

Beyond Ben Graham's Currency Proposal Retrospect and Evolution

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Abstract

Benjamin Graham (1894-1976) is widely known as the father of Value Investing (VI), the identification and trade of stocks in relation to changes in their intrinsic value. He developed VI through his experience as a Wall Street investor during the turbulent 1920s, 30s and 40s. It is little known today that Graham also dedicated much of his effort to macroeconomic reform that he considered could reduce uncertainty about the value of money in investment decisions. He developed and published plans for a commodity-reserve currency system to price money in relation to its intrinsic value (IV) in the physical economy. His proposals were considered at the Bretton Woods Conference in 1944, but sidelined. These commodity-reserve currency ideas were further developed under the United Nations Conference on Trade and Development (UNCTAD) and debated in the economics literature until the 1960s, but they have since been neglected by more recent generations of economists.

The global monetary disorder of the current decade is opening minds once again to Graham's way of thinking about monetary system discipline. This paper reviews the origins of Graham's commodity-reserve currency proposal, explains why the approach did not prevail at the time, and suggests some general criteria from systems theory and information theory for any new attempt to link money to tangible economic life. It encourages renewed collaboration to develop, prototype and test a family of practical options inspired by Graham's monetary work, and by those who inspired him.

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Part 1: A Look Back at Ben Graham's Commodity-Reserve Currency Proposal

The last time the world was forced to fundamentally re-think markets and money was during the 1930s and 1940s. In that period Benjamin Graham wrote four books. Two of these, *Security Analysis* with David Dodd (1934) and *The Intelligent Investor* (1949), have remained prominent throughout the past half century at the foundations of an investment strategy known as “Value Investing”: the identification and purchase or sale of stocks in relation to their intrinsic value. For this leadership, he is referred to as the “Dean of Wall Street” (Graham 1996) and the “Father of Financial Analysis” (Irving & Milne 1977). Graham's two other books, *Storage and Stability* (1937) and *World Commodities and World Currency* (1944) were logical extensions of his unwavering focus upon intrinsic asset value, as they explained why and how to provide money a foundation in essential commodity price and supply stabilization. In a 2007 paper on *The Monetary Economics of Benjamin Graham*, Columbia University economist Perry Mehrling observes:

"For Graham himself, the disconnect between the world of money and the world of goods was fundamentally a source of macroeconomic investment risk that could upset any amount of careful security selection by the conservative value investor. Graham wanted a money that would remove uncertainty about the value of money from the investment decision by aligning the price of money with its intrinsic value. (Mehrling 2007)"

Through the depression of 1920-21 and The Great Depression of the 1930s, Benjamin Graham observed that even well-managed banks and investors ultimately depend upon coherence in the monetary system. In our own time, the relative stability or failure of various banks through the global financial shocks of 2008-09 demonstrates the benefits of adherence to core *operational* banking principles (Bank for International Settlements 1997, 2001). But Graham emphasized the importance of a more basic *value* principle: that the currencies the central and commercial banks deal in should be genuinely liquid in the sense of being reliably convertible into useful physical commodities, which depends upon reasonably stable price and supply.

Graham's original macroeconomic proposal attracted the interest of many leading economists of his generation, among them J.M. Keynes (1938), F.A. Hayek (1943), N. Kaldor (1964) and M. Friedman (1951), and his ideas were circulated at the International Monetary and Financial Conference, Bretton Woods, New Hampshire in 1944. Keynes and Friedman rejected Graham's proposal on practical grounds, while Hayek and Kaldor both supported it as the reasonable way forward. Their vigorous debates subsided with the passing of that generation, and it has almost been absent from applied or academic economics in recent decades. But markets and money around the world are again in the midst of redefinition. In these circumstances, Graham's monetary proposal bears reconsideration as a way to reconnect money to tangible reality, to tame fluctuations in commodity supply, demand and price, and to harness market forces in the public interest.

Graham developed his initial ideas on commodity price stabilization during the market disruptions of 1920-21 that followed the end of World War I (Kahn & Milne 1977). As a 26-year-old newly-hired partner at the Wall Street firm Newburger, Henderson & Loeb, he reasoned that what was needed was a general mechanism to contain speculative commodity price volatility during a bull market, and to accommodate surplus capacity during a bear market.

Graham's early thoughts on currency were influenced by coverage in the *New York Times* (4 and 6 December 1921) about an innovative proposal to the US Government from industrialist Henry Ford. Ford was proposing way to finance completion and operation of the massive Wilson Dam project and nitrate plants at Muscle Shoals on the Tennessee River in Alabama. The megaproject had been started in 1918 near the end of the First World War, but work had been stalled due to the post-war market crash of 1920-21. Debate was underway in Congress to finance the project through government debt, by authorizing the issue of \$30 million in Treasury bonds. A front page article in the *New York Times* on 4 December 1921 reported that Ford had presented an unsolicited proposal he claimed would demonstrate a way to eliminate the need for government debt and interest obligations on major public works projects, and instead provide a flow of money to government as well as underwrite the purchasing power of the currency. Ford wanted a 100-year lease on the Wilson Dam project and the nitrates plants, and to finance construction and operations he asked that the Treasury issue, and loan to his firm, a special currency in the amount of \$30 million backed by the federal government's ownership of the natural resource being used, and the capital infrastructure being built. He explained that his firm would use the new currency to pay wages and supplies, and in addition, pay to the Government an annual 4 per cent rent throughout the life of the lease. After 25 years, he observed, the full amount of the special credit issue would be retired, and yet the government would continue to receive annual rent payments from his firm throughout the remaining 75 years of the lease. Ford asserted: "We shall demonstrate to the world ... first the practicability, second the desirability of displacing gold as the basis of currency and substituting in its place the world's imperishable natural wealth". In detailed coverage on 6 December, Thomas Edison, the inventor and a close friend of Ford, supported the proposal and commented: "The whole country has an abiding faith that Ford will not operate it to get every dollar possible out of it for himself. He will make it an American institution, doing the greatest good for the greatest possible number."

In the following months, Edison further took up the cause. On 20 February 1922 the *New York Times* reported that Edison had sent a letter to bankers and economists throughout the country to solicit their views on a generalized system whereby the US Government would "issue currency to build the dam and ditches and

construct the power station ... backed by actual value which continues forever". In the letter, Edison expanded upon Ford's idea by proposing that the federal government should also set up warehouses for the storage of basic commodities, against which the Treasury or the Federal Reserve Bank would "issue 50 per cent of the market value of these commodities in money (such market value being based on the average selling price over a period of twenty-five years and so endorsed in the certificate)" (*New York Times*, 20 February 1922). The other half of the value would be provided as an equity certificate that the producer could choose to hold, sell, or use as collateral. Combining Ford's and his own ideas in a fixed proportion, Edison proposed:

"...say 90 per cent of our currency was issued for one-half of the value of necessities of life and 10 per cent issued on projects like this land and irrigation operation, not separately, but both back of a uniform currency of one character and made unchangeable by amendment to the Constitution by popular vote, so that this ratio of 90 per cent and 10 per cent could not be changed. ... Do you think that civilized countries have from experience and knowledge of economics, reached a stage where they could drop the fiction, unreality and chaotic state of a currency based on gold, and adopt a money back of which is real useful wealth of twice the value of the money issued? Must we always remain on a gold basis? Is it beyond the wit of man to devise any equivalent method? (*New York Times*, 20 February 1922)"

The *Times* dedicated a full page in its 16 July Sunday Special Features section to Edison's "commodity-dollar" concept (Garrett 1922a; 1922b), followed by a letter to the editor by Edison the following Sunday in which he further pointed out:

"What is really wanted is a single currency based entirely on mortgage loans with twice the value of the par of the bank note behind it. To do this it would be necessary to withdraw greenbacks and gold and silver notes, put these in the vaults and then issue a single type of currency representing loans on property of twice the value (average value over a period of years); all such loans to be self-liquidating through the warehouse plan with commodities, including gold and silver (Edison 1922)."

The Ford-Edison plan for the Wilson Dam project was rejected by Congress, as were other competing private sector proposals, while the Alabama megaproject became mired in a nationwide controversy over public versus private ownership and operation of major infrastructure facilities. Only a decade later was project construction resumed by the New Deal's publicly-owed, debt-financed Tennessee Valley Authority.

Benjamin Graham's own first formal draft of a commodity-reserve and currency mechanism inspired by Edison's idea appeared ten years later, after the crash of 1929. In 1931 Graham had begun meeting with an informal group convened weekly by the President of the New School for Social Research in Manhattan, to discuss possible solutions to the economic crisis. He circulated to the group a short mimeographed paper (1931) advocating four ideas, one of which was his first description of "The Commodity-Reserve Plan". He developed this idea more formally, and submitted an article entitled "Stabilized Reflation" to *The Economic Forum* quarterly journal (1933). Unknown to Graham at the time, a similar concept had also been published in a 1932 pamphlet "How to Stop Deflation" by Professor Jan Goudriaan (1932) of Rotterdam. The two soon exchanged regular

correspondence.

There were two central elements to Graham's concept. The first part he outlined as a distributed public sector corporation to intervene in the market to stabilize prices for commodities that meet the requirements of being both economically important and easily storable. Graham acknowledged this storage system to be a variant of the ancient commodity reserve systems maintained in China, Peru, Egypt, and Rome, as well as in 17th century France. He observed:

“This twofold mechanism of storage and price control was formally set up some five centuries after Confucius under the name of the “Constantly Ever-Normal Granary (Chen 1937). 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 ages from 54 B.C. to the present time' (1937: 30).”

The second part of Graham's proposal was a currency that would represent a standard composite unit of the reference commodities on a model more sophisticated than Edison's plan. The commodity unit “is monetized directly in the same way that gold and silver have been coined into currency (Graham 1937: 226).” At this time Graham was apparently unaware of the earlier “tabular standard of value” by W.S. Jevons (1877: 328ff; 1884: 123ff), who proposed:

“Might we not invest a legal tender note which should be convertible not into any single commodity, but into an aggregate of small quantities of various commodities the quantity and quality of each being rigorously defined? ... This scheme would, therefore, resolve itself practically into that which has long since been brought forward under the title of the Tabular Standard of Value. (Jevons 1877 328)”

However Graham did note that a half century earlier, Alfred Marshall recommended to the Royal Gold and Silver Commission of 1888 the issuance of currency against reserves of gold and silver in a fixed ratio, referred to as *symmetalism*. Graham comments that “The advantages of this arrangement were acknowledged by all the members, but the suggestion was rejected because too much time would be needed to gain popular support” (Graham 1937: 267n). Marshall was aware that his proposal amounted to “an extensive reconstruction of our whole monetary system” (Marshall 1996: 208). But Graham found Marshall's mechanism suitable to a multi-commodity unit, stating:

“It will be recognized that the underlying principles of symmetalism and of our commodity-unit currency are identical. Our monetary proposal may therefore be defined as symmetallism applied to a fairly large group of basic commodities, instead of to gold and silver (Graham 1937: 216).

In Graham's design, a federated network of commodity-reserve banks would buy and sell standard commodity bundles to maintain the average price of the standard composite commodity unit, accepting that relative prices amongst the commodities vary. When the average market price of the basket of commodities reaches a low threshold, reflecting a shortfall in effective demand, the Treasury or commodity-reserve banks purchase

commodities for storage in the defined standard proportion. They purchase in sufficiently large quantities to stop the average price from falling further, issuing the commodity-reserve currency as payment, instead of fiat or gold-backed money for these transactions. When the average market price of the basket of commodities reaches a high threshold, the Treasury sells commodities from storage in the defined standard proportion in exchange for any type of money . “Such an arrangement would amount simply to putting the State in the role of a shrewd long-term operator in basic commodities, blessed with an unlimited bank roll” (Graham 1937: 39).

Graham's initial list included 23 major exchange-traded commodities:

- *Wheat (all grades)*
- *Barley (No. 2)*
- *Cocoa (Accra)*
- *Corn (No. 3 white & yellow)*
- *Cottonseed oil (yellow refined)*
- *Oats (No. 3 white)*
- *Rye (No. 2)*
- *Sugar (granulated)*
- *Cotton (middling upland NY)*
- *Silk (Japanese 13-15)*
- *Wool (raw)*
- *Flaxseeds (No. 1)*
- *Rubber (smoked sheets)*
- *Cottonseed meal*
- *Tobacco (avg farm price + 10%)*
- *Coffee (avg import price)*
- *Tallow (inedible)*
- *Copper (electrolytic)*
- *Lead (refined)*
- *Tin (straits)*
- *Zinc (prime western)*
- *Petroleum (Kansas-Oklahoma price at well + 20%)*

The currency unit, once issued, would circulate as money in normal trade. Graham distinguished his plan from Edison's, which was carried out by means of non-interest-bearing loans against individual commodities (Graham 1937: 226). While Graham considered Edison's plan unworkable, he noted:

“We must add, however that Edison's monetary philosophy was much broader than his specific plan. ... We should like to claim for our plan that it carries out the fundamental concepts of the great inventor, which his own plan would fall short of realizing (Graham 1937: 226).”

With the worsening economic situation in 1931, the stabilization of basic commodity prices and supplies had become a common objective amongst economists and politicians in many countries. The US Government expressed early interest in Graham's proposal:

Ben gave a copy of his plan to a friend of [NY Governor] Franklin D. Roosevelt. The friend sent word that it was receiving serious consideration in Washington. Nothing happened for two years. Then Louis Bean, economic adviser to Secretary of Agriculture Henry Wallace, visited Ben. The Commodity Credit Corporation had been formed to support farm prices and had acquired large quantities of farm products. Bean thought that Ben's plan might be used as a method of financing the food surpluses, with the added benefit of stimulating prices, in general, by increasing the quantity of money in circulation. (Kahn & Milne 1977)

Within days of US President Roosevelt's 1933 inauguration, Henry Wallace carried the Agricultural Adjustment Act through Congress with the objective of balancing supply and demand for farm commodities so that prices would support an acceptable level of income for farmers. However Graham was very disappointed that his plan was not incorporated into the Act. Instead, the Agriculture Department imposed a new tax on value-added of secondary processors as a way to raise funds for purchasing major commodities for a national storage program. But this Act also authorized the Agriculture Department to pay farmers directly to take land out of production,

and even to pay them to destroy crops and livestock, in a series of desperate measures to prop up prices that violated the intrinsic value fundamentals of Graham's proposal. The interest, and yet evident failure of US government decision-makers to implement the structure of his proposal compelled Graham to press forward with an entire book on the topic:

Ben continued to work on the plan, compiling a sizable statistical base to lend credence to its practicality. Finally he was satisfied, publishing in 1937 the book *Storage and Stability*. ... Bernard Baruch discussed the plan most enthusiastically, and Ben provided him with a set of galley proofs so that Baruch could speed these to President Roosevelt. (Kahn & Milne 1977)

During this period Graham also exchanged several letters with John Maynard Keynes, but the two had very different ideas about how large-scale commodity storage should be financed. The plan advocated by Keynes shared an aspect of Edison's warehousing plan of 1922, wherein the countries of the British Commonwealth would make government-subsidized warehouses available for commodity stockpiles. But in Keynes' plan the commodities would remain entirely in the ownership of the depositors in an open market (Keynes 1938). This approach was not unique, indeed it became central to commodities management in many countries through the Second World War.

The centrepiece of Graham's proposal went beyond storage to direct monetization of commodity-reserves units in currency as Ford and Edison advocated. In Graham's view, the only genuine liquid assets are inventories of generic commodities, because these are immediately useful in material economic life. Purely monetary instruments such as cash, securities and receivables are artificial constructs of the financial system which, according to Graham, “have no support in concrete realities and which depend for their validity on the persistence of a fundamentally irrational mass psychology” (Graham 1937: 10-11). Cash itself is only as liquid as its purchasing power. This is why, in Graham's plan, inventories of useful commodities are, in substantive fact, the most liquid of assets, and therefore the logical basis for a currency (Mehrling 2007). Graham explains:

In an oversimplified phrase, we may say that we are placing the farmer and other raw materials producers in the same category as the owners of gold mines, by according the same monetary status to basic commodities as a group that has long been conferred on gold. But this extension of the coinage privilege is not proposed as a favor, or as a relief measure, or as a convenient means of stimulating business by creating more purchasing power. It is based on the considered principle that the primary raw materials are really primary throughout the economic sphere. Not only do all the material things of life begin and develop with them; but the complex and delicately interrelated organization of business receives its first impetus and its controlling tone from this area. The economic flow has a definite *entropy*, or permanent direction, from raw materials outward. Thus our identification of the monetary medium with raw materials as a group is merely a logical synthesis of the two primary elements out of which our elaborate economic fabric is constructed. (Graham 1937: 229)

Graham's currency proposal was intended to be more than a substitute for central bank notes. Like Ford and

Edison, he intended it to be a reasonable replacement for the gold standard. He states: “We define the dollar as equivalent to the commodity unit, in the same way that it was formerly defined as equivalent to 23.22 grains of pure gold....It does not seem an exaggeration to say of the commodity-backed dollar that it will be essentially sounder than the gold dollar”(1937: 146). He states:

"The commodity-backed currency ... will constitute 'sound money' in the old-fashioned and conservative sense. In the conflict between 'hard money' and 'soft money,' ... we are definitely on the side of an automatic, self-generating and self-liquidating currency, free of management and political pressure. Our currency ... is opposed to the group comprising unsecured currency, government-bond-secured currency and all 'secured' currency where the intrinsic value of the security is definitely less than the money issued against it (Graham 1937: 146)."

In Graham's view, currency is less than genuine if it is said to be “secured” by gold certificates, but yet is not convertible into them, and especially when the certificates themselves are not actually convertible into gold. In any case, he deemed gold convertibility inadequate as a currency base because of its mainly speculative monetary value. According to Irving Kahn and Robert Milne:

“The plan's chief merit was in providing a link between the real world in which major commodities are used and the world of money creation. It also avoided the problem of trying to stabilize the price of a single commodity, because each commodity could fluctuate in price, becoming a larger or smaller component of the "market basket" reflecting supply and demand changes” (Kahn & Milne 1977).

Professor Perry Mehrling (2007) emphasises that Graham sought to align his proposal closely with core banking principles: that the currency must be both convertible and self-liquidating. The functional mechanism of Graham's currency operation is, according to Mehrling, a generalization and socialization of the "commercial bills" instrument. Everyone is familiar with postal money orders and bank drafts, and now in the digital era, the role played by PayPal and Google Checkout. These are examples of commercial bills: short term, trusted instruments authenticated by the issuer, that direct payment of a stated amount of money to a particular person, or to the bearer. Commercial bills of all types are said to be self-liquidating because upon delivery of the goods or services, a stated amount of cash redeems the bill, which then goes out of circulation. Mehrling points out that Graham's generalization is to create a special currency that is essentially a system of commercial bills representing a standard number of units of each of the 23 reserve commodities, backed by auditable warehouse receipts. Whereas normal commercial bills are used when something is sold in the private market and remains to be delivered, Graham applies this instrument to major exchange-traded commodities that have not been sold as such, but instead are kept off the market and delivered into registered warehouses.

For his part, Keynes' 1938 paper briefly mentions “an experimental purchase by the Bank of Sweden of certain stocks of commodities as a form or central banking reserves alternative to gold, a policy which could be made a means, if widely pursued, of flattening out the fluctuations of prices (Keynes 1938: 454)”. However the Swedish case did not amount to a generalized commodity-based currency. Graham mentions the work of British

economist Paul Einzig (1936) who discussed “using basic commodities as part of the monetary reserve” (Graham 1937: 216). It was in this period also that Frederick Soddy (1934) was publishing ideas for energy-based money.

In his second book in 1944, Graham also credits the work of Jevons: “It is clear that Jevons had not developed in his mind the full implications of his own idea. He had not envisaged the apparatus by which actual convertability between currency and commodities would be effected” (Graham 1944: 70). Graham's own formulation of a tabular standard served as the data framework that guides the federated network of commodity-reserve banks in their purchase and sale of standard commodity bundles to maintain the average price of the standard commodity unit, while the relative prices amongst the commodities would vary.

As the currency based on commodities with intrinsic value is issued, an equivalent face value in fiat or gold-backed central bank currency is taken out of circulation. For this reason, Graham's plan would not increase the money supply, and is therefore not inflationary. It would steady the price level of the target commodities in a downturn by taking surplus commodities off the market, while increasing the purchasing power of primary producers by paying them in the new currency. Once issued, the commodity-reserve currency circulates as a medium of exchange in normal trade, or it can be saved. In an upturn, the currency is always redeemable in terms of the standard proportions of 23 commodities held in storage.

Graham therefore describes a counter-cyclical general mechanism under which the quantity of commodity-reserve money will automatically expand in a deflationary depression, and it will automatically contract as prices rise during expansion. The plan therefore limits inflation in boom times in two ways:

- Commodity supplies from the reserves respond to an expansion in effective demand; and,
- Since warehouse sales constitute direct demonetization, money supply contracts as currency units are redeemed for standard exchange-traded commodities.

Graham's approach would permit the expansion of credit, but only the growth of commodity reserves could expand the supply of money. This reverses the usual pro-cyclical approach of central banks. Mehrling observes:

"Graham appealed to orthodox banking principles, but ... completely reversed their supposed logical implications. So far as I can see, this line of argument is completely original to him, but there is clear indication that it was sparked by his reading of Berle and Pederson's 1936 *Liquid Claims and National Wealth*" (Mehrling 2007).

Through the early 1940s several different bases were considered for currencies, including a return to the gold standard, some variations of Marshall's gold-silver symmetalism, fiat currency, and various tabular standards.

Graham worked further to adapt the commodity-reserve proposal for use at the international level, and excerpts from his forthcoming *World Commodities and World Currency* (1944) were submitted by the US Committee for Economic Stability to the International Monetary and Financial Conference at Bretton Woods, New Hampshire, in July 1944, along with insightful supporting rationale for the monetary plan by Princeton University's Frank Graham (1942, 1944), and F.A. Hayek's overview *A Commodity Reserve Currency* (1943). Through the pages of *The Economic Journal* in the same year, Keynes expressed interest but rejected the plan as too complex and not mature enough in its design to set up in the short time available:

"I have no quarrel with a tabular standard as being intrinsically more sensible than gold. My own sympathies have always fallen that way. I hope the world will come to some version of it some time. But the opinion I was expressing was on the level of contemporary practical policy; and on that level I do not feel that this is the next urgent thing or that other measures should be risked or postponed for the sake of it. ... The right way to approach the tabular standard is to evolve a technique and to accustom men's minds to the idea through international buffer stocks. When we have thoroughly mastered the technique of these, which is sufficiently difficult without the further complications of the tabular standard and the oppositions and prejudices which this must overcome, it will be time enough to think again" (Keynes 1944: 429-430).

The Graham proposal did not advance at Bretton Woods. The reasons expanded upon briefly by Keynes included the practical matter that it was considered Keynes also mentioned political reasons: submitting national monetary policy to the discipline of an international standard was considered to infringe on sovereignty; and, the vested interests in gold were too powerful to be resisted.

Keynes had been proposing a different international currency unit to be called the *bancor*. He supposed that its nominal value should be fixed in terms of gold, and that national currencies should set their par values in terms of the *bancor*. New *bancors* would come into existence as overdrafts to cover imports, or in exchange for central bank gold deposits with the International Clearing Union. Gold would be a reserve in Keynes' plan, but the *bancor* would not be redeemable in gold (Bordo & Eichengreen 1993: 30). Nor could *bancors* ever be withdrawn from the system; they could only be transferred from one account to another. (Robinson 1943: 163)

The outcome of the Bretton Woods Conference was a politically imbalanced agreement that assigned to the US dollar the role that Keynes sought for the neutral *bancor*. It made other national currencies convertible into US dollars, and the dollar convertible into gold at a price managed by the US Federal Reserve. The International Monetary Fund (IMF) would depend upon reserves of national currencies established by member quota. The system that emerged therefore did not address commodity price stabilization, nor offer a broadly-based connection between money and commodities, nor did it conform with conservative banking principles of convertibility and self-liquidation. Graham and a network of colleagues persisted with the suggestion that the

standard commodity unit would complement the new Bretton Woods mechanisms. Without some variant of this solution, he believed, gold-based money still lacked any intrinsic value definition in relation to the material economy:

To the fullest extent possible the monetary uses of gold should be conserved, and the limited currency values inherent in silver should not be rejected. But *in addition to these*, the world can use its basic durable commodities as monetary reserves. By doing so it can contribute mightily, and at a single stroke, to solving a host of major post-war problems: the promotion of wide expansion; the attainment of reasonable price-level stability; the establishing of useful and non-disruptive stockpiles; the creation of more adequate purchasing power in the hands of farmers and of raw-materials nations; and the facilitating of foreign trade, or trade-balance settlements, and of stable currency values. (Graham 1944: viii)

In an article two years after the Bretton Woods Agreements entitled *Money as Pure Commodity*, Graham further emphasized the importance of intrinsic value for the monetary system:

"The proposal for commodity reserve currency marks a new departure in the monetary field. Its object is not so much to give commodity value to money as to give monetary value to commodities. There should be a real advantage in having our money backed in part by basic commodities --"objects applicable to the purposes of life", for the generally bad history of unsecured and inconvertible paper money suggests that physical backing and convertibility are desirable attributes of money. But the novel monetary aspect of the commodity reserve idea is that it is designed to benefit the producers of raw materials by giving them as a group the economic advantages now enjoyed by producers of gold and silver; namely, an unlimited market at a level price for balanced production. As a derived effect, it is designed to protect the entire economy from the baleful results of recurrent wide fluctuations in the market price of basic commodities. (Graham 1947)"

The variety of objections to the concept of a commodity-reserve currency were described in a detailed paper by Milton Friedman (1951). He explained that the currency system proposed by Graham would be too complicated and expensive to administer, too open to political interest, and in any case, unlikely to achieve greater price stability than the simpler gold or fiat solutions. Instead Friedman highlighted the "strong emotional appeal" and "widespread popular support" that brought favor to gold as the culturally most pragmatic base for currency. Despite his systematic opposition at the time, three decades later Friedman himself proposed the use of the tabular standard for financial futures targeting, using price indices to cover the entire array of goods without requiring direct convertibility:

"The goal of a monetary system that provides assurance against fluctuations in purchasing power is ancient. One frequently suggested and repeatedly rediscovered proposal is to attain that result by linking the currency unit to a price index. That device was proposed in the nineteenth century by W. Stanley Jevons and by Alfred Marshall, who named it a tabular standard. It has been repeatedly rediscovered. In Marshall's version it required no governmental action except the issuance of a price index number, something which has of course become widely prevalent. ... Despite the theoretical attractiveness of this idea and the absence of any effective hindrance to its adoption, it has never become popular. ... The recent explosion in financial futures markets offers a very different possible road to the achievement of the equivalent of a tabular standard through private market actions. This possibility is highly speculative-little more than a gleam in one economist's eye." (Friedman 1984: 165-166)

In the 1960s, however, Nicholas Kaldor, Jan Tinbergen and Albert Hart (Kaldor 1964) directly pursued and extended the commodity-reserve tabular standard for currency in their joint proposal on behalf of the United Nations Conference on Trade and Development (UNCTAD). They suggested an alternative type of commodity-based *bancor*, merging Keynes' policy concept of a neutral global reserve currency with Graham's intrinsic value mechanism based on a basket of 30 commodity reserves. This generated considerable discussion in the pages of academic journals. But their more elaborate scheme failed to attract significant commitment amongst monetary economists or financial executives. Since that time, many authors (eg. Streeten 1982: 3) have confused the Kaldor-Tinbergen-Hart composite commodity *bancor* proposal for Graham's model for commodity reserves with Keynes' composite currency *bancor* mechanism based ultimately on gold. As pointed out earlier, however, Keynes opposed the Graham proposal at Bretton Woods. In the late 1960s when the IMF found it necessary to create the special-purpose currency referred to as "Special Drawing Rights" (SDRs), this system was based on a basket of major currencies similarly to Keynes' original *bancor* proposal, not on the alternative commodity-reserve *bancor* described by Kaldor and colleagues.

The international gold-based US dollar standard adopted at Bretton Woods began to falter in the 1960s, and was unilaterally abandoned by the American government on 15 August, 1971. In a retrospective upon Graham's death in 1976, Columbia University economist Albert Hart expressed disappointment that there was not yet a functional commodity-reserve currency proposal approaching implementation, and that few policy-makers had really understood its essentials (Hart 1976). Nor did the more fundamental idea to associate the price of money with the material things of life find fertile ground in applied or academic economics through the 1970s through the 1990s. Increasingly, the very intent of the commodity-reserve concept for counter-cyclical moderation was being opposed by a new generation of academic and public sector economists who idealized the unfettered market (Targetti 1992: 315), but yet who were willing to grant central and commercial banks quasi-public authority to create and manage national money supplies based upon virtual units of credit obligation issued by central banks, extended many times over by commercial banks through a fractional-reserve rule.

Under the new debt-based fiat system, liquidity became little more than a market lubricant, and money was not intended to represent any intrinsic meaning relative to the material basis of life. Indicators such as M0 (cash in circulation), M1 (equal to M0 plus demand deposits), and M2 (being M1 plus savings deposits) have been taken as reflecting business and consumer liquidity. However M3 (M2 plus large time deposits, institutional money-market funds, short-term repurchase agreements, and other monetary assets) came to be considered a superfluous measure in a fiat currency world. In March 2006 the U.S. Federal Reserve stopped publishing data for M3, as well as the totals for large-denomination time deposits, repurchase agreements (RPs), and Eurodollars. The Fed issued a very brief statement to explain why:

“M3 does not appear to convey any additional information about economic activity that is not already embodied in M2 and has not played a role in the monetary policy process for many years. Consequently, the Board judged that the costs of collecting the underlying data and publishing M3 outweigh the benefits (United States Federal Reserve. 2006a; 2006b).”

Like the abandonment of the gold standard in 1971, this unilateral move had global significance because of the primary role of the US dollar in international trade. Numerous other central banks followed suit, but not everyone agreed that M3 was useless. An editorial in *The Economist* magazine observed at the time:

“Financial deregulation and innovation made the money supply harder to interpret, let alone control. As the link between money and prices seemingly broke down, central banks scrapped money targets and instead focused on inflation directly. Or as Gerald Bouey, a former governor of the Bank of Canada, once said, 'We didn't abandon the monetary aggregates, they abandoned us.' Today, America's Federal Reserve barely glances at money. Indeed, from this week it will stop publishing M3, its broadest measure of money. ... It is true that the two Ms move in step for much of the time, but there have been big divergences. During the late 1990s equity bubble, for example, M3 grew faster; over the past year, M3 has grown nearly twice as fast as M2. So it looks odd to claim that M3 does not tell us anything different. The Fed is really saying that it doesn't believe money matters. (*The Economist* 2006).”

Various statisticians have continued to provide competent estimates of US M3 (Williams 2009; Bart 2009). Their figures illustrate that by the first quarter of 2008, whereas the annual growth rate in M1 was about 0.5 per cent, and M2 was 7 per cent, the rate of growth in M3 had reached 17 per cent.

Graham and F.A. Hayek both warned that a pure fiat currency system untethered to physical assets would allow for limitless issuing of currency units by government and the financial institutions, each of which are inevitably susceptible to pressures from all sorts of organized interests. But even they might have been surprised to witness the eventual hyper-extension of pseudo-liquidity enabled through the “derivatives” market in the 1998-2008 decade, a form of money that is outside even the orbit of M3 and beyond the scrutiny of public accountability. Lacking any connection whatsoever with intrinsic value, derivatives are complex algorithm-based financial contracts for future payments, wherein the amounts eventually to be paid out are contingent upon a set of synthetic indicators, such as interest rates, stock prices or currency values. Value and risk assessment for derivatives investment has relied heavily on David X. Li's *Gaussian copula function* (2000). Observing unwarranted market faith in his work, Mr. Li himself cautioned in 2005: "The most dangerous part is when people believe everything coming out of it (Whitehouse 2005).” Warren Buffet was calling out the “mayday” distress signal as early as 2003:

"Charlie and I are of one mind in how we feel about derivatives and the trading activities that go with them: We view them as time bombs, both for the parties that deal in them and the economic system. ... The derivatives genie is now well out of the bottle, and these instruments will almost certainly multiply in variety and number until some event makes their toxicity clear. Knowledge of how dangerous they are has already permeated the electricity and gas businesses, in which the eruption of major troubles caused the use of derivatives to diminish dramatically. Elsewhere, however, the derivatives business continues to expand unchecked. Central banks and governments have so far found no effective way to control, or even monitor, the risks posed by these contracts. ... We try to be alert to any sort of megacatastrophe risk, and that posture may make us unduly apprehensive about the burgeoning quantities of long-term derivatives contracts and the massive amount of uncollateralized receivables that are growing alongside. In our view, however, derivatives are financial weapons of mass destruction, carrying dangers that, while now latent, are potentially lethal. (Buffett 2003: 13-15)”

The phrase "point of no return" comes from aviation. It refers to the point on an aircraft's journey when there is insufficient fuel to reverse direction and return to the place of origin. Metaphorically it describes the point in any sequence of events when it is no longer possible to reverse course or stop the process. The world's most senior monetary and investment authorities had difficulty responding to early warnings that this unfettered global financial market was expanding without proper regulatory support structures. By 2008, three quarters of global liquidity was in the derivatives market, which had ballooned in nominal size to more than 800 per cent of global Gross Domestic Product (Bank for International Settlements 2008). "Group-think" confidence in Li's algorithm and its variants meant that "ratings agencies like Moody's—or anybody wanting to model the risk of a tranche—no longer needed to puzzle over the underlying securities. All they needed was that correlation number, and out would come a rating telling them how safe or risky the tranche was. (Salmon 2009)". This badly engineered machine began falling from the sky in late 2007, and in light of governmental pressure to prop up a diversity of "too big to fail" companies, central banks worldwide have been responding by hurriedly typing into their computers additional trillions of currency units based upon nothing more than inter-generational credit, while political leaders and business executives do their best to keep the material economic engine running on vapor. By 2009, many governments resorted to selling massive IOUs to their central banks, a method referred to euphemistically as "quantitative easing", which had previously been considered extreme. A summary of current US monetary strategy is provided in a recent speech by James Bullard, President of the Federal Reserve Bank of St. Louis:

"By expanding the monetary base at an appropriate rate, the Fed... can signal that it intends to avoid the risk of further deflation and the possibility of a deflation trap. ...the Fed's balance sheet has grown at an astounding rate since September of last year, and the monetary base has more than doubled. But the new, temporary, lender-of-last-resort programs are blurring the meaning of this picture. A temporary increase in the monetary base, by itself, would not normally be considered inflationary. The increase would have to be expected to be sustained in the future in order to have an impact. Much, but not all, of the recent increase in the balance sheet can reasonably be viewed as temporary. The outright purchases of agency debt and MBS are likely to be more persistent, however, and it is these purchases that may provide enough expansion in the monetary base to offset the risk of further disinflation and possible deflation. The quantitative effects of policy actions in this new environment are more uncertain than normal, but nevertheless these less-conventional policies can have every bit as powerful an impact on the economy as changes in the intended federal funds rate (Bullard 2009)."

Many doubt that the US Federal Reserve and other central banks will be able to reverse the process that has been set in motion, and conclude that money and markets around the world are due for an overhaul. Possibly our own generation deserves the same reprimand as R.M. Hutchins delivered in his 1933 Commencement Address at University of Chicago:

"The gadgeteers and data collectors, masquerading as scientists, have threatened to become the

supreme chieftains of the scholarly world.... As the Renaissance could accuse the Middle Ages of being rich in principles and poor in facts, we are now entitled to inquire whether we are not rich in facts and poor in principles." (Hutchins 1933, In Rosen 1979: 3)

The global macroeconomic trajectory of the past decade has shaken the confidence of some in debt-based fiat money, and has led to new global interest in linking the value of money to physical assets. From some quarters there are calls for a return to some form of gold standard, but these are countered by concerns that a gold base extended with a fractional reserve rule simply masks fiat money with a gold veneer, while a fully convertible gold system is too restrictive.

The commodity reserve currency concept was re-introduced to the top levels of international monetary discussions in March 2009 by Zhou Xiaochuan, Governor of the People's Bank of China. In a major address entitled "*Reform the International Monetary System*" Zhou stated:

"The desirable goal of reforming the international monetary system, therefore, is to create an international reserve currency that is disconnected from individual nations and is able to remain stable in the long run, thus removing the inherent deficiencies caused by using credit-based national currencies. Though the super-sovereign reserve currency has long since been proposed, yet no substantive progress has been achieved to date. Back in the 1940s ...[it was] already proposed to introduce an international currency unit ... based on the value of 30 representative commodities. Unfortunately, the proposal was not accepted. The collapse of the Bretton Woods system ... indicates that the ...[commodities] approach may have been more farsighted. (Zhou 2009)"

Zhou's speech misattributed the composite commodity standard to Keynes, when the statement should have cited Graham, Hayek and F. Graham, if not also Edison before them, and Kaldor, Tinbergen and Hart after. It should be understood, however, that Zhou's interest in the commodities money concept itself has a long and autonomous history in ancient China's Ever-Normal Granary to which Graham pointed. Indeed, the State Reserve Bureau (SRB) created in 1953 under the Ministry of Land and Resources remains active today "adjusting the market, coping with emergencies and guaranteeing security of resource supplies" (MoneyNews 2006). The "Parity Deposit Unit" (PDU) was introduced in June 1949 by the new People's Bank of China to denominate retail bank deposits and bonds in relation to four basic commodities: rice, wheat flour, cotton cloth and coal. And it has long been common for producers in China to obtain bank loans mortgaged against commodity reserves, and for the state to subsidize storage costs (Alibaba Group 2009).

With the benefit of hindsight, it is time to consider afresh how we might align money with intrinsic value, to respect core banking principles, to concern ourselves with sustainable commodity supply, demand and pricing, and to harness market forces in the public interest. Professionals in economics, finance and banking ought to read the intrinsic value currency proposals, reflect on them, and participate in re-fashioning some variants of them suitable to our life and times, and through at least the next half century. There is more than one legitimate pathway forward, and as Walter Pitkin remarked in the midst of the Great Depression years:

"There are a few right ways of doing anything (some say there is only one, but that is not true); and there are a million easy ways of doing each thing wrongly"(Pitkin 1935: 16).

In each case, we need to understand the problems that require resolution, and consider what criteria are needed for sound money and coherent monetary systems going forward.

Part 2: Why Graham's Proposal Did Not Prevail

There are several reasons that Graham's proposal for a currency based on commodity reserves was not adopted at the Bretton Woods Conference or afterwards, despite a considerable volume of published literature on the concept from the 1930s through the 1970s. While his idea has continued to inspire occasional papers, for the most part it has been relegated to a back shelf in the archives of monetary economic theory. Following is a summary of a dozen issues highlighted at the time in published literature by Keynes and Friedman, with some additional problems raised in the present author's informal discussions with S. El Serafy and J. Waugh. It offers a representative, but not a complete list of issues that must be resolved or answered in any pragmatic reformulation of this currency proposal. In any case, a genuine effort to reformulate Graham's concept for 21st century requirements must begin by addressing the shortcomings of the original plan, whether real or perceived.

2.1 Flexibility. The commodity-reserve system as originally proposed was too rigid from an economic policy perspective, according to Keynes (1944), who insisted that monetary authorities must retain a sufficient degree of flexibility to manage within a well-structured monetary system. "The immediate task", explained Keynes in 1944, "is to discover some orderly, yet elastic method of linking national currencies to an international currency, whatever the type of international currency may be (Keynes 1944)."

2.2 Organizational Prerequisites. The development of governance systems together with management regulations and standards for large buffer stocks must logically precede the introduction of any realistic commodity-based tabular standard for currency. Inadequate governance and management can lead to unintended consequences, leaving producers room to game the commodity-reserve and therefore the currency system, for example, by deliberately overproducing commodities that the state would then be obliged to purchase. (Keynes 1944) The information requirements to manage an international network of commodity reserves strictly enough to support a trusted composite commodity currency unit, are excessive. Standardized auditable records would have to be maintained by thousands of registered warehouse personnel

under diverse national and state/provincial jurisdictions. The formal administration and auditing program would be enormous. Annual warehouse testing and certification would be required against common quality parameters, and even the process of arriving at equivalent testing and certification criteria appropriate to different climates would be a challenge.

2.3 Sovereignty. Keynes objected to the international version of Graham's currency proposal, insisting that domestic prices and wages are "a matter of internal policy and politics" that cannot be submitted to an international authority. "We must solve it in our own domestic way, feeling that we are free men, free to be wise or foolish." (Keynes 1943, 1944) National sovereignty must be respected in monetary affairs.

2.4 Comprehensiveness. A commodity-reserve currency system necessarily includes just a small, unrepresentative proportion of an economy's output, because it is limited to commodities that can be easily "standardized, traded in broadly based markets, supplied under reasonably competitive conditions, and be physically and economically storable" (Friedman 1951: 230-231). With such a limited scope, the commodity-reserve standard cannot be expected to yield stable commodity prices across the board. Graham states that "the commodities which will actually enter into the physical units will be limited to the grades tenderable under the standard commodity contracts of the various commodity exchanges" (1937: 281). This approach is challenged when competitive innovation in the agrofood sector emphasizes qualitative differences amongst alternative cultivars and production methods. Moreover, since 1996 proprietary genetic modification and crossbreeding processes have been on the market under restrictive patents, according to which each patented genetic strain is considered a unique commodity in jurisdictions where this class of process patents is recognized. An international, national or regional commodity reserve becomes hopelessly complicated by the legal requirement to document the pedigree of each shipment to the reserve, the logistical requirement to store distinct strains separately, the procedural requirement to obtain the patent-holder's contractual approval for each re-sale from the reserve, and the information requirement to monitor compliance with all of these.

2.5 Free Market Neutrality. Inequality in the natural distribution of resources that are included in the monetary system can have destabilizing impacts on international trade. Friedman also

notes the potential for disruptions if a government holding a significant proportion of in-ground resources or produced commodities were to impose trade controls. He believes: "The commodity-reserve scheme could operate internationally and produce stable exchange rates if, and only if, the various countries were willing to permit complete free trade in the commodities in the bundle and to submit their internal monetary and economic policies to its discipline. (Friedman 1951: 231) "

2.6 Sectoral Equivalency. Any commodity reserve system exists to manage supplies and prices against a set of priorities or objectives related to industry and society. Former World Bank economist Salah El Serafy has commented that when the additional step is taken to directly link the money supply to the reserves, the choice of which commodities to include or exclude becomes more critical and controversial in terms of impacts due to the higher level of control to be imposed on particular commodity sectors. The Graham proposal would have differential impacts on various sectors. (El Serafy 2009)

2.7 Predictability. Only a relatively small proportion of total production of the identified reserve commodities are added to or released from the reserves in any given period. Any countercyclical effects on the quantity of money would be scaled to the impacts of variations in output of the selected commodities (Friedman 1951: 231), potentially leading to greater monetary volatility. For example, agricultural production is dependent upon erratic forces determining growing conditions. In a situation where reserves are low, changes in the relative cost of production could aggravate price instability. Even a rise/decline in prices of complementary and competitive *non-reserve* commodities can lead to a substantial decrease/increase in the supply and price of reserve commodities, which would carry through as a decrease/increase in the stock of money (Friedman 1951: 231) Therefore pivotal monetary phenomena may not be foreseeable.

2.8 Motivation. A commodity-reserve lacks the cultural foundation and relative transparency of gold that helps to protect a gold-reserve system against excessive manipulation. Friedman explains:

"A commodity currency can be a bulwark against political intervention and attain acceptance by many countries only if the popular support for it is sufficiently strong and widespread to make 'tinkering' with it politically dangerous, and to overcome differences in national interests and attitudes. Gold has had, and may still have, this kind of support. Commodity-reserve currency does not. (Friedman 1951: 231) "

Graham's commodity-reserve currency concept, being a somewhat complicated technical solution, would be less able to harness popular resistance to politically or economically motivated intervention that could compromise the monetary system's integrity, including the potential for indirect influence via activities that affect the cost of commodity storage (Friedman 1951: 231) . In 1944 Keynes commented that Grahams's original plan had no hope at all of competing against the overwhelming political influence of the gold interests leading up to Bretton Woods:

"This does not strike me as an opportune moment to attack the vested interests of gold holders and gold producers. Why waste one's breath on what the Governments of the United States, Russia, Western Europe and the British Commonwealth are bound to reject? (Keynes 1944) ”

2.9 Responsiveness. Once the currency is based on commodity reserves, the sunk cost of accumulating and maintaining the system is bound to impose an inertia on monetary decision-making. Stability might well be an intended goal, but it remains important to acknowledge the trade-off: monetary authorities forego the agility and technical efficiency that a fiat system provides to respond to changing economic circumstances (Friedman 1951: 231).

2.10 Physical Security. Providing physical security to the certified reserve warehouses is difficult and expensive, and would become absolutely critical when the reserves are backing the currency. Reserves must be guarded against thieves, vandals, and economic enemies, and in the case of agricultural commodities, infestation by rodents, insects, fungus, moulds, harmful bacteria, and humidity.

3. Building Upon Graham's Essential Concept

3.1 A Call for Collaboration

Benjamin Graham grounded Value Investing (VI) upon the identification and trading of stocks in relation to changes in their intrinsic value. Few today are aware that he also dedicated himself to intrinsic value in macroeconomics to reduce uncertainty about the value of money in investment decisions. Part 1 of this paper briefly reviewed the origins and features of his commodity-reserve currency proposal to safeguard the intrinsic value of money through physical backing and convertibility. Part 2 explained why the plan he and others developed was not adopted. It remains in this paper to suggest a practical path forward based upon Graham's

wise counsel, suitable to today's macroeconomic challenges. The present economic crisis is sufficiently profound and complex that the monetary work of Graham should be given urgent, open and thoughtful consideration.

If the central principle of the currency proposal floated by Graham *et.al.* is not to flounder again on the same shoals, then everyone on deck ought to be peering into the murky waters to report back potential channels through which it might be successfully steered. It is hoped that this paper stimulates reflection and discussion of Graham's essential purpose, and that it may also attract timely collaboration to develop, prototype and test a family of practical options inspired by his monetary work, and by those who inspired him. It may be acknowledged from the outset that any innovative monetary proposal will raise objections. A document from the Food and Agriculture Organization (addressing an entirely different context) expresses the riddle we face, and the open participatory approach required:

“Complex problems do not have fixed solutions because each solution brings its own problems, depending on the perception of the stakeholder and the boundaries of the system involved. Many methods have been developed to address these issues of complexity. Most of the methods are based on participatory approaches that take into account the perceptions of the different stakeholders at several levels of the system hierarchy in order to make interpretations, classifications and solutions acceptable.” (Food and Agriculture Organization 2001: Chapter 3)

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Improvements to Part 1 of this paper are invited to enhance documentation of the original series of commodity-reserve proposals. Contributions to Part 2 could provide further explanation for why this concept was not accepted at the time, and why it remains barely known today. Collaboration is sought in Part 3 to outline some

broad design requirements for any new 21st century monetary system grounded in the material economy. Annexes should be used for explorations inspired by the commodity-reserve proposal, but that may depart from the work of Graham *et.al.*, as is the case with the one appended to the present version.

3.2 Suggested Requirements from Systems Theory and Information Theory for a Currency Based on Physical Assets

It has long been attractive to associate currencies with physical units of a standardized asset such as gold, historically a symbol of wealth. But in the past four decades monetary authorities around the world have been provided the ultimate book-keeping indulgence of defining money in terms of bank-issued credit, basing on nothing more than the general expectation that most debts will be repaid. These fiat currencies depend upon exclusive judicial support from states as “legal tender”, and they carry an implied symbolism of allegiance.

If a currency would be tied to primary physical assets that have utility in a healthy economy, monetary theorists must somehow come to terms with constraints of applied physics and biology, as engineers and agronomists have no choice but to accommodate. The monetary philosophies of Jevons, Marshall, Ford, Edison, Graham, Kaldor, Tinbergen and Hayek outlined above were, as Graham expressed it, much broader than each of their specific plans. The objective of this paper is to attract the interests and abilities of a community of pragmatic innovators to re-examine and extend options derived from their shared contributions.

The following strategic principles are suggested to guide efforts for the design and development of monetary systems based on physical assets that reflect genuine value in terms of economic life and human well-being.

3.2.1 The Information Function of Money. If currency is to reflect intrinsic value, then *information feedback* about tangible reality is identified as a core function of money, beyond its role as a medium of exchange, a unit of account, a standard of deferred payment, and a store of value. Money is then a global language, articulated in a variety of currency dialects (rupees, pesos, euros, dollars and so on), through specialized communications media (using metal, paper, or bytes). Jay Forrester (1953) observed that the basic structural element of an organisation is the “information-feedback loop”. He proposed that a set of interacting feedback loops comprises the underlying structure of a system. No complex system will be free of flaws in design or operation. But positive information feedback loops motivate the development and use of adaptive mechanisms for resilience in the face of external or internally-generated shocks, errors,

omissions and transgressions. Negative information feedback loops motivate denials, workarounds and malfeasance, which erode systemic coherence. Therefore the structure of information feedback becomes a strategic consideration in the design of the monetary system, and is essential for the soundness of the monetary unit.

3.2.2 Resilience Over Stability. It is normally considered that a monetary system should be designed to ensure the short-run stability of prices, employment and real output, while providing for the long-run expansion of economic activity. But if the underlying physical basis of the economy is discontinuous and constrained, then we must ensure the capacity of the monetary system to absorb disturbance, adapt, and yet retain its essential support to financial, employment and real production functions. Central bankers will indeed generally prioritize resilience over stability. In 1973 systems theorist C.S. Holling pioneered this distinction:

Resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist. In this definition, resilience is the property of the system, and persistence or probability of extinction is the result. Stability, on the other hand, is the ability of a system to return to an equilibrium state after a temporary disturbance. The more rapidly it returns, and with the least fluctuation, the more stable it is. In this definition, stability is the property of the system and the degree of fluctuation around specific states the result. ... With these definitions in mind, a system can be very resilient and still fluctuate greatly, i.e. have low stability. (Holling 1973: 17)

The stability view emphasizes equilibrium, and the maintenance of a predictable world with as little fluctuation as possible. The resilience view emphasizes function and persistence, and requires that we devise systems that can absorb and accommodate unexpected events (Holling 1973: 21). Recently in an article in *Fast Company*, Jamai Cascio described how the resilience and stability viewpoints yield very different approaches to business management (Cascio 2009). The strategic significance of resilience is more fully expressed in a paper subtitled “Building Adaptive Capacity in a World of Transformations” by twenty five of the world’s top systems scientists:

Resilience provides the capacity to absorb shocks while maintaining function. When change occurs, resilience provides the components for renewal and reorganisation. ... In a resilient system, change has the potential to create opportunity for development, novelty and innovation. ... The concept of resilience shifts policies from those that aspire to control change in systems assumed to be stable, to managing the capacity of social-ecological systems to cope with, adapt to, and shape change (Folke et.al. 2002: 4).”

Both resilience and stability are desirable, but it is folly to seek stability at the expense of resilience, and wise to operate the other way around.

- **3.2.3 Pluralistic View.** Monetary economists who would attempt to design a system linked to physical assets need to accommodate the "principal message" that physicists Gregoire Nicolis & Ilya Prigogine wished to convey in their book *Exploring Complexity* (1989: 5-6), that "a pluralistic view" is necessary to describe the physical world. In his work on perception, scale and complexity, ecologist Tim Allen explains that "several different world views or perceptions are required to solve a problem", because "parameters at one level become variables at higher levels" (Allen 1987; Allen & Wyleto 1983: 539). A monetary concept linked to material assets must embrace such a multi-scaled and fully multidisciplinary logic, and remain open to diverse schools of thought. A corollary is that the monetary architecture should not itself pre-empt or be the determinant of policy direction. Competing perspectives and spheres of influence should be resolved through open and independent peer review, and democratic discourse.

3.2.4 Well-Defined, Validated and Accessible Data. The essential data supply for a monetary system based on physical assets should rely upon rigorously defined, methodologically validated and openly accessible data sources. This will sometimes require new research, but filling information gaps often demands significant additional time and overhead. Care should be taken that new information should be of a type that is directly useful towards further understanding real-world trends, consequences or feasibilities, and it should be practical to carry out within present capabilities. The data must be traceable to original sources and units of measurement, and be subject to independent multidisciplinary peer review.

The data system should implement the quality standards and principles published by the International Monetary Fund and by the International Council for Science. In 1996-97 the International Monetary Fund issued its *Data Dissemination Standards* to guide comprehensive, timely, accessible, and reliable economic, financial, and socio-demographic data. The associated *Data Quality Reference Site* assembles material related to macroeconomic data quality issues and approaches. (IMF 2008) The International Council for Science (ICSU 2008) outlines the following principles for data supply:

- Universal and equitable access (everyone everywhere without discrimination)
- Reliable and efficient access.
- Efficient data deposition and retrieval.
- Maintenance and validation of quality, authenticity and standards adherence.
- Long-term data sustainability.

- Interdisciplinary relevance and mapping.
- Flexibility in response to changing demands and knowledge.

From an ICSU perspective, an ideal data system:

- Enacts a common global vision for the stewardship of data and information.
- Accommodates a federation of active participating organizations.
- Provides a forum to identify, articulate and advocate common needs and interests.
- Promotes data publication and accreditation.
- Encourages complementary and linked provision of data and information.
- Earns stakeholder trust in the data, and in the steps required for the management of this data.

3.2.5 Transparency and Freedom of Information Systems. All present-day monetary systems and their supporting analytical systems are implemented in the form of computer programs. These computer programs are the *de facto* official translations of legislation, regulations, policies, standards and agreements in operation (Lessig 2006). A computer program is typically defined in legislation as a type of “literary work” that exists as “a set of instructions or statements, expressed, fixed, embodied or stored in any manner, that is to be used directly or indirectly in a computer in order to bring about a specific result” (Canada 1985). Therefore they are not neutral algorithms. People of a free and democratic society can rightly demand openness, transparency and accountability for the computer programs used in monetary system operations, analysis and reporting. This is expressed in the International Monetary Fund's *Code of Good Practices on Transparency in Monetary and Financial Policies* (IMF 2000), specifically that “the coverage of transparency practices for financial policies in the Code includes those for the operation of systemically important components of the nation's payment system”. It is a democratic principle of monetary systems design that the computer programs implementing them, engage free/libre/open methods and licensing (Stallman 2002; Potvin 2009a). A computer program is available under free/libre principles when everyone with a copy of it has the following four freedoms:

- Freedom 0: The freedom to run the program for any purpose.
- Freedom 1: The freedom to study how the program works, and adapt it to one's needs.
Access to the source code is a precondition for this.
- Freedom 2: The freedom to copy the program and to redistribute copies.
- Freedom 3: The freedom to improve the program, and release any modified versions. Access to the source code is a precondition for this. (Stallman 2006)

Financial institutions including central banks are increasingly participating in projects under the free/libre business model. For example ERP5 Banking is a GNU-GPL licensed system that “integrates management of banknotes and coins taking into account the vintage and place of

issue in monetary unions" (Nexedi 2009; ERP5 Enterprise 2008). The Bank of Canada's Dynamic Systems Estimation (DSE), also maintained under the GNU-GPL, is an R software package (R Foundation 2009) package for studying multivariate time series techniques and forecasting models (Gilbert 2009; Gilbert & Pichette 2003). The Bank of Canada also shares several other utilities under the GNU-GPL for statistical analysis.

3.2.6 Straightforward and Comprehensible Logic. The bare essentials of the system must be relatively straightforward for people to explain and to comprehend because complexity undermines transparency and accountability. This is not to deny that the design of a monetary system based on some idea of intrinsic value is inevitably a highly complex multi-disciplinary, multi-objective optimization problem. But under democratic premises, we assume a general incentive structure based upon both market forces and social demand, and both of these depend upon valid communication and comprehension. If the system is to be genuinely understood by households, businesses and policy makers acting individually and collectively to attain their objectives, then simple, accessible descriptions must be available that are consistent with the advanced descriptions of structured disciplines.

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ANNEX 1: Brainstorming an Earth-Reserve Currency Standard²

A1.1 Overview

The experimental Earth-reserve concept separates and rewrites the *storage* and the *information* functions of warehousing described in Benjamin Graham's system, in an effort to achieve a mechanism that might address all of the issues raised against the commodity-reserve concept, while remaining closely bound with material economic life.

Graham began the last chapter of *World Commodities and World Currency* (1944) with a quote borrowed from a *New York Herald Tribune* column that same year by Walter Lippmann:

“If we fix our minds upon the fact that the capacity to produce is the nation's wealth, and upon the dislocation of that capacity as the supreme evil to be avoided, we shall, I believe, have hold of the saving truth.” (W. Lippmann, In Graham 1944: 106)

This passage seems to be inspired more by Henry Ford's idea to engage “the world's imperishable natural wealth as the basis of currency” (New York Times 1921a), than by Edison's commodity warehouse system. Ford spoke of Capital and Land in combination, but his contemporary, the grandfather of 20th century economists Alfred Marshall, was emphatic about the difference in his *Principles of Economics* (1920), noting:

“that a far-seeing statesman will feel greater responsibility to future generations when legislating as to land than as to other forms of wealth; and that, from the economic and from the ethical point of view, land must everywhere and always be classed as a thing by itself (Marshall 1920 [1979]: 661)”.

The basis for this difference is found in David Ricardo's definition of economic rent on Land, nearly two centuries ago, which is considered the foundation of the rent concept in economic theory to this day. Yet most economist have de-coupled their thinking from Ricardo's key condition, which is that we maintain the powers of the land as a generative and regenerative system. Ricardo's unequivocal clarification on this point merits reproduction here in full:

"Rent is that portion of the produce of the earth which is paid to the landlord for the use of the original and indestructible powers of the soil. It is often, however, confused with the interest and profit of capital, and, in popular language, the term is applied to whatever is annually paid by a farmer to his landlord. ... Adam Smith sometimes speaks of rent in the strict sense to which I am

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desirous of confining it, but more often in the popular sense on which the term is usually employed. He tells us that the demand for timber, and its consequent high price, in the more southern countries of Europe caused a rent to be paid for forests in Norway which could before afford no rent. Is it not, however, evident that the person who paid what he thus calls rent, paid it in consideration of the valuable commodity which was then standing on the land, and that he actually repaid himself with a profit by the sale of the timber? If, indeed, after the timber was removed, and compensation were paid to the landlord for the use of the land, for the purpose of growing timber or any other produce, with a view to future demand, such compensation might justly be called rent, because it would be paid for the productive powers of the land; but in the case stated by Adam Smith, the compensation was paid for the liberty of removing and selling the timber, and not for the liberty of growing it. He speaks also of the rent of coal mines, and of stone quarries, to which the same observation applies -- that the compensation given for the mine or quarry is paid for the value of the coal or stone which can be removed from them, and has no connection with the original and indestructible powers of the land. This is a distinction of great importance in an inquiry concerning rent and profits; for it is found that the laws which regulate the progress of rent are widely different from those which regulate the progress of profits, and seldom operate in the same direction. ... In the future pages of this work, then, whenever I speak of the rent of the land, I wish to be understood as speaking of that compensation which is paid to the owner of land for the use of its original and indestructible powers." (Ricardo 1973 [1817]: 34)

In Ricardo's day as in ours, it was easy to see examples of the original powers of the Earth actually being destroyed. The meaning of "indestructible" is given in Samuel Johnson's Dictionary of the English Language (1755) as: "not to be destroyed". The nuance of the earlier usage, that the productivity of the land ought not to be destroyed, seems to be the only reasonable interpretation of Ricardo's text. Today it is generally assumed that where this condition does not hold, resource and ecosystem degradation can be considered negligible, can be reversed, can be circumvented, or can be substituted for. It is assumed that market signals provide sufficient information feedback, and that whenever the market is impacted, intelligent people with sufficient incentive in a sufficiently free society can always be expected innovate out of physical and biological constraints. Regardless of whether or not one has faith in such technology optimism, economists are obliged to account correctly for rents versus profits by measuring changes to what Ricardo refers to as the productive powers of the Land. Ecosystem integrity and resource availability together are the wellsprings of raw materials, and thus, the preconditions of economic rent. If expenditures for the basic maintenance of ecosystem integrity and resource availability are obligatory, not discretionary, then economists must track accumulated obligations of this type from one fiscal year to the next. The size of the deficit, each fiscal year can be estimated as the financial amount that the society fails to spend to fix ecosystem degradation it is responsible for, plus the financial value lost from exhaustible resources rendered unusable. In discussions that led to the original national accounting concepts in the 1940s, John Hicks understood this. Explaining the idea, he stated "we ought to define ... income as the maximum [we] can consume during a week, and still expect to be as well off at the end of the week as [we were] at the beginning (Hicks 1946: 172).

A1.2 The Storage Function.

In an Earth-Reserve currency system, Graham's physical commodity-reserve concept is shifted back one stage in the production chain so that *the Earth itself is the warehouse*. Instead of stockpiles of a limited range of commodities produced and transported into a logistically complex global network of constructed warehouses, the Earth-Reserve system is linked to changes in the measured preconditions of economic rent in each economy.

Rather than *kinetic* commodities tracked in physical warehouses, commodity *potential* is tracked *in situ*. What is “stored” in this framework are factors such as topsoil volume, fertility and distribution, water availability, quality and distribution, species populations, diversity and integrity, the extent and condition of local, regional or global habitats and routes, essential biogeochemical cycles, and multiple other critical indicators.

Some of the more complex attributes can be measured indirectly. Dale Quattrochi and Jeffrey Luvall (2004), for example, review a decade of progress in the utility of thermal remote sensing techniques whereby infrared reflectivity from the Earth's surface provides a valid proxy for monitoring general ecosystem integrity. For their part, geologists and engineers maintain estimates of production and depletion rates for copper, petroleum, potash and other useful exhaustible resources, in relation to currently deployed extraction, processing, recovery and recycling technology.

A1.3 The Information Function

The 21st century medium for a tabular standard is a *data warehouse*. Instead of monitoring the quantity and quality of stored primary commodities using warehouse receipts, the Earth-Reserve indexing system would tabulate measured changes to relative ecosystem integrity and resource availability. The indices can be tailored to each currency's geographical extent through the use of standardized international data on the currency of invoicing (Donnenfeld & Haug 2003; Melvin & Sultan 2005). An Earth-Reserve composite index relevant to each currency is proposed to take the place of Graham's composite commodity unit. It supplies a basis on which to peg the worth of each currency in relation to Ricardian rent in that currency's region of use, which is to say, in reference to changes in the state of ecosystem integrity and resource availability. Neither gold, nor a commodity-reserve currency system provide any link to Ricardo's essential condition in regard to accounting for rent and profit.

The essential data for trends on ecosystem integrity and resource availability are monitored by the world's science community. For example, the World Data System (WDS) of the International Council for Science (ICSU 2009) provides a useful set of primary data sources. The ICSU functions as a consortium of 116 national scientific bodies and 50 international, non-governmental, scientific professional organizations. The WDS is an inter-disciplinary data management and data exchange initiative involving major international programs such as the Group on Earth Observations (GEO), Global Earth Observation Systems of Systems (GEOSS), the International Polar Year (IPY), the Millennium Ecosystems Assessment (MEA), and the Coordinated Energy and Water Cycle Observation Project (CEOP). The WDS engages current information technology and advanced data management and exchange techniques for the long-term stewardship and provision of quality-assessed data and data services to the international science community and other stakeholders via global, distributed data management and exchange.

For exhaustible resources, services such as the *Geoscience Data Repository* (Natural Resources Canada 2009), the *BP Statistical Review of World Energy* (British Petroleum 2009) and the *World Energy Outlook 2008* by the International Energy Agency (2008) provide useful statistics. The latter report in particular demonstrates that it is difficult to validate reports on exhaustible reserves. Data that does not meet quality or validation requirements should not be included in the Earth-Reserve tabular standard.

An Earth-Reserve tabular standard would use available data from the biogeochemical and engineering disciplines, combined with commodity market analysts and currency statistics. It requires the following types of measured and modeled data:

Measured Data: Biogeochemical Sciences, Commodity Market Statistics, and Currency Statistics

- Identification of a set of biophysical indicators relevant to ecosystem integrity and resource availability (including effects of compensating enhancement to ecosystems; durability of resource applications; and recycling of materials and energy, etc.);
- Base year measurements/estimates for each indicator, which must be independently verifiable;
- Current year measurements/estimates for each indicator, also independently verifiable;
- Relative weighting of indicators in relation to ecosystem integrity;
- Standardized international data on the currency of invoicing.

Modeled Data: Biogeochemical Sciences, Commodity Market Analysis and Socio-Economic Policy

- A “Worst Case Scenario” description relevant to each indicator. This is a realistic description of potential conditions that absolutely must be averted. The scenarios are dynamically modelled, in order to reflect cumulative impacts of multiple factors and the acquisition of new knowledge.
- A “Best Case Scenario” description relevant to each indicator. This is a realistic description of a target state, also dynamically modelled. When ecosystem and resource degradation occurs that is irreversible, the range of possibilities for Best Case Scenarios relevant to each indicator becomes more constrained.

The diversity of measurement units described above can be shown in a consistent way by using the percentage change of each measurement from a common base year to the best and worst case scenarios. Also, each of the multiplicity of indicators has a different significance in terms of inter-relationships and consequences for ecosystem integrity and resource availability, therefore a weighting structure is applied. In practice, weights related to significance would be model-based, and can also be formula-driven to gradually adjust as the state of ecosystems and resource dependencies change, and as knowledge advances.

The specific design of a proof-of-concept Earth-Reserve index mechanism is addressed in a separate paper (Potvin Forthcoming). The work of establishing and calibrating such a system is somewhat complicated, but immensely simpler than physically building and operating a global commodity-reserve system of warehouses in the manner proposed by Graham *et.al*. The Earth already is a special sort of warehouse that stores the capacity to produce commodities and other essentials of life. Compared with the Edison-Graham idea of tracking standardized warehouse receipts for standardized commodities, the essential monitoring data for ecosystem integrity and resource availability is obtained from existing sources, or is accessible through research that is practical to carry out given present capabilities. When it is determined that additional research is needed, such effort is nevertheless useful towards further understanding trends, consequences or feasibilities relevant to human well-being. On a diversity of issues opinionated judgement and debate are inevitable, and there is no doubt that this scheme would result in greater pressures for the politicization of science than seen today. However reliance on broadly-based initiatives such as the *World Data System*, the *Geoscience Data Repository* and statistics from the International Energy Agency provide a reasonably effective way to mitigate the impact of politics on science, by being subject to scientific peer review and a reasonable degree of consensus.

A1.4 Theoretical Foundations for Measuring Economic Rent

Graham's commodity-reserve system was grounded in the role and function of primary commodity markets in the economy. He explained:

Not only do all the material things of life begin and develop with them; but the complex and delicately interrelated organization of business receives its first impetus and its controlling tone from this area. The economic flow has a definite entropy, or permanent direction, from raw materials outward. (Graham 1937: 229)

His statement applies moreso to the original sources primary commodities, than to commodities already produced. The present proposal builds upon the role and function of ecosystem integrity and resource availability as preconditions for producing primary commodities, and it explicitly accommodates Ricardo's condition that we maintain the powers of the land as a generative and regenerative system when accounting for rent versus profit.

Financial and economic analysis would therefore depend upon the reliable scientific characterization, measurement and monitoring through time of relative ecosystem integrity and resource availability. For this purpose recent systems theory offers us a consistent interdisciplinary framework based on relative *organizational complexity*. It is also valuable to acknowledge that almost a century ago economist Alfred Marshall (1920: 114) described Organization as a distinct agent of production.

A1.4.1 Origins of Organizational Complexity Analysis in Economic Systems Theory

After cultivation and harvesting of farm products, and after discovery and extraction of exhaustible resources, raw materials proceed through a system of production and consumption cycles. This process was described in François Quesnay's *Tableau Economique* (1758), which Piero Sraffa, editor of *The Works and Correspondence of David Ricardo* (1951-1973) referred to as the “original picture of the system of production and consumption as a circular process” (1960: 93). In *Production of Commodities by Means of Commodities*, Sraffa (1960) then provided a formal mechanism for Quesnay's *Tableau* to enable systems analysis for all production and consumption relationships scaled to an entire economy. Independently, Carl Menger emphasized the increasing degree of organization that brings society towards more complex multilateral and multi-tier production/exchange (Menger 1871: 51-76). and also from autonomous origins, John Furnivall focused on the organization of consumption, with its increasingly more refined and complex forms and expressions of demand (Furnivall 1910). Together these authors provide a rigorous foundation for describing organizational complexity in human activity. This can be situated within an analytical framework for describing organizational complexity in the broader bio-geo-chemical world.

A1.4.2 Origins of Organizational Complexity Analysis in Ecosystem Science and Engineering

In the 1970s and 80s an interdisciplinary community began to measure resource availability through formal indicators of physical organization (Georgescu-Roegen 1975; Ayres 1978, Szargut 1986, Szargut et.al. 1988; Palmer 1987). Empirical data describing physical gradients offers "a quantitative measure of the ability to cause change (Palmer 1987: 248)", and this offers a rigorous means of describing “dissipative patterns and structures” first articulated by Ilya Prigogine and Gregoire Nicolis (1977, 1989). Systems ecologists such as James Kay (1984), Bob Ulanowicz (1986), Goran Wall (1986) and Karl-Erik Eriksson et.al. (1987) proceeded to analyze living systems using this framework, based on the measure of resource opportunities that enable self-organizing systems (including humanity) to structure matter, or to maintain structure, in states that serve the system functions. Physicists, engineers and ecosystem scientists have generally approached a consensus in describing any system's integrity as its dynamic ability to maintain its relative level of organization and to continue its

process of self-organisation under changing intrinsic and environmental conditions (Kay 1991, 2002) This work has demonstrated how the relative degree of organization of an ecosystem can be empirically described with reference to its growth and development. Growth is meant as an increase in physical dimensions and total system throughput, as well as in the number of system compartments. Development refers to advancement in hierarchical and structural differentiation of a system, wherein distinct components become more interrelated to function as an articulated, harmonious unit, without compromising their own distinctiveness (Ulanowicz 1986: 96-97). More recent advances in this approach to system measurement are reported in Muys et.al. (2001), de Groot et.al. 2002, Chen (2005) and Wagendorp et.al. (2006). This provides a framework for measuring ecosystem integrity and resource availability in a comprehensive theoretical framework.

A1.4.3 Recent Directions in Interdisciplinary Organizational Complexity Analysis

Structural systems analysis spanning economics and science was pioneered by Bruce Hannon (1973) and Patten, Bosserman, Finn and Cale (1976) who relied upon the linear input/output structure of Wassily Leontief (1951). However Piero Sraffa's analytical framework (1960) based on Quesnay's *Tableau* is directly able to incorporate non-linear feedback loops, and therefore technical change, which is essential to complex systems analysis (Potvin 1992) and to addressing Ricardo's condition. In this direction, Kōzō Mayumi (2001) published a valuable interpretation of Sraffa's scheme in light of Nicolas Georgescu-Roegen's physical analysis of the economy. Mayumi's most recent empirical work, focused on the Chinese economy (2007; 2008), offers a promising direction for fully-integrated modeling and analysis.

A1.5 Macroeconomic Information Feedback Under an Earth-Reserve Currency Standard

When on a gold standard, adding gold to the reserve puts more money into circulation and is inflationary, whereas the sinking of a ship loaded with reserve gold is deflationary. To the extent currencies are based in whole or in part according to an index derived from indicators of the productive powers of the land, an increase in resource availability or in ecosystem enhancements will be inflationary, and degradation in both these will be deflationary. The monetary implications can be followed through.

In a multi-jurisdictional multi-currency setting, measured resource and ecosystem degradation in a currency's region of use relative to a base year would cause this currency to become relatively more expensive to buy against other currencies, and the goods and services exported in exchange for this currency would become more expensive. In a country or community context, exports would thus tend to fall, bringing some loss of domestic

production and employment. At the same time, imported goods and services become relatively cheaper for households and businesses that operate in the given currency, so that the volume of imports will tend to rise. This erodes the market share of this region's or community's producers. As employment within the country or community suffers, social pressures and lost profits make it unattractive for public or private sector decision-makers to continue in such a direction.

These are all desirable consequences from the viewpoint of macroeconomic resilience, because they impose significant self-correcting pressures that favor the maintenance of relative resource availability and ecosystem integrity for each country or community through time, underlying its capacity to produce raw materials, and thus support wealth and wellbeing. Benjamin Graham sought to align money with the things upon which human life depends physically and biologically. This variant of Graham's proposal would deeply internalize resource and ecosystem *integrity* and *degradation* into markets and trade, and information feedback would be a core function of this sort of currency.

Some will object that such a system would not permit monetary authorities sufficient agility to respond to circumstances by creating greater liquidity on demand. This complaint is understandable for a generation that is accustomed to central banks that, when pressed, can simply type virtual fiat units into databases, and to commercial banks that “loan” out money they do not have due the convenience of the fractional reserve rule. But as Graham emphasized, physical commodities supply the liquidity, and money is only as liquid as its purchasing power. In Graham's commodity-reserve system, inventories of useful commodities are the most liquid of assets. We accept this in principle, but add that in an Earth-Reserve system, the capacity to produce commodities is the wellspring of that liquidity. If greater liquidity is required, this can be obtained by improving ecosystem integrity and resource availability, the preconditions of rent. If this cannot be accomplished, then greater liquidity is not warranted by real circumstances, regardless of how much it is desired.

A1.6 An Earth-Reserve Reference Implementation

The present economic crisis is sufficiently profound and complex that the monetary work of Benjamin Graham *et.al.* should be given urgent, open and thoughtful consideration and development. With the benefit of hindsight, it is time to consider afresh how we might build on their counsel to align money with intrinsic value, to respect core banking principles, to concern ourselves with sustainable commodity supply, demand and pricing, and to harness market forces in the public interest. Professionals in economics, finance and banking ought to read the intrinsic value currency proposals, reflect on them, and participate in re-fashioning some variants of them

suitable to our life and times, through at least the next half century.

Skilled and creative collaborators are invited to help advance an Earth-Reserve Currency Standard Reference Implementation as a potential basis for proof-of-concept monetary systems in global, country, community or sectoral contexts. Work on the project is being started at <http://www.brettonwoodsII.org>. The system requires a suitable data model, functional software, operation of a web service, some experimental macroeconomic modeling and analysis, and for all of the above, a suitable model for community intellectual rights management.

A1.6.1 Data Model: Technical participants are needed for an interdisciplinary working group to develop the Earth-Reserve data model. Creation, calibration and maintenance of a normalized, trusted data store from diverse sources begins with standards-based metadata documentation. Therefore documentation should conform with the ISO 11179:2003 standard for definitions, descriptions, business rules and metadata.

A1.6.2 Functional Reference Implementation: Database analysts and software programmers are invited to advance the Earth-Reserve reference implementation under free/libre licenses. The particular software components to be used are not fixed, and the system is modular. The current idea is to implement the system as an advanced generation data warehouse (Piprani 2008) in a *PostgreSQL* database www.postgresql.org in which the SQL code conforms with ISO 9075:2003 for shareability. This will be integrated with the statistical and graphic capabilities of the *R Project* www.r-project.org using *PL/R* (*R* Procedural Language for PostgreSQL <http://www.joeconway.com/plr/>). In the current view, the main user environment of the reference implementation would be based on *Rattle* <http://rattle.togaware.com>. Revision control and issues management for the reference implementation source code and documentation is maintained in an instance of the Redmine project management environment www.redmine.org.

A1.6.3 An Earth-Reserve Standard Indices Service. Start-up and operation of a proof-of-concept web service depends upon the collaboration of a small number of technical and business partners. Partner organizations and other participants may assist through funding or in-kind assistance. The resourcing model for the service will not be based on user access fees, but will pursue an open access approach that provides opportunities for testing and peer review.

A1.6.4 Earth-Reserve Macroeconomics. Analysts from government, commercial and not-for-profit organizations, academia and civil society are invited to explore, discuss and develop the potential use and

implications of Earth-Reserve indices as a basis for currency valuation.

A1.6.4 Intellectual Rights Management. The Earth-Reserve Currency Standard Reference Implementation is being created as a fully free/libre project licensed under the GNU-GPL v3 and the GNU-FDL v1.2 licenses (Free Software Foundation 2009; Wheeler 2007), via the FLOW.through.1 business model (Potvin 2009). Each contributor also retains authors' rights in their own work, to use, modify and distribute, in whole or in part, through any channel, for any purpose, under any terms and conditions. To permit easy intellectual rights management through time, each contributing author also assigns joint independent copyright to the core project team. Putting the GNU series of licenses at the centre of this intellectual resource community helps to attract back, under unified business terms and conditions, the improved, derivative and/or combined works acquired through this project that anyone else may create for distribution.

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