash are stored in a warehouse under the signed terms and conditions, at any subsequent date the cash amount to be stored in any warehouse by any participants agreeing to the same contract for that currency is determined as the price of 1 metric tonne of grain (1/2 tonne of the top two grains in the country) on the present date of deposit, multiplied by the Earth Reserve Index of the Currency (ERiC) from the start date to that present. This ensures equivalency with the worth of the earliest deposits which will have been attached to changes in ecological productive capacity throughout that currency zone relative to the starting date.

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26 The ERA Experimentation Framework Agreement Version 1.0.0 provides the basis for each participant to sign an ‘Accession Letter’ to the framework agreement. Together this comprises a contract between each signatory and all other signatories. The template texts of the framework agreement and the accession letter are annexes to the Earth Reserve Assurance (ERA) Specification (Potvin, Forthcoming 2024) (Potvin, 2019). In addition to conformance with the existing laws of each jurisdiction, the proposed rule set for this method is detailed in the as well as the

27 It is sufficient here to outline how this method can be deployed with physical artifacts and records, all of which can optionally be reproduced with current and emerging electronic methods, although resilience principles require that these cannot solely exist in electronic form. The ERA Specification makes use of the Data With Direction Specification (DWDS) for an Internet of Rules (IoR) (Potvin, 2023) but also requires building a physical offline mode, to ensure that any electronic implementation is backed by comprehensive disaster-recovery to the point of being able to fully re-create electronic records and functions from physical archives and artifacts. To illustrate, ERA relies on IPFS to store the ERA ownership registry lookup table in a decentralized, distributed way, across many networked computers. This does not depend upon a single organization, and anyone can download the registry in order to save or print a whole or partial electronic or printed paper snapshot in time. This accessibility creates a useful secondary market for distributed massively redundant electronic and paper copies for validation, as well as for decentralized reconstruction of the registry’s data in the event of a catastrophic global electronic system failure (e.g. due to a large solar flare). Similarly the GenERiC-dr and ERA-dr designs would operate equivalently as physical tokens in a warehouse or electronic warehouse receipts in a data warehouse (UNCITRAL, 2017) (UNCITRAL, 2019). The ERA team is considering the adaptation of Open ID Connect and OAuth 2.0 Token standards (Jones et al., 2020) as well as re-purposing the Federated Authentication for the Registration Data Access Protocol (RDAP). (Hollenbeck, 2022) Although RDAP was designed by the Internet Corporation for Assigned Names and Numbers (ICANN) and the Internet Engineering Task Force (IETF) for accessing registration data associated with domain names, IP addresses, and related Internet Protocol resources, its design logic may be repurposed into a greater variety of use cases for data transmission between registries and applications.

When cash is being placed in a warehouse under an ERA agreement, a notary arranges for a manufacturer to instantiate<sup>28</sup> the correct number of metal deposit receipts,<sup>29</sup> referred to as ‘Generalized Earth Reserve Indexed Currency Deposit Receipts’, or “GenERiC-dr”<sup>30</sup> and then creates an ownership entry in a decentralized online registry. (The steps are further outlined on Annex 1; and will be fully detailed in the ERA Specification. (Potvin, Forthcoming 2024)) The registry entry includes the relevant 3-letter currency code of the banknotes, their face values and serial numbers, the two unique identifiers of each metal deposit receipt, and the present owner.<sup>31</sup> (Anonymity as an option depends on the laws of the jurisdiction(s) involved.) A mutual contract among all holders of GenERiC deposit receipts stipulates that their worth is attached to the primary productive capacity of ecosystems throughout the geographical currency zone, relative to the most recent base year, and relative to ‘best’ and ‘worst’ case scenarios.

The GenERiC-dr have a potential utility that is much broader than serving only as a direct record for the warehoused banknotes. As negotiable financial instruments they take on a Money-of-Account role for that currency, tied to changes in the primary productive capacity of ecosystems for the given currency zone. Even without wide deployment, a small number of GenERiC-dr could serve as a general benchmark for third-party contracts in the given currency. They represent the stable monetary worth of the particular currency, within and among regions, at any given time and through time, relative to the ecological co-determinants that underly economic activity in that currency zone. Since the future relative value of the GenERiC-dr in terms of floating currency remains uncertain relative to the general floating currency, it will be considered a type of ‘unregulated cash security’ from a legal perspective.<sup>32</sup>

Similarly to any other banknotes that are considered by some to be ‘collectible’, the effective market value of the GenERiC-warehoused banknotes will seem to deviate from the printed face values of normally-circulating cash that is subject to inflation or deflation. However, it is not the grounded Money-of-Account that rises and falls in tangible worth; it is the floating Money-in-Trade that falls and rises.

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28 The term "instantiate" is borrowed from the domain of computer programming, where it means to create an instance of an object based on a class or a template, including allocation of memory space and initializing its value, which can then be used to access its properties and methods. In our present context instantiate means to create instances of GenERiC-dr and ERA-dr that are conformant to the ERA Specification, then adding them to the registry to initialize their value, so they can be used in the market.

29 See footnotes 36 and 46.

30 The deposit receipts are referred to in some documentation with the following set of symbols:  $\text{[ ]}[\text{ }]\oplus$ . This indicates a receipt  $\text{[ ]}$  for warehoused currency  $[\text{ }]$  anchored to the Earth’s productive capacity  $\oplus$ . This uses the astronomical sign for Planet Earth  $\oplus$  (NASA, 2018) (Unicode Consortium, 2010) and the generic currency sign  $\text{[ ]}$  (Unicode Consortium, 1993b). When placed in square brackets here  $[\text{ }]$ , we refer to the warehoused subset in general. When referring to Generalized Earth Reserve Indexed Currency Deposit Receipts issued as particular banknotes are put in a warehouse, the ERA Specification employs square brackets around the three-letter codes for that currency, as specified through the International Organization for Standardization, (ISO, 2015) such as [EUR]; [USD]; [BRL] or [AED].

31 Whether or not ownership can be anonymous depends on the laws applicable in the jurisdictions of both the owner and the notary. Where laws allow anonymity, the owner’s identity can be replaced by a unique sequence of letters and digits.

32 Unintentionally the present design falls methodologically beyond the scope of guidance concerning stablecoins” and “commodity-linked tokens”. The regulatory scope ought to widen For example, the UK Treasury stated recently:

“As defined in the *Consultation on the Future Financial Services Regulatory Framework for Cryptoassets*, fiat-backed stablecoins include stablecoins that seek to maintain a stabilized value of the cryptoasset by reference to, and which may include the holding of, one or more specified fiat currencies. ... Other types of stablecoins (for instance, non-fiat backed stablecoins) or unbacked cryptoassets will still be allowed to be used in payment chains, but these transactions will remain unregulated. This is because HM Treasury judges that they are currently unsuitable for use in regulated payments. ... This definition [of fiat-backed stablecoins] does not include commodity-linked tokens, which share characteristics and risks with unbacked cryptoassets. There are established regulatory structures to accommodate products which provide entry into the market for commodities or other assets. If a commodity-linked token meets the definition of a specified investment or the arrangements relating to the token meet the definition of a collective investment scheme, it should for the most part continue to be regulated accordingly. However, custody of such tokens will no longer be regulated in the same way as other specified investments and will instead be in scope of the new regulated activity for custody in phase 1 (please see below). If there are other commodity-linked tokens which do not meet these definitions, then activities relating to these tokens should be dealt with through the broader cryptoasset regime in phase 2. (Phase 1 concerns "the regulation of fiat-backed stablecoins" and Phase 2 concerns "the regulation of other activities in relation to cryptoassets." (UK Treasury, 2023, p. 6-10)



Ownership of each banknote stored in a GenERiC warehouse can be transferred to another individual or entity if its current owner gives physical custody of the deposit receipt to them, and through a notary updates the ownership title in the registry to name the new owner. Both steps are required, and with two-factor authentication, registry updates can be made highly efficient.

These warehouse receipts are negotiable financial instruments within the law, which can be traded for goods, services, assets and permissions, or swapped for other ones representing warehoused banknotes of other currencies. This would occur as a type of ‘barter’ market in which goods and services are exchanged for GenERiC-dr. Sales tax is typically not applicable to the sale or barter of regulated or unregulated over-the-counter securities, however it is applicable to barter transactions where the goods or services bartered are a normal offering of one's business.<sup>33</sup> The result is that sales tax would be the same for transactions conducted with cash, or with GenERiC-dr.

Through the GenERiC-dr, the effective worth of the stored Money-of-Account banknotes will diverge from that of conventional Money-in-Trade banknotes, so there will also emerge a speculative market and an arbitrage market for GenERiC-dr to be bought and sold with conventional circulating currency. These markets will strengthen rather than weaken the integrity of the ERA system as a whole, consistently with its design intent.

The Money-of-Account banknotes that are stored in a GenERiC warehouse can be reverted at any time to their prior role as circulating Money-in-Trade under the pre-existing valuation scheme. To do so, the bearer of the physical deposit receipt validates their ownership to a notary and presents the metal tag. The notary archives the registry record corresponding to this tag and to the serial numbers of the associated banknotes, removes those particular banknotes from the warehouse, supplies them to the client, and destroys the metal tag. At that point the deemed worth of those banknotes immediately reverts to the conventional Money-in-Trade value which resulted from whatever net international foreign exchange and domestic inflation/deflation changes had occurred since they were stored in the warehouse. Whether the removal of banknotes from a GenERiC warehouse will be experienced as a gain or a loss for their owner will depend on the degree to which the ecosystems of the currency zone have been enhanced or degraded during the period of storage. If the GenERiC-dr is worth more than the face value of the warehoused banknotes, then removing them from the warehouse is tantamount to putting rare ‘collectable’ banknotes into one’s wallet for use at their conventional printed face value.

The GenERiC-dr method is designed to strengthen any monetary system's functional conformance with Jevons’ axiomatic premises of archetypal “Money” in terms of trade [J1] as a well-structured physical "medium of exchange"; accumulation [J2] as a "store of value"; quantification [J3] as a "common measure of value" and stability [J4] as a "standard for value" through time. This auxiliary Money-of-Account method establishes a practical way to conserve the worth of existing currency, but it does not offer a way to instantiate new currency. This second objective is addressed in the next section.

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33 The ERA Specification incorporates a positive role for taxation, although the specific tax mechanisms and rates are to be determined by each jurisdiction. The overarching rationale for taxation in the context of ERA is that corporations and communities directly and indirectly involved in the ERA-dr market rely on well-structured legal frameworks and functioning justice systems administered by governments. Operationally as well, taxation of ERA operations should in principle cover the additional public sector administration costs associated with legal and policy analysis, regulation, enforcement, and communications, in addition to the central bank's technical validation of ERA-dr prospectus claims, ERA-dr redemptions expenses, ERA-dr reselling operations, and overall systemic risk management associated with public sector participation in introducing and operating this system. Ultimately this is analogous to how private sector financial institutions and management firms cover their operating costs through service fees.

## 8. A Sound “Money-in-Trade” Extension of Any Currency

Earth Reserve Assurance Deposit Receipts (ERA-dr)<sup>34</sup> offer central banks a method to inject new sound money into their economies when needed, based upon strengthening the ecological co-determinants of primary commodity supply within their geographic currency zone. This involves an equitable allocation of special-series banknotes towards corporations and communities (for-profit, not-for-profit and governmental) that have verifiably enhanced (in effect, “made a deposit to”) the long-term availability of primary commodities in the market.<sup>35</sup>

Both the GenERiC-dr and ERA-dr, although novel in their purposes, are intended to be functionally aligned to the forthcoming “Model Law on Warehouse Receipts”<sup>36</sup> of the United Nations Commission on International Trade Law, and of the International Institute for the Unification of Private Law. (UNCITRAL, 2019) (Dubovec & Elias, 2017) In many sorts of agricultural and industrial storage systems, warehouse receipts are commonly issued, and they may persist as tradable instruments. The term ‘warehouse’ was used in a conventional sense for the GenERiC-dr for storing paper and polymer banknotes; however its meaning is stretched for the ERA-dr context, in two ways:

- Instead of describing a specific quantity and quality of a commodity that has been deposited into a built warehouse, an ERA-dr describes ‘deposits’ made to the primary productive capacity of the Earth. In this context, the Earth serves as a sort of ‘warehouse’. All types of deposit receipt are premised upon future delivery, however the conventional type refers to *a fixed amount that has been produced and stored for future delivery*, while the ERA-dr attests to the assurance of *a stream of commodities that can be produced for future delivery*.<sup>37</sup>
- Rather than being a *direct* claim on access to a fixed amount of stored commodities, an ERA-dr is an *indirect* claim on the benefits of functioning in an economy with enhanced primary commodity production capacity. However it is a *direct* claim on a potential cash redemption arising from an expectation that the central bank may eventually agree to attach part of its monetary expansion to validated increases in the capacity for producing primary commodities within its currency zone, because they strengthened the integrity of the economy and its monetary base.

ERA-dr can be instantiated by successfully restoring or strengthening ecosystem productive capacity, and then assuring that outcome for at least 200 years (seven generations). This duration may seem long, but in most counties it is typical of civil engineering design specifications for major built infrastructure investments (bridges, tunnels, undersea cables, dams, pipelines, sewers, critical water supplies, and

34 *Earth Reserve Assurance Deposit Receipts* are represented in the ERA Specification with the set of symbols: ☰[☷]⊕, in which the trigram symbol *k’un* ☷ (Unicode Consortium, 1993a) from the *I Ching* (Lauer, 1975) signifies to the dynamic self-organizing Gaia Earth. (Lovelock & Margulis, 1974) Placing ☷ between square brackets [☷] is intended here to represent a tangible ‘deposit’ towards physically restoring and assuring the natural primary productive capacity of Earth’s ecosystems.

35 Individual projects that tangibly enhance and assure into the future the ecological infrastructure, including in locations that inaccessible to the general population, and in other jurisdictions, have a ‘common pool’ aspect (Ostrom, 1990) with positive external effects for society as a whole. A hundred years ago Arthur Pigou introduced positive and negative external effects to formal economics as follows:

“Thus, as Sidgwick observes, “ it may easily happen that the benefits of a well-placed light-house must be largely enjoyed by ships on which no toll could be conveniently levied.” (Sidgwick, 1883, p. 406) Again, uncompensated services are rendered when resources are invested in private parks cities; for these, even though the public is not admitted to them, improve the air of the neighbourhood. The same thing is true—though here allowance should, be made for a detriment elsewhere—of resources invested in roads and tramways that increase the value of the adjoining land—except, indeed, where a special betterment rate, corresponding to the improvements they enjoy, is levied on the owners of this land. It is true, in like manner, of resources devoted to afforestation, since the beneficial effect on climate often extends beyond the borders of the estates owned by the person responsible for the forest. It is true also of resources invested in lamps erected at the doors of private houses, for these necessarily throw light also on the streets. It is true of resources devoted to the prevention of smoke from factory chimneys, for this smoke in large towns inflicts a heavy uncharged loss on the community, in injury to buildings and vegetables, expenses for washing clothes and cleaning rooms, expenses for the provision of extra artificial light, and in many other ways.” (Pigou, 1920, p. 160-161)

36 The UNCITRAL / UNIDROIT “Model Law on Warehouse Receipts” currently in draft:  
[https://uncitral.un.org/en/working\\_groups/1/warehousereceipts](https://uncitral.un.org/en/working_groups/1/warehousereceipts)

37 This derives from the rationale of an ancient proverb of diverse origins:

*“If you give them fish, you feed them for a day; if you teach them to fish, you feed them for a lifetime.”*

railways).<sup>38</sup> In addition to practical methods for physical resilience, there are legal and cultural means for achieving long-term assurance. The appropriate set of protections will depend on the context. Legal, contractual and administrative methods may include covenants, treaty-based declarations, keepwell clauses, maintenance agreements, tradable buy-back options, and long-term forward supply contracts.

There are innumerable potential project types that can contribute to long-term productive capacity for primary commodities in agriculture, forestry, fishing and aquaculture, surface and subsurface mining, electrical power, and related primary refinement. Some examples are:

#### *Renewable Commodities*

- Increased and assured depth and metabolic integrity of agricultural topsoil;
- Restored and assured inter-tidal shoreline habitat for shellfish;
- Expanded and assured tree cover through synergy with livestock grazing;
- Increased and assured long-term 'embodied exergy' of a forest area.<sup>39</sup>

#### *Exhaustible Commodities*

- 200-year optimized extraction rates, methods and undiscounted price models;
- Circular resource supply chains via tradable buy-back options in metal, mineral, and energy markets;
- More and cleaner energy per tonne of coal by converting from pulverized to gasified methods;
- Swap finite fuels with ammonia (NH<sub>3</sub>) made from electrolysis of seawater and nitrogen from the air.

Upon completing an ERA project, it is the project implementer's responsibility to demonstrate with freely-accessible data sources that they have significantly increased the ecosystem's long-term primary productive capacity; to provide a verifiable estimate of the aggregate undiscounted generative value added over the next 75 years,<sup>40</sup> and to reasonably, credibly assure that this improvement will be maintained for at least 200 years. As the issuer of a new ERA-dr set, the project implementer would assemble this documentation and monitoring plan as a "simplified prospectus".<sup>41</sup> In conformance with the Earth Reserve Assurance (ERA) Specification, the issuer would post the prospectus online via the Internet of Rules (IoR) (Potvin, 2023) on the IPFS distributed network. (Benet, 2021) This will generate a unique ContentID (CID) for this specific version of the prospectus.<sup>42</sup>

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38 This is also similar to the duration of copyright entitlement in most jurisdictions, for works from corporate entities.

39 'Exergy' is general-purpose method for measuring energy gradients (i.e. a difference), not to be confused with the term 'energy' itself (i.e. a sum). There is an extensive technical literature on the use of 'exergy' analysis in ecologically-sound economics, for example: (Wall, 1977) (Rocco, 2014) (Sousa et al., 2017) (Sciubba, 2019). This framework is very useful, although naturally it has limitations to keep in mind, for example: (Gaudreau et al., 2009).

40 No discount rate is applied to future years because the generative value added of project's outcome is the 75-year 'peace of mind' obtained in the present with the assurance of the real option value that the project secures for the future. Given that the reference case is that ecosystems within the currency zone shall have a comparable degree of primary productive capacity throughout the next 75 years as experienced at present. A discount rate of 0% simply means that 'we' today place our children's, grandchildren's, and the grandchildren of our grandchildren's supply and demand interests on a level of priority with our own. The rationale can be illustrated with a simple analogy. When a group of back-country hikers is setting out on a one-month journey through the mountains, they may send ahead by mail or courier a package of supplies to a particular warden's station where they expect to arrive in two weeks. (GDTA, 2023) There is no requirement that the cache grows during the period of storage. The hikers' only requirement is that their static cache of supplies remains intact quantitatively and qualitatively, and can be counted on to be available when needed in the future. This 'assurance' logic is intrinsic to Jevons' [J4] "standard of value".

41 A 'prospectus' is a formal legal document prepared by the issuer to provide comprehensive information about an investment opportunity so that potential investors can make well-informed decisions. According to the International Organization of Securities Commissions, a "simplified prospectus" is:

"[D]esigned to ensure that these documents are clear, concise, understandable and well-organized and contain the most important information that an investor would consider in making an investment decision. Investors should be encouraged to read and consider the contents of a simplified prospectus through the application of plain language principles and concise and standardized formats. (IOSCO, 2002, p. 2)

42 The Earth Reserve Assurance (ERA) Specification would have the set of project records structured into a set of [rule.dwd] and [lookup.dwd] files, indexed in a single [lookup.dwd] file, and published on the IPFS Internet (Benet, 2021) in accordance with the 'Data With Direction Specification' (DWDS). (Potvin, 2023)

Next, the issuer would conduct a so-called “shelf offering”<sup>43</sup> of 10% of their expected ERA-dr based on the undiscounted 75-year estimate. The values are to be expressed with reference to the Money-of-Account which is anchored to the ecosystems of the currency zone, since floating currency values are impossible to project on such a long time horizons. Anyone should be able to scrutinize the prospectus and its risk profile, and it is this wider market that validates any ERA-dr assertions.

The sale of any ERA-dr can be invoiced in either in GenERiC-dr Money-of-Account or floating currency Money-in-Trade.<sup>44</sup> Once contracts for 10% of the offering are signed, the market's view of the worth of this specific ERA-dr series is deemed reasonably well-established, and the issuer can complete that opening proportion of initial sales. They must then produce the remaining 90% quantity of standard-dimension ERA Deposit Receipts to cover the full 75-year generative value added to the Earth's productive capacity, calculated in terms of the grounded Money-of-Account for the same currency. The issuer is then in a position to offer the remaining 90% for sale in the regulated securities market, at any grounded Money-of-Account or floating Money-in-Trade price or pace they prefer.

It is the project implementer's responsibility to contract with a manufacturer capable of producing ERA-dr steel tags that meet the required technical specifications.<sup>45</sup> The ERA Specification calls for the proof-of-concept general market ERA-dr to be made as high-carbon steel tags to a precise ‘industrial design’ requirement.<sup>46</sup> They cannot be made of paper or polymer, and they must not be solely electronic,<sup>47</sup> as they must remain tradable for at least 75 years and persist in representing infrastructural assurances for 200-years. They must remain functional through disasters such as fire, flood, hurricane, informatic systems failure, or attack. Upon receiving the set of ERA-dr steel tags, the project implementer would have a notary update the online registry of ERA-dr ownership (optionally with anonymity if allowed by law), in a manner that facilitates offline and physical registry back-ups.

Previously it was explained why deployment of the Earth Reserve ‘walking base’ auxiliary Money-of-Account is positioned with an unconventional ‘grassroots’ market-led approach, relying on *decentralized* decision-making and *distributed* resources. Thus far, the description has portrayed central banks, national government policy-makers, and regulators as observing, assessing, potentially allowing as well as offering guidance to facilitate conformance with each jurisdiction's laws. Those are essentially reactive roles. There is one significant proactive action that central bankers and national government policy-makers are invited to

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43 A “shelf offering” is one in which the proponent files a registration statement with the securities regulator that puts a proportion of the securities “on the shelf” for future sale, without having to sell them all at once. The company can then offer additional securities to the market at one or more later dates. (IOSCO, 2001)

44 This is similar to the method by which agricultural land prices in Hungary are calculated with reference to Golden Crowns (Money-of-Account), but may be exchanged for Golden Crowns or Forints (Money-in-Trade).

45 The technical details are included in the Earth Reserve Assurance (ERA) Specification. (Potvin, 2024).

46 For multi-jurisdictional markets the ERA-dr and GenERiC-dr would be manufactured as 3-gram, 5-gram, 7.5-gram 10-gram, and 12.5-gram standardized steel tags with rounded corners. These would be made of a precise high-carbon steel-zinc alloy containing 97.5% iron, 2% carbon, 0.2% zinc and 0.3% nickel. These proportions in the steel would be verifiable using any hand-held x-ray fluorescence device. Each steel ERA-dr and GenERiC-dr would have a simple standardized design stamped on each side, like a coin, but their rectangular shape will help to ensure they are distinguishable from government-issued ‘coins’. Methods for supplementary electronic instantiations of warehouse receipts will change over periods of many decades and need not be detailed here or in the ERA Specification. When making a GenERiC-dr the manufacturer laser-engraves the front of each steel tag with the CID of a high-resolution image of the banknotes placed into the warehouse. For an ERA-dr the manufacturer laser-engraves the front of each steel tag with the CID of the simplified prospectus [lookup.dwd] file on the IPFS and Internet of Rules. For both the GenERiC-dr and ERA-dr, the manufacturer then publishes a high-resolution photo of the front of the steel tag on the IPFS network to obtain a second unique CID, which is then laser-engraved on the back of each steel tag. This procedure will result in GenERiC-dr and ERA-dr steel tags that are specific to each set of banknote and each prospectus.

47 See footnote 27.

undertake—if they agree that it is reasonable to attach the money supply to verifiable changes in the long-term capacity to produce primary commodities in their currency zone. Once any set of ERA-dr has demonstrated its market worth through the initial 10% sale, a supporting government agency or any certified assessment professional could review the prospectus, analyze the verifiable facts, and come to their own assessment of the undiscounted, aggregate 75-year generative value added in terms of the grounded Money-of-Account, as well as the related 200-year assurances upon which ERA-dr are premised. From these assessments a central bank or currency board could assemble a portfolio of validated ERA-dr assessments.

When the central bank deems it essential to inject additional money into the economy, for instance, in response to a recession, restricted credit, deflation, or increased demand for cash, they could redeem ERA-dr by making use of their existing laws, regulations, and procedures to create a special series of commemorative<sup>48</sup> banknotes.<sup>49</sup> These banknotes would express, both through their purpose and their graphic design, the significance of enhancements to, and long-term assurance of, the natural productive capacity of ecosystems throughout the currency zone.<sup>50</sup>

In the ERA framework, the total redemption amounts based on the undiscounted, aggregate 75-year generative value added, are intended to be substantial. These large injections of new money would go directly to the corporations and communities (for-profit, not-for-profit and governmental) that have tangibly strengthened the productive capacity of ecosystems in the currency zone, which is its basis of tangible supply. Commercial financial institutions would compete to provide recipients of these grounded banknotes the ability to exchange them for conventional floating currency at the going rates. Ongoing financial market trade in both the conventional floating currency and the special-series grounded currency would influence the volume and direction of currency swaps, hedging and speculation.

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48 There is an interesting connection between the words *commemorative* and *money*. In Proto-Indo-European linguistic research, the ancient spoken word *\*men* means “to think”. The form *\*mem-* found in *commemorative*, carries the meaning of “to remember”, which combined with the prefix *\*com-*, signifies “to remember together”, “to commemorate”. The causative form of *\*men*, meaning “to cause to think” or “to remind”, is the word *\*moneyo*, which provides the word “money” and its variants in many European languages. (Watkins, 2011, p. 2051)

49 In accordance with established legislation, collectible banknotes and coins have long been bought and sold based on criteria distinct from those applied in the primary currency markets. Otherwise conventional banknotes are traded, within the law, at values much higher than their face value due to official distinctions intended to make them commemorative, or arising from community-based interest in unique patterns in the serial numbers, rarity of a specific banknote series, historical significance, printing errors, and other notable distinctions. This dual pricing phenomenon arises from the coexistence of different valuation models, each with its own specialized criteria.

50 It is useful to consider a scenario in which central banks were to redeem the ERA-dr with conventional floating currency instead of the special series commemorative banknotes proposed here. They would need to perform in-house calculations of the relative worth of the fluctuating conventional currency in relation to the slowly-shifting grounded Money-of-Account. Occasional redemption and selling operations would impose temporary price floors and ceilings on ERA-dr trade, leading to subsequent abrupt market adjustments. For these reasons it would be enormously simpler and far more useful for central banks to redeem ERA-dr with a special series commemorative banknote that is also valued in reference to the grounded Money-of-Account, leaving market participants to perform their own relative valuation estimates.

With experimentation and adaptive refinement in various jurisdictions, the ERA framework can be introduced in monetary systems characterized by conventional central bank policy, constituting a proportion of central bank open market operations without being inflationary, or by currency board rules, substituting the usual fixed-rate foreign currency role with the ‘walking base’ GenERiC-dr Money-of-Account.<sup>51</sup> Either way, if this approach is gradually adopted, domestic purchasing power and cross-border exchange rates would increasingly adjust in a non-disruptive manner to relative and absolute shifts in the productive capacity of the ecosystems within each currency zone, compared with the most recent base year, and to the ‘best’ and ‘worst’ case scenarios. Economic activity will begin to adapt to changes in these fundamental co-determinants of supply and demand.

## 9. Conclusion and Further Design Research

Adapting some precedents from ancient and modern examples,<sup>52</sup> this paper introduces a novel approach to sound Money in the full sense of the term for trade, accumulation, quantification, and stability. It suggests a way to retrofit any currency in a multi-currency international system, without requiring a central reference unit of account.

Instead of expressing ecosystem productive capacity in terms of money, the Earth Reserve framework expresses money in terms of ecosystem productive capacity. The operational design has two parts.

- A simple method is described for storing and registering some otherwise conventional banknotes, whereupon a tradable warehouse receipt security would be introduced with its price contractually indexed to changes in the capacity of ecosystems within the currency zone to produce primary commodities, in comparison to the most recent base year, and relative to ‘best’ and ‘worst’ case scenarios.
- A second type of tradable deposit receipt security would be issued and entered into the registry by corporations and communities documenting projects that, in some way, have made independently-verifiable improvements to the primary productive capacity of ecosystems in their currency zones. In the course of normal central bank monetary management, or normal currency board operations, these deposit receipt securities are redeemable with special-series commemorative banknotes serving as Money-in-Trade valued to the Money-of-Account.

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51 An ERA currency board would issue GenERiC-dr at the posted rate based on deposits of conventional floating currency in a network of GenERiC warehouses. In this adapted design, GenERiC-dr is an indexed security that takes the place of the international reference currency (instead of USD, EUR, RMB or SDR). Participants place an amount of any floating currency equal to the 5-year average national price of the standard physical referent of grain (details above) into a GenERiC warehouse to serve as the ‘anchor asset’ (instead of a standard physical amount of gold). Then the price at which a GenERIC-dr is issued and redeemed in any given month is equal to the face value of those deposits of floating currency relating to the 1-tonne physical grain referent, multiplied by the Earth Reserve Index of that floating currency for that month. Arbitrage will keep the supply of GenERIC-dr in the market such that its price is the same as the anchor price. The first GenERiC-dr would be instantiated on par with the 5-year average price of 1 tonne of grain. But going forward, the published price in relation to the floating currency would shift slowly with changes in the productive capacity of ecosystems within the currency zone, relative to the most recent base year, and relative to ‘best’ and ‘worst’ case scenarios. In any given month the floating currency's purchasing power may equal, exceed, or fall below the GenERiC-dr anchor price. As mentioned, arbitrage would ensure that the market value of the floating currency will tend towards the GenERiC-dr anchor price, with market participants exchanging floating currency for GenERiC-dr when its purchasing power is above the anchor price, and vice versa when below. This design would not suffer the rigidity problem commonly associated with currency boards that fix the value of a domestic currency to the value of a major foreign currency.

52 A recap of the precedents drawn from ancient Sumer and present-day Hungary would be helpful. In the course of this paper, the barley fields of Sumer were generalized as the ecosystems of any currency zone; their clay tablets of cuneiform data on field productivity have been reframed to satellite remote sensing data revealing ecosystem trends; and their silver *gerahs*, *shekels* and *minas* here represent any Money-in-Trade currency. Hungary's Golden Crown (AK) has illustrated the linkage of monetary worth to agricultural land quality, stabilizing that sector during a tumultuous century of social, political, and economic changes. It supplies a partial model for maintaining an auxiliary Money-of-Account indexed to ecological infrastructure, alongside a country's fluctuating Money-in-Trade currency. The special significance of agricultural and forestry lands in Hungary has been broadened here to encompass all primary commodity sources across agriculture, forestry, fishing, aquaculture, hunting, gathering, as well as in the acquisition of metals, minerals, and energy gradients.

To the extent multiple countries gradually adopt this approach, their domestic purchasing power and international exchange rates would begin to reflect the relative and absolute shifts in the productive capacity of the ecosystems within their respective currency zones, from the most recent base year, compared with the ‘best’ and ‘worst’ case scenarios. Supply and demand shaping each economy will then gradually reflect and adapt to changes in the ecological co-determinants of economic activity.

This framework is designed for compatibility with existing currencies and institutions, respecting all jurisdictional prerogatives and regulatory requirements. It would commence on a limited and experimental basis, and with increasing formalization and rigour, and incrementally scale without discontinuity.

A working group organized on the basis of decentralized decision-making, distributed resources, and a culture of "rough consensus and running code" (Russell, 2006) would enable anyone involved in various self-governed ERA initiatives across diverse jurisdictions to learn and share insights as experimentation proceeds. A variety of approaches to data selection, processing, and agent-based modeling<sup>53</sup> would contribute to the required quantitative methods. Formal documentation is necessary for evaluation and constructive criticism among technical specialists, including regulators. Summary reports, videos, and interactive events would facilitate in-depth discussions with target audiences and the general public. For GenERiC-dr to be instantiated in the market, minimum viable currency warehouses must be operational; and, for ERA-dr to be brought forward, tangible projects that enhance local and regional ecosystems need to have demonstrated measurable outcomes. In preparation for regulatory review, the end-to-end production, registration, and trading of these securities would begin in a small-scale experimental mode, perhaps gamified in some way, and also the system at scale can be simulated in agent-based models.

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53 An “Economic Petri Dish” with user-defined supply chain lengths and other has been created to support comparative modelling of ERA and competing options. (Kelter, Potvin, et al., 2022) (Kelter, Wilensky, Potvin, 2022)

## **Annex 1: An Operational Summary of GenERiC and ERA Deposit Receipts based on the Earth Reserve Assurance (ERA) Specification**

### **1. Create a Grounded Money-of-Account from Floating Money-in-Trade**

#### **1.1 Corporations & Communities Store & Register Conventional Floating Money-in-Trade Currency**

##### *1.1.1 Charter Participants Calibrate Initial Warehouse Deposits of Floating Currency to Tangible Market Worth*

The initial amounts of a floating currency to be stored in ERA ‘warehouses’ are calibrated to cover the price of 1 tonne of grain with a composition of 1/2 tonne of each of the top two most-traded grains by weight, from among corn, wheat, rice, barley, and sorghum. This calibration is based on the most recent published 5-year average price data from the largest-volume commodity exchange of the country that issues this currency.

##### *1.1.2 Later Participants Apply the Earth Reserve Index of Currency (ERiC) to Determine the Size of All Subsequent Registered Deposits of the Same Floating Currency in a Participating Warehouse*

To determine the deposit amount required to issue 1 GenERiC-dr, multiply the value of an initial calibrated deposit of floating currency by the Earth Reserve Index of the Currency (ERiC). This adjustment accounts for the change in ecological productive capacity across the currency zone since the initial calibration for Charter Participants.

#### **1.2 Warehouse Notaries Issue Generalized Earth Reserve Indexed Currency Deposit Receipts (GenERiC-dr)**

##### *1.2.1 Warehouse Notaries Provide GenERiC-dr as Physical Records of Stored Currency*

The GenERiC-dr are rectangular, high-carbon steel-zinc alloy tags with a standard design, featuring an embossed 3-letter currency code in square brackets preceded by the generic currency symbol in square brackets [¤]. This indicates that they were issued based on a ‘deposit’ of the indicated currency into a warehouse. This can be any secure retail vault or safe deposit service, overseen by a notary. Each tag also has two unique identifiers (IPFS CID) laser-etched within recessed strips, one on the front and the other on the back. (The physical artifacts might be implementable in electronic form if ‘high resilience’ principles are adhered to, but they must not be solely electronic. The proof-of-concept system is being implemented mainly with physical artifacts.)

##### *1.2.2 Warehouse Notaries Log Each GenERiC-dr in a Distributed Decentralized Online Registry*

Each GenERiC-dr is entered into a distributed decentralized online registry with the 3-letter currency code, face values, serial numbers, both unique identifiers, and the present owner (anonymity depends on jurisdiction laws). Costs so far involve maintenance of the ERiC; vault and notary services, and deposit receipt production.

##### *1.2.3 Anyone Can Refer to GenERiC-dr as an Auxiliary Money-of-Account Reference in Sound Money Pricing*

Each GenERiC-dr serves as a grounded Money-of-Account valuation reference directly for the amount of floating Money-in-Trade currency deposited in the warehouse. It can also be used indirectly by anyone wishing to ground the valuation intent of any contract or transaction in the sound Money-of-Account of their particular currency of invoicing, in order to express stable absolute and relative worth within a given region, and among all regions, at a given time, and through time, relative to the underlying ecological co-determinants of economic worth. The inevitable divergence over time between the grounded GenERiC-dr Money-of-Account and the floating Money-in-Trade currency stored in the warehouse will be due to the instability of the stored currency. In terms of the floating currency, the GenERiC-dr value will seem to increase as ecosystems of the currency zone improve, and will seem to decrease as the ecosystems degrade. However, the grounded Money-of-Account itself does not rise and fall in tangible worth; it is the floating Money-in-Trade that falls and rises.

##### *1.2.4 The Worth of the GenERiC-dr can be Independently Validated*

To validate the present worth of 1 GenERiC-dr of a currency on any given date, the original currency calibration amount is multiplied by the Earth Reserve Index of this Currency (ERiC) of the same date. This is done in order to reflect the changes in ecological productive capacity across the currency zone since the initial calibration. The original amount is the published market price of 1 tonne of grain, consisting of a half a tonne each of the top two most-traded grains (chosen from corn, wheat, rice, barley and sorghum), using the 5-year average prices preceding the date of calibration, reported by the largest-volume commodity exchange of the issuing country.

##### *1.2.5 There is a Default Standing Invitation for Central Banks to Redeem Any Verifiable GenERiC-dr at Market Price*

The central bank of the country issuing the currency identified with the 3-letter code on a GenERiC-dr has a standing invitation to redeem this deposit receipt at the market price, in exchange for special-series commemorative banknotes anchored to the GenERiC Money-of-Account. It is always up to the owner of a GenERiC-dr to determine whether or not to redeem the security at the price offered by the central bank.



## **2. Enable Sound Money-in-Trade Based on a Grounded Money-of-Account**

### **2.1 Project Implementers Produce 10% of their ERA-dr Attestation of Verifiable Assured Outcomes**

Project implementers produce 10% of the physical ERA-dr that they attest as corroborated by the undiscounted, aggregate 75-year generative value added, which can be independently verified. These resemble GenERiC-dr, in the form of rectangular, high-carbon steel-zinc alloy tags with a standard design, and two unique ID's (IPFS CID) laser-etched within recessed strips, front and back. (A type of ERA-dr might be implementable in electronic form if 'high resilience' principles are adhered to, but they must not be solely electronic.) The observable difference of ERA-dr tags is that the embossed 3-letter currency code in square brackets is instead preceded by the *k'un* symbol for Earth in square brackets [≡] to indicate that this warehouse receipt was issued on the basis of a tangible 'deposit' towards restoring and assuring dynamic self-organizing ecosystems.

### **2.2 Project Implementers Test and Calibrate the Market Worth of Newly-Issued ERA-dr**

The issuer proceeds with the first tranche of a "shelf offering" of 10% of the planned ERA-dr based on their estimate of their undiscounted 75-year generative value-added. The ERA-dr price is expressed in conventional floating Money-in-Trade currency, as well as in the grounded GenERiC-dr Money-of-Account for the same currency. During this initial offering, the ERA-dr may only be sold for conventional floating currency indicated by the 3-letter code. All of the test-market and actual market ERA operations are deemed to be regulated under existing securities law, even if regulators have not yet commented at all, or 'sufficiently', on this initiative.

### **2.3 Issuers Pursue the ERA-dr Market at Their Own Pace**

#### **2.3.1 Project Implementers Produce the Remaining 90% of this Particular ERA-dr Attestation**

Once 10% of the 75-year generative value added has an established opening market value, the issuer will know how many more ERA-dr in their physical form they should proceed to make, in order to cover the remaining 90% of the undiscounted 75-year generative value-added. Within 60 calendar days, all of the remaining ERA-dr associated with the asserted outcome shall be manufactured and registered through a GenERiC Warehouse Operator (if stored there, or self-stored), or through a participating notary (if self-stored).

#### **2.3.2 Project Implementers May Retain or Sell any Portion of the Remaining 90% of their ERA-dr**

As this is a 'shelf offering', the project implementer may retain, sell or swap the remaining 90% of their ERA-dr at the price and pace they prefer. This security may be sold in exchange for conventional floating currency of any jurisdiction; or it may be swapped for GenERiC-dr of any currency. All offerings and transactions must conform with national and international law concerning securities, finance and trade.

#### **2.3.3 There is a Default Standing Invitation for Central Banks to Redeem Any Verifiable ERA-dr at Market Price**

After a set of ERA-dr has established its market worth through the initial 10% sale, a central bank, a supporting agency or any certified assessment professional may review the prospectus, analyze the verifiable facts, and make their own assessment of the undiscounted, aggregate 75-year generative value added, and related assurances, based on the grounded Money-of-Account. Such assessments provide a way for each central bank to assemble and maintain a portfolio of market value assessments.

The central bank of the country which issues the currency identified with the 3-letter code on an ERA-dr has a standing invitation to redeem any ERA-dr at the market price, in exchange for commemorative banknotes anchored to the GenERiC Money-of-Account. It is always the prerogative of the owner of an ERA-dr to determine whether or not to redeem the security at the price offered by the central bank.

## **3. Central Banks May Issue Sound Money-in-Trade Based on a Grounded Money-of-Account**

When any central bank needs to inject new money into the economy in response to circumstances like a recession, restricted credit, deflation, or an increased demand for cash, it can issue commemorative banknotes to redeem available GenERiC-dr and ERA-dr, selected in order of the dates they were logged in the ERA registry.

This special series commemorative banknote would have its worth (and graphic design) associated with long-term enhancement and assurance of the natural productive capacity of ecosystems throughout the currency zone. (The commemorative banknotes might be implementable in electronic form if 'high resilience' principles are adhered to, but they must not be solely electronic. The proof-of-concept system relies mainly on physical artifacts.)

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