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DIGITAL DESIGNS (PART II)

WHAT CENTRAL-BANK DIGITAL CURRENCIES MIGHT AND MIGHT NOT BE ABLE TO DELIVER.

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IN A NUTSHELL

_ If history is any guide, states are likely to continue playing a central role in determining the future of money and payment systems.
_ The largely forgotten story of the world's first central-bank digital currency offers some useful pointers.
_ Textbook answers on the functions of money will only get you so far.

1 / Introduction

"*Money has always been a sexy topic. As has technology.*" the Economist noted back in 2000, reporting on the already fizzling hype that had greeted the arrival in the mid-1990s of various kinds of digital cash. "*Some predicted that private electronic currencies would swiftly compete with dollars or D-marks. Central bankers began to worry that – perish the thought! – they might become obsolete.*"[1]

Twenty years later, many would argue that this point has gotten closer. As we argued in Part I [CIO Special – Digital Designs Part I], money and payment systems are intrinsically linked. Thinking about one necessarily requires thinking about the other. And at least as far as payment systems are concerned, there has been plenty of change. Reality is nevertheless likely to be different. In territorial states, it is generally quite difficult to separate monetary history from that of state power. Historically, "money" was simply too important to territorial states to allow it, or its guardians, to become obsolete.

That is well illustrated by the largely forgotten episode of how digital central-bank currencies first got started we turn to next. We go on by explaining why textbook answers on the functions of money will only get you so far and conclude by introducing the topic we will turn to in Part III: re-thinking payment systems as social networks.

2 / When thinking about money, don't forget about states either

Consider how paper money first evolved in China. Apparently, it started as private promissory notes backed by precious metals, but government soon took over (just as it did a couple of centuries later in the West). Under Wang Anshi, China's Imperial Chancellor of the day, the state was suddenly able to use freshly printed money to directly invest in various enterprises or provide loans at a much lower interest rate than the prevailing market one. Freed from fiscal constraints, the Song Dynasty (960–1279 AD) was thus able to pursue a strikingly "*proto-Keynesian economic policy.*"[2] In addition to some promising reforms, such as breaking up private monopolies, the Song bureaucracy began to spend lavishly on early forms of welfare

[1] https://www.economist.com/finance-and-economics/2000/02/17/e-cash-20
[2] Zhao, X.; Drechsler, W., "Wang Anshi's economic reforms: proto-Keynesian economic policy in Song Dynasty China", Cambridge Journal of Economics, Volume 42, Issue 5, September 2018, Pages 1239–1254, https://doi.org/10.1093/cje/bex087

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payments and military adventures using freshly printed paper money. Such a currency derives its value “only” from government fiat. It will survive and prosper only if the state issuing it does. In China’s case, the results of these early monetary experiments appear to have been two episodes of run-away inflation and, eventually, the fall of the Song Dynasty.[3]

One way to read such histories is as morality tales. Modern critics of fiat money – and Keynesian policies to stimulate demand more generally – might use the example to point out how paper currency may have paved the way to the conquest of China by the Mongols.[4] Perhaps, the more important lesson is that whether a territorial state adopts a monetary innovation is never just a matter of what seems economically sensible to private actors. Nor of what is politically feasible, given the institutions and technologies it already has. It is whether political decision makers of the country in question judge it to be desirable and even imaginable. From then onwards, money and payment systems tend to proceed via trial-and-error, with the results at any given stage *"not deliberately founded upon definite reasons,"* to use Bagehot’s evocative phrase.[5]

Politics often gets lost when economists think about monetary history. Yet, even within Western civilization, money from coining precious coins did not spontaneously emerge in order to reduce the costs of transactions.[6] When metal coins began to be minted in Europe and the Middle East in the last few centuries before the current era, this might have looked like a purely technological innovation. From the very beginning, though, standardized coins – usually minted under state supervision – were also deeply political projects.[7] Soon, coins came to be used by rulers to establish their authority, facilitate trade and extract taxes. Indeed, a strong case can be made that Rome’s system of imposing money taxes first on its Italian allies and later across conquered provinces promoted economic integration: “the tax exporting provinces had to earn money with which to pay their taxes by exporting goods of equal value” to the rest of the empire.[8] Such effects tend to be indirect and to a great extent unintentional. Still, the idea that currency unification can promote integration is probably one of the easier economic concepts for policymakers to intuitively grasp. Certainly, it was one of the main reasons for launching Europe’s common currency, in the process creating the continent’s largest currency zone since Roman times. And it again highlights the links between state power, territorial control and money.

Nor does that only apply to either the modern euro or the early "monies” – metal coins – that happened to be adopted in the Old World. For striking examples that contrast sharply with those of the early states in Europe and Asia, consider pre-Columbian empires of ancient Mesoamerica. Famously and to the surprise of their European conquerors, the Maya, Incas and Aztec tended to use commodities such as cacao beans, rather than gold or silver as “money” in so far as there even was such a concept.[9] These examples also illustrate that the choices of which commodities could serve the purpose of a common medium of exchange tend to be quite a bit more complicated than Western textbook accounts on the functions of money make it sound.[10] In Mesoamerica, geography – how far big centers of wealth and power were from where cocoa was grown or gold was found – appears to have played a decisive role. Even more critical, though, was state power. In the Inca and Aztec civilizations “trade and payment systems” largely consisted of taxes and tributes, imposed by what were essentially imperial city states over far-flung territories. These tributes comprised mandatory labor, rare feathers, cacao beans, precious cloths and probably a host of other items those at the top of the political pecking order desired.[11]

Thinking through such unfamiliar examples and their implications helps direct attention towards where to look out for those “many singular events” Bagehot mentioned with big consequences. Upon closer inspection, very little in the history of money or indeed any other aspect of human life is as foreseeable, let alone inevitable as it might first appear to a doctrinaire. For example, it is actually quite easy to imagine Inca and Aztec voyagers “discovering” and invading Europe, instead of the other

[3] See Lui, Francis T. 1983. Cagan’s Hypothesis and the First Nationwide Inflation of Paper Money in World History. Journal of Political Economy 91, no. 6: 1067–74. https://www.journals.uchicago.edu/doi/abs/10.1086/261201;

[4] Note that this happened more than 200 years after Wang Anshi’s fall from grace. So, if there is a causal connection, we are talking about truly long and variable lags between a monetary policy and its eventual effects. For an interesting attempt to make the case for such links, see: Onge, P. (2017) How Paper Money Led to the Mongol Conquest https://www.independent.org/pdf/tir/tir_22_2_09_stonge.pdf

[5] See Part I of our Special [https://www.dws.com/insights/cio-view/macro/digital-designs/]

[6] https://www.economist.com/finance-and-economics/2012/08/18/on-the-origin-of-specie

[7] For a succinct overview, see Goodhart, C. (1998) “The two concepts of money: implications for the analysis of optimal currency areas”, European Journal of Political Economy, Volume 14, Issue 3, pp. 407-432. https://modernmoneynetwork.org/sites/default/files/biblio/goodhart_-_two_concepts_of_money.pdf

[8] Hopkins, K. (1980). Taxes and Trade in the Roman Empire (200 B.C.-A.D. 400). The Journal of Roman Studies, 70, 101-125. doi:10.2307/299558; p. 101

[9] On cocoa beans in particular, see https://www.sciencemag.org/news/2018/06/maya-civilization-used-chocolate-money;

[10] For a handy historical overview of different goods used as currency in various parts of the world and the sheer variety of “payment systems” (including giant stone discs on the South Pacific island of Yap as an early distributed ledger) see: http://archive.nytimes.com/www.nytimes.com/packages/html/magazine/2013/innovations-issue/#/?part=currency;

[11] Unfortunately, much of that knowledge has been lost, making it hard to draw clear comparisons with the ancient empires of the old world. See, in particular: Restall, M. (2003) Seven Myths of the Spanish Conquest. Oxford University Press, and Hill Boone, E. (1994). The Aztec World. Montreal: St Remy Press

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way around.[12] If so, the promissory notes of early banking might well have been backed by cocoa beans. Perhaps, money today would still be commodity-backed – but tied to a basket of edible commodities, rather than gold or silver.[13]

Such historical counterfactuals are not just entertaining. They also serve the very useful purpose of broadening the imagination, rather than simply thinking about technological advances in how certain goods are produced.[14] In the case of monetary history, real or potential turning points tend to be found just as much in the realm of political action and theorizing. If history is to offer useful pointers the political context needs to be taken into account. For example, under what circumstances might the nearby existence of competing states re-impose fiscal constraints when rulers yield to the temptation of debasing – that is, lowering the precious-metal content of – their currencies? Early modern European history offers an interesting contrast to what happened in Song China.[15] Alternatively, historically curious central bankers with a shorter time horizon might ponder what could have been, when thinking about such innovations as the electronic currencies of the 1990s and early 2000s. Most of these were private schemes, but with one notable exception.

3 / How digital central-bank currencies first got started

"The coming of e-money would seem to demand that governments of the world get together and implement a scheme in an orderly fashion," U.S. technology magazine Wired declared. "But that's not happening. *The US, in particular, is promulgating public cluelessness. When I called a spokesperson for the Federal Reserve to ask about electronic cash, he laughed at me. It was as if I were inquiring about exchange rates with UFOs. I insisted he look into it and he finally called me several days later with the official word: the Federal Reserve is doing nothing in that area."*[16]

To be fair, the year was 1994. Wired was a one-year-old media start-up. And the world's first central-bank digital currency – electronic money for anyone who wants it, directly backed by an established central bank? Well, shame on you if you are thinking that was the stuff fact of science fiction. As a matter of fact, it had already been launched two years earlier by the Bank of Finland; 16 years before anybody had heard of bitcoins and a few years before Nick Szabo developed his ideas for what he called "Bit Gold."[17]

Alongside early forms of private e-money, that mostly forgotten Finnish project and especially how it ended still holds valuable lessons for digital natives and older generations alike. Back in the late 1980s and early 1990s, the Bank of Finland was a pretty lonely pioneer among central banks.

The first known usage of a central-bank digital currency happened *"in December 1992 when [Bank of Finland] board member Harri Holkeri made the first phone call* using *the Avant card."* [18] (p. 5) The monetary value was stored on the card itself, with no tracking of who held which cards or how much money remained stored on each card. From a typical user's perspective, having an Avant card was quite a lot like a wallet full of coins – except that the Avant card was less heavy and took less space. It did not require any (let alone permanent) Internet connectivity. The idea was to use *"smart card technology in parking, phone booths, and other small-value payment situations. To avoid unnecessary fragmentation, and to ensure a sufficient level of*

[12] In a recent novel, Laurent Binet does just that. The main, and quite defensible, assumption, he makes is different patterns in the spread of pathogen during the centuries preceding the conflict. In Binet's version of "world history" Viking discoverers made it all the way down to Mesoamerica, bringing with them certain technologies and – more importantly – pathogens, leaving indigenous populations immune to diseases already common among Europeans. Binet, L. (2019) Civilizations (Grand Prix du Roman de l'Academie Francaise), French & European Pubns, ISBN-13 : 978-1547909445; English translation forthcoming.
[13] For more on the idea of how a basket of edible commodities might serve as an international currency standard, see the following classic article introducing the concept of Burgernomics: https://www.economist.com/news/2015/01/23/on-the-origins-of-the-hamburger-standard
[14] Tetlock, P., Lebow, R. and Parker, N. (2006) "Unmaking the West: 'What-If?' Scenarios That Rewrite World History, University of Michigan Press, ISBN: 978-0472031436
[15] For example, the BoE was set up in 1694 as what we might today call ring-fenced, privately funded, special purpose vehicle to allow the government to borrow. The reason was that following decades of political instability, England's government was deemed not sufficiently credit-worthy to borrow itself. See: Bagehot, W. (1873) Lombard Street: A Description of the Money Market, Chapter 3, available at: http://www.gutenberg.org/cache/epub/4359/pg4359.html
[16] Steven Levy, E-Money (That's What I Want), Wired - 12/01/1994 available at https://www.chaum.com/ecash/articles/1994/Wired/12-01-1994%20-%20E-Money%20(That_s%20What%20I%20Want).pdf
[17] https://nakamotoinstitute.org/bit-gold/
[18] Last year, the Bank of Finland helpfully summed up some of the lessons for the rest of the world in a still largely overlooked a paper, which the below account is largely based on. https://helda.helsinki.fi/bof/bitstream/handle/123456789/17590/BoFER_8_2020.pdf; for earlier, detailed accounts by the Bank of Finland, also see: https://www.econstor.eu/bitstream/10419/211994/1/bof-rdp2004-027.pdf and https://helda.helsinki.fi/bof/bitstream/handle/123456789/7955/107277.pdf

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security and oversight, the Bank of Finland decided to take a leading role". (p. 3) Users could buy prefunded smart cards and top them up as needed. The card was distributed through *"a leading chain of convenience stores."* (p. 6)

The public sector initially got involved to avoid the emergence of several competing systems, which could have led to over-investment and a lack of standards. The reason the Bank of Finland ended up initially running the scheme – on its own balance sheet – was that Finland's commercial banks were in crisis at the time of the launch (following the collapse of the Soviet Union, which triggered a deep economic downturn). After about three years, once the banking sector had recovered, the central bank eventually decided to spin off and sell the business to commercial banks. After all, it had never intended to take such a leading role in the first place. Commercial banks swiftly began offering combined cards, where one physical card could serve three different functions: credit (i.e. paid for later), debit (deducted from user accounts right away) and Avant (electronic quasi-cash that could be used offline, without requiring authentication).

The scheme ended when debit cards became sufficiently competitive to offer customers similar benefits (including improving security features) at lower cost (even for low-value payments) than Avant. [19] And interestingly, neither new payment technology quite lived up to the hype of the time of e-money cards (whether public or privately run) replacing cash altogether before very long. *"There had been predictions that e-money could make cash practically disappear in a matter of years. (…) The handling of cash was an expensive undertaking, and any solution that would reduce those costs would be welcome. It was commonly assumed that at least coins could be largely replaced by e-money (…). Most of these predictions have later turned out to be grossly exaggerated."* (p.9)

In short, "the world's first CBDC" happened more or less by chance. If the history of virtual currency schemes of the past 30 years teaches anything, it is that many of the wilder predictions – for better or for worse – will probably turn out to be overblown.[20] In Finland, the end result, almost 30 years later, is a domestic payment system that does not look all that different at least compared to its Nordic neighbors. That holds important lessons for thinking about central-bank digital currencies now.

4 / Textbook answers on the functions of money will only get you so far

We have already shown that in modern economies, "money" of any sort is intrinsically linked with payment and settlement systems and that you should not forget about states either. The Avant card illustrates both points. The reasons Finland ended up with (at least for a while) the world's first and (for long afterwards) only central-bank digital currency also highlights the role of historical contingencies.

There is, though, a different way to look at that story, perhaps more familiar to one-time students of economic textbooks. Avant card and various private electronic money schemes simply lost out to superior payment technologies. To an economist, that result might look inevitable, almost no matter what the Bank of Finland or other public or private actors did from the early 1990s onwards. Such thinking of available technologies and resources quasi automatically determining how goods and services are produced or paid for has a long history of economic theorizing.

Carl Menger made the case that there was something special about precious metals, making gold and silver particularly well suited as early monies. "*There is no centre of population, which has not in the very beginnings of civilization come keenly to desire and eagerly to covet the precious metals,*" Menger argued (p. 252) and: "*Money has not been generated by law. Its origin it is a social, and not a state-institution*" (p. 255).[21] As we saw, such broad claims tend to turn out to be historically dubious or even inaccurate upon closer inspection. There is no human instinct or natural law that would dictate gold to be

[19] Indeed, one might argue that high costs and lack of user friendliness made Avant inherently inferior – and raise similar questions about today's CBDC projects. See: https://davidgerard.co.uk/blockchain/2020/01/25/avant-card-a-central-bank-digital-currency-from-1990s-finland/
[20] For a marvellous collection of press clippings, see: https://www.ft.com/content/2a2f5d98-4269-310d-8ae4-4f25457bf9af Our favourite ones are the following two from 1999 and 2000 in the Guardian: "But when companies can settle their bills with each other electronically, without needing to use the banking system, then central banks no longer control the levers of the economy. Digital payments systems will allow companies to instantly transfer wealth, without the risk of default." (November 4, 1999). And: "Hayek's dream of companies challenging governments for the right to issue money may yet be realised." (August 17, 2000).
[21] Menger, C. (1892) On the Origins of Money", The Economic Journal. Available at: https://is.muni.cz/el/1456/podzim2009/MPE_MOEK/um/8972262/menger1892.pdf

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more precious than silver.[22] Moreover, valuing a lump of gold would be quite hard without a lot of very specialized expertise – much harder than, say, assessing the quality of a bag of cocoa beans.

Still, it is often worth asking why self-interested individuals would have invented a system like the one we see today. What economic problems were they trying to solve? What sort of commodity might have been useful in an early barter economy for example? What hints does the available historical record offer? And is it perhaps possible to derive some general characteristics from early "monies" and payment systems still relevant today? In modern textbooks, the answer usually takes the form of introducing the three functions something needs to fulfill to serve as "money":

_ **a store of value**, which allows individuals to transfer purchasing power from today to some future date;
_ **a medium of exchange** with which to buy other goods and services;
_ **a unit of account**, against which the value of all other goods and services can be measured.

Between these functions, a different range of goods emerges that can potentially serve each function. There also seems to be a hierarchy with only a few things having the potential to fulfill the core function of money as a unit of account. To do so, the "money" in question needs to be acceptable as potential medium of exchange for most others an individual might interact with, not just now but into the future. In other words, the "money" under consideration needs to keep its value. A lot of things can serve as store of value – basically, anything that is durable and likely to be both scarce and useful in the future. A house or a plot of agricultural land, for example, are usually quite effective stores of value. They are not, however, all that useful for buying other goods and services.

As medium of exchange, livestock might be a bit better. William Stanley Jevons notes in his highly influential "Money and the Mechanism of Exchange," published in 1875: "*In several languages the name for money is identical with that of some kind of cattle or domesticated animal. It is generally allowed that pecunia, the Latin word for money, is derived from pecus, cattle.*"[23] Livestock has the disadvantage of not being easily dividable, though. A piece of cloth might be better, but has the potential drawbacks of not being all that durable and would presumably lose some of its value by being cut (reducing its usefulness and therefore demand for it at any future barter exchange). In that sense, a cattle or piece of cloth is not as good as, say, cigarettes, coins – or indeed cocoa beans.

This kind of logic can be quite useful in some settings, such as the spontaneous emergence of a new medium of exchange – cigarettes in a prisoner's of war (PoW) camp.[24] Still, it is worth keeping in mind that at different times and places, different individuals will make different choices, even when it comes to such private "monies." PoWs presumably lost no time in switching to more conventional "currencies," once they were released. Once states are involved, moreover, there is no strong reason why these three textbook functions of money necessarily would need to go together.

With new technologies, it is becoming easier still to imagine the functions being reordered, becoming jumbled or even disaggregated altogether. That clearly applies to such early digital innovations as the Avant card. To most users, it might look like a payment scheme. As such, it is close substitute to a debit card or more recent options offered by mobile companies or banks to use a prefunded smart card or smart-phone wallet for small payments. All of which is true. But technically, and using contemporary definitions, it was also a CBDC: money directly backed by the central bank and digitally stored on smart payment cards. Like small denomination coins or bank notes, there was initially no way to identify the rightful owner. That made Avant suitable as an anonymous medium of exchange for small transactions – but a potentially very risky way to store much of your wealth in case the smart card happens to malfunction.

[22] See, for example, Ridley, Matt (1998) The Origins of Virtue: Human Instincts and the Evolution of Cooperation, Penguin Books, ISBN: 978-0140264456 for a brief but fascinating history (pp. 204) on the drivers of gold and silver prices in Europe and the Muslim world from the early middle age through the crusades to the discovery of large gold and silver deposits in Latin America from the 1500s onwards. In part, that appears to have simply reflected differences in preferences as to which groups saw which metal as particularly precious.
[23] Jevons, W. (1876) Money and the Mechanism of Exchange, D. Appleton and Co. Ch. 4; available at: https://oll.libertyfund.org/title/jevons-money-and-the-mechanism-of-exchange#Jevons_0191_229; that book also introduced the three functions of money mentioned above: a medium of exchange, a common measure of value (= unit of account or common denominator) and a store of value, though he also mentioned a few others, notably that money should serve as "a standard of value". By that Jevons meant that in order to be able to lend and charge or receive interest, you need a special sort of commodity you are likely to be able to "exchange for many other commodities at nearly unchanged ratios in the future" (chapter 3).
[24] For a fascinating example of such a cigarette currency, see Radford (1945), who writes: "Although cigarettes as currency exhibited certain peculiarities, they performed all the functions of a metallic currency as a unit of account, as a measure of value and as a store of value, and shared most of its characteristics. They were homogeneous, reasonably durable, and of convenient size for the smallest or, in packets, for the largest transactions. Incidentally they could be clipped or sweated by rolling them between the fingers so that tobacco fell out." Available online: http://icm.clsbe.lisboa.ucp.pt/docentes/url/jcn/ie2/0POWCamp.pdf

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Or to take the opposite extreme, consider Mark Twain's charming short story about a million pound bank-note (nowadays worth the equivalent of 130 million). That might seem pretty useless as medium of exchange for the individual possessing the bank-note. It does, however, serve as a temporary store of value and marks out Henry, the story's protagonist, as someone very rich. Indeed, the genius of Twain's story is that it turns the traditional hierarchy of "the three functions of money" in the economic textbook on its head. This allows the reader to explore a couple of new, additional ones.

Henry swiftly discovers that everybody he encounters, from the tailor he visits to get new clothes to the humble feeding house where he eats his first meal is very happy to defer payment, once they see his banknote. Soon, the London press starts to write about the "vest-pocket million-pounder." *"Then came the climaxing stroke (…) which in a single instant transmuted the perishable dross of notoriety into the enduring gold of fame: Punch caricatured me! Yes, I was a made man now; my place was established."*[25]

Not content to just defer payment, every one of his new acquaintances tries to lend Henry money and relies on his advice on financial matters. In particular, on whether a goldmine one of his American friends has unsuccessfully been seeking investors for is a worthwhile venture. Being rich and famous, Henry is sure to be listened to while his friend wasn't. These are the very human elements at the core of what standard accounts on the history of monetary systems tend to miss. They also point in a vitally important direction: re-thinking payment systems as social networks, the topic we will turn to in Part III.

5 / Conclusion and outlook

Imagine a world with physical banknotes, but with slightly different historical origins from the ones we use today. In Section 2 of Part II of this CIO Special, we argued that you should never forget about states when thinking about money. On balance, that is probably a smart strategy, whether money is digital or not. Indeed, Western monetary history strongly suggests that states were instrumental in the use of coins made from precious metals. Still, we also outlined the uses of counterfactual scenarios in that section: thought experiments of how and why things might have turned out differently in the past or do so in the future.

We hinted at the intriguing possibility of a slightly different and quite plausible version of world history, in which Inca and Aztec voyagers "discovered" and invaded Europe, instead of the other way around. That, in turn might have led to early promissory notes being backed by an edible commodity, such as cocoa beans. And today, we might still have money backed by a standardized basket of goods and services, perhaps initially geared towards edible commodities. That basket might have changed at various points in history, and the link at various points in history being broken and reestablished, much as it was with the gold standard.

How much of a difference might that historic journey have made to contemporary monetary policy? If you think that central banking has worked reasonably well in recent decades, probably not all that much. After all, modern central banks promise to keep the value of their currency stable compared to a standardized basket of goods and services known as the consumer price index. Very different historical paths could potentially have led to a very similar result.

But would that be the end of the story? Not necessarily. Section 3 outlined how the world's first digital central-bank currency got started, against the backdrop of private-sector innovations in the 1990s. How might a fully private global currency have emerged in a still largely pre-digital age – the 1980s, say? And could it have lasted? We will return to this question in Part III and show how one such scheme could have served the three functions of money outlined in Section 4, as a store of value, a medium of exchange and a unit of account.

However, we also argued that textbook answers on the functions of money will only get you so far. The actual emergence and success of such a scheme is a matter of imagination, not just among policy makers but within societies at large. That points to the need to re-think payment systems as social networks, the next building block in our story.

[25] Twain, Mark (1893, reprint 2021) The Million Pound Bank Note. Independently published, ISBN: 979-8726647104, p. 24.

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GLOSSARY

The consumer price index (CPI) measures the price inflation as a percentage, year over year, of a basket of products and services that is based on the typical consumption of a private household.

Fiscal policy describes government spending policies that influence macroeconomic conditions. Through fiscal policy, the government attempts to improve unemployment rates, control inflation, stabilize business cycles and influence interest rates in an effort to control the economy.

Inflation is the rate at which the general level of prices for goods and services is rising and, subsequently, purchasing power is falling.

Monetary policy focuses on controlling the supply of money with the ulterior motive of price stability, reducing unemployment, boosting growth, etc. (depending on the central bank's mandate).

Purchasing power parity (PPP) is a technique used to determine the relative value of currencies, whereas the purchasing power in both currencies is the same.

The U.S. Federal Reserve, often referred to as "the Fed," is the central bank of the United States.

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