The Colour of Money: Reserve Currencies in the Era of Fiat Money
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Introduction

It is a great pleasure to return to Gresham College for what will be my third Gresham lecture in seven years. My goal today is to help demystify the concept of 'reserve currency' or 'anchor currency'—especially as it relates to globalisation, geopolitics, and the economic competition between nation states, as much of what is circulating in the blogosphere these days, and even in respectable news outlets, is rank nonsense. Confusion abounds, even amongst the well-read and well-educated. Many people, for example, are unsure if the establishment of the pound sterling as a reserve currency was a cause or consequence of Britain's putative position as a global hegemon in the nineteenth century, if the ascendancy of the dollar in the twentieth century was cause or consequence of America's hegemonic position after World War II, and now if China's rising economic might will result in the RMB eclipsing the dollar in the currency baskets of leading central banks. As the cartoon in Slide 1[i] illustrates, many people envision this as a kind of ball game in which one side wins and the other loses.

Now some of what you can read online on this subject is straightforwardly xenophobic: the adherents of the QAnon conspiracy theory in the United States appear to have convinced themselves of the delusional fantasy that COVID-19 was a plot by the Chinese government to replace the dollar with the renminbi as the world's reserve currency if Trump loses the US elections. But others are just unsure of what a reserve currency is, who decides what is or isn't one, and why it matters. It is my belief that we have collectively have a duty, a civic responsibility even, to make sure we understand the rough contours of the international monetary system, so as not to be taken in by spurious claims, and in order to understand why the rather technical question (properly one 'of maths and money'—the subject of this series) of what constitutes a 'reserve currency' has been hijacked by those with nationalist agendas and preoccupations.

If RMB internationalism is the subject of low-brow conspiracy theories in the United States, 'currency nationalism' takes on a different hue in the United Kingdom. From 1973 to 2019, Britain was a member of the European Union, initially as a member of the European Communities, but we were never a member of the Eurozone. Many people have forgotten why, in the wake of Brexit, but in reality, we were on course to adopt the euro when we joined the European Exchange Rate Mechanism in October 1990. Membership was short-lived, as Britain was forced to exit the ERM after the Black Wednesday crash of 16 September 1992, when the Bank of England proved unable to defend the pound sterling against speculators. This confirmed the wisdom of the 'opt-out' clause Britain had negotiated before signing the Maastricht Treaty. Yet the idea of joining the euro, which was briefly mooted again under Gordon Brown's government in the wake of the collapse of sterling again during the Global Financial Crisis, re-invigorated a bugbear for those who wished Britain to leave the European Union altogether. 'Britishness' soon found itself bound up in 'keeping the pound sterling', 'restoring blue passports', and 'tougher immigration controls', without much thought to whether or not other countries had been able to achieve these things within the European framework.

In the popular press, there is a tendency to conflate reserve currencies with currency unions, or currency blocs. If a currency union is sufficiently large, central banks will necessarily tend to hold that currency in their reserves. This is also true if an individual national economy is sufficiently large. This is the view of reserve currencies illustrated by the cartoon in Slide 2. Now leaving aside the question of what it means to be invited to join the table, which we will return to later, central bank holdings of euros have steadily increased in the last two decades. By the same token, the existence of the sterling area, or sterling bloc, from 1931 to 1972, contributed to the pound sterling remaining a reserve currency, albeit not *the* reserve currency, for longer than it might have done otherwise. Given the fever-pitch of British politics in 2020, perhaps it is not surprising that people ascribe a high prestige value to retaining a national currency, that they might recall with fondness other countries use of British currency, and that they might well assume that every country aspires to having one's own national currency become the dominant 'reserve currency' even if such status might not be in a given country's best interest. Post-Brexit, 'currency nationalism' has not just been a feature of popular politics. Technocrats could also fall prey to it, and there have been accusations on both sides as Britain and the EU negotiate the place of London as a major financial centre post-Brexit.

So, my lecture today aims to clarify these issues for you, by explaining the competing macroeconomic theories of reserve currencies, and to tell you how in practice central banks decide which currencies to hold in their reserves, as well as to outline the advantages and disadvantages of reserve currency status. Then I will sketch the history of reserve currencies, in order to underscore the *contingent and accidental*, as well as the *path-dependent and deterministic*, elements of the story. After that I will discuss the relationships between reserve currency holdings and economic globalisation and geopolitics, which amounts really to thinking about which arrangement: unipolar, with a single global hegemon, bipolar, with two superpowers, or multi-polar, with several significant alignments of major powers, produces the most stable international economic and monetary order. And finally, I will examine likely future scenarios, informed by consideration of the implications of the digitalisation of money, which you heard about in Professor Andrew Lewis-Pye's lecture, and the geopolitical horizon, especially as it is informed by major global challenges such as climate change and biodiversity loss.

The Economic Theory of Reserve Currencies

Before we turn to the economic theory of reserve currencies as such, it is worth reviewing the three uses of money. Many economic writers have expounded this view, and perhaps some in the audience will remember that Adam Smith explained in the *Wealth of Nations* that 'money' simultaneously serves as a unit of account, a store of value, and as a medium of exchange. An American dollar is clearly a unit of account, as globally many goods are priced in dollars, think of petrodollars, for example. It is also a medium of exchange, as banks hold dollars to settle trade invoices, and as a store of value, particularly for countries with runaway inflationary fears.

In eighteenth-century Britain, pounds-shillings-pence were the units of account, but we know most transactions happened on credit, particularly trade credit, which was settled perhaps twice per year. Large transactions were handled by promissory notes and bills of exchange. Shop credit was also very common, and if people carried coins, they were most often copper farthings or perhaps gold guineas, half-guineas, and even quarter-guineas, but one effect of Newton's decision to fix the value of a guinea at 21 shillings in 1717 was that quite a lot of the silver coin in the kingdom (those very silver pounds, silver shillings and silver pence) was melted down and disguised as Spanish bullion for export abroad. This, in effect, put Britain on the gold standard, and, indeed, gold acted as a store of value in the eighteenth century.

Now the term 'reserve currency' or 'anchor currency' if other currencies are pegged to it, really just refers to any foreign currency that central banks or monetary authorities, or other official institutions,

hold in their foreign exchange reserves. In practice, foreign exchange reserves are not just bank notes, but also include government bonds, treasury bills and notes, i.e. government securities denominated in sterling, dollars, euros, renminbi, etc. Foreign exchange reserves vary a lot by country. Famously, China holds $3.142 trillion dollars (if dollar is used as the unit of account) in foreign exchange reserves, Japan just under half that, and Switzerland just under a third at $929 billion. The United States holds $140 billion while the UK holds about $183 billion. Of those countries, Switzerland is the only one that still holds a significant percentage of its foreign exchange reserves, just over forty percent, in gold, which is a legal requirement in that country.

There are many *reasons* that central banks hold foreign exchange reserves (and in differing amounts), and those reasons have changed over time. In 2020, foreign exchange reserves are not equal to a country's treasure, though many people persist in thinking of it that way. But think about it this way: if the dollar is the most common reserve currency, then the United States does not necessarily need to hold large foreign exchange reserves, whereas the central banks of countries with large economies, like China, whose currencies do not heavily feature in the foreign exchange reserves of other countries, will need to do so.

Which leads me to the next point: when we say that the *dollar* is the main global reserve currency, we do not mean that the dollar is the only one.[ii] Globally, in 2020, the dollar accounts for about sixty-percent of the total allocated reserves, followed by the euro, which is about twenty percent of the total, with the Japanese yen at about 6% and the British pound at about 4.5%. The renminbi, by contrast, is around 2% of the foreign exchange reserves held by central banks and other official institutions—hardly, at present, a threat to dollar supremacy. That 2% is double what it was in 2016, but this is still far from significant as a portion of the total.

Now why do central banks hold foreign exchange reserves? Before the collapse of the Bretton Woods Agreement in the 1970s, outside the Soviet bloc, exchange rates were fixed, pegged to the value of the dollar, which was pegged to the value of gold. Under such a system, central banks needed foreign exchange reserves to maintain the exchange rates of their domestic currencies, by ensuring they had the ability to buy it if necessary. For countries in the sterling bloc, their currency was pegged to the pound sterling, and so they had to maintain large sterling balances in order defend their currency pegs. This was no longer needed after the collapse of the Bretton Woods system, but many sterling area countries, especially those who were also members of the Commonwealth, had significant trading ties to the United Kingdom. One big advantage of the sterling area is that membership allowed its members to settle payments in sterling without having to worry about foreign exchange controls, which were very common in the post-World War II period. Over time, in part spurred by Britain's membership in the EEC, Commonwealth countries that needed currency pegs in an era of floating exchange rates usually switched to the American dollar.

The Eurozone is a monetary union which has created a currency area. Before the establishment of the Euro, Deutsche marks (German marks) and French francs were also held in significant quantities by central banks, so it is not surprising that a fifth of foreign exchange reserves today are held in euros. Although I will spare you the digression in this talk, one feature of currency unions is that they are not just 'monetary' but are also 'economic' phenomenon, and they tend to transform the economic interdependencies within and across the agricultural and industrial sectors of their constituent members, with knock-on effects on productivity and competitiveness. Those of you who are interested to learn more might enjoy my work with colleagues, Professor Roberto Scazzieri and Dr Ivano Cardinale, on the political economy of the Eurozone.

For a long time, economists assumed that one currency would have to dominate the global economy as a reserve currency because of what economists call 'network externalities' or 'network effects,' or rather the benefits in terms of efficiencies and reduced transaction costs of everyone using the same unit of account in trade invoicing and denomination of foreign debt. At a particular point in the

past (i.e. for the half century after World War II), this might well have been the case, but, as Barry Eichengreen has argued forcibly in *Globalising Capital* (2019) and *Exorbitant Privilege* (2011), multipolar arrangements have been much more the rule than the exception.

The remaining theoretical issue to clarify is whether or not being the dominant reserve currency is a good thing for the country in question, is it, as the French thought of the American position in the post-war period, an 'exorbitant privilege'?[iii] Although the concept was coined by the French in the 1960s, many observers have similar feelings today.

On a certain level, this seems obvious. The United States appears to be in the enviable position of issuing the world's most important reserve currency. The United States borrows in dollars, and central banks need to hold dollar assets, so they appear to be willing to buy a nearly unlimited quantity of U.S. government debt. As Eichengreen (2011) succinctly puts it, printing $100 bills takes only a few cents, but foreigners have to buy dollars with hard-earned cash. This is called seigniorage and the income involved appears jaw-dropping.

That said, there are also disadvantages to being a dominant reserve currency, one that explains to a large extent the de-industrialisation of the Heartlands of the United States and the Midlands of the United Kingdom. Demand for dollars or pounds to hold as reserve assets drives up exchange rates, which makes exports, particularly manufactured goods but also agricultural products, more expensive to those who import them. This makes a country's agriculture and manufacturing base less competitive. In short, this 'exorbitant privilege' may well be that for state actors, and may even make households better off in the short-term as they are able to consume cheaply, but at the risk of making export-oriented firms worse off and with the consequence of damaging international competitiveness, which can harm the life chances of future generations, even as large-scale public borrowing can result in austerity and higher interest rates down the line.

Such 'hollowing out' of an economy can have dire political consequences, as we have seen with the rise of Trump in the United States. The Rest of the World has not been 'cheating America' but this is the price paid for the 'exorbitant privilege' of collecting seigniorage and being able to issue and sell staggering quantities of government securities, the proceeds of which sales largely spent on the military, without having to make attendant investments in improving the country's economic productivity. Now there might well have been a time when, following James Macdonald's logic in 2015 in *When Globalization Fails: the Rise and Fall of Pax Americana*, when the world might have been willing to tolerate this arrangement, and to pay that seigniorage, as the price of enjoying a 'benevolent' global hegemon, but that consensus around both American benevolence and America's ability to play that role is rapidly eroding given the shifting geopolitical sands.

A Brief History of Reserve Currencies

Reserve currencies in a technical sense date from the mid-nineteenth century when central banks and other official institutions began to take shape. The Bank of England, for example, was not nationalised until after World War II, but Bagehot's 'lender of last resort' doctrine, which requires the maintenance of significant reserves, appeared in the 1870s, on the eve of the first era of financial globalisation.

Before there were reserve currencies, there were currencies that were widely accepted internationally for payment of claims. The Roman *denari* is often-cited as the first recognisable ones (and the Frome Coin Hoard found in 2010 of Roman coins in Britain attests to its geographical reach – Slide 14), but claims can be made for the Greek drachma, and perhaps even earlier for the Mesopotamian empires (Goetzmann 2016).

Our own pounds-shilling-pence (£sd) pre-decimal currency was introduced by Charlemagne and though rendered differently in different languages was the unit of account in Europe until decimalisation. Determining actual composition of gold and silver coins, the percentage of base metal, or alloy, was complicated, as Professor Norman Biggs' lecture has illustrated vividly. Getting it wrong, as Newton did in 1717, had, as we have seen, enormous consequences, in that it shifted Britain from a silver to a gold standard in the eighteenth century. Dutch guilders, which were themselves a gold coin in this period, were the most common currency used in trade invoicing in Europe, and only gradually gave way to the pound sterling with the growth of international capital markets in the nineteenth century.

Britain was unusual in the early nineteenth century for being on the gold standard. Many European countries maintained a bimetallic standard. The dominance of the gold standard was not a foregone conclusion. Bimetallism, the maintenance of gold and silver standards simultaneously, was still an option, and the Latin Monetary Union was an attempt to do just that, by creating a currency area in which member states would freely exchange both gold and silver coins based on a fixed ratio silver to gold of 15.5 to 1 as determined by the French franc. The LMU was established by treaty in 1865, and members were added over time. There were a number of motivations for the LMU, particularly for smaller states who wanted to capture network externalities in trade, but principal among them was Napoleon III's ambition to internationalise the franc on par with sterling. Although the LMU survived Napoleon III's downfall after the Franco-Prussian War, the bimetallic standard fell victim to the volatility of relative gold and silver prices in the fourth quarter of the nineteenth century. Eventually the LMU migrated to a gold standard, and continued to operate until the late 1920s, though was largely a dead letter after the first World War, even though the percentage of foreign exchange reserves held in French francs had nearly doubled from 16% to 31% from 1899 to 1913. By 1929, that percentage had fallen to single digits, whereas the dollar had grown from single digits to over half as a result of World War I.[iv] This reversal of fortunes is precisely that kind of rapid change that has made many commentators imagine that something similar could happen with the dollar and the renminbi, though there are good reasons to think it unlikely.

Remember that gold-silver ratio from Norman Biggs' talk? Even today, geologists believe that the ratio of gold to silver in the ground is about 19:1, yet gold is far more valuable relative to silver than that. The gold ratio is a matter of intense interest to market commentators today, because many see the rising gold ratios as prefiguring economic crises and even depressions, as investors flee to gold as a safe haven[v]. Certainly, the second and third quarters of 2020 would tend to support that view.

The other point to make, as Barry Eichengreen has repeatedly done, is that the Bretton Woods Agreement is rather unusual in effectively establishing a global reserve currency by international agreement, i.e. by enshrining dollar convertibility in the same treaties that created the World Bank and the International Monetary Fund. The Bretton Woods Agreement required that central banks maintain dollar reserves adequate to support its own currency in foreign exchange markets. The United States, in turn, was required to maintain gold convertibility. In truth, after World War II, the United States was the only country in a position to perform this role and one thing the Allies had learned from two world wars was the cost of doing nothing. Over time, dollar hegemony became self-reinforcing, or path dependent, such that Richard Nixon's decision to close the gold window in 1972 did not materially affect the dollar's status as a reserve currency, though it did fundamentally alter the international monetary regime.

In the post-Bretton Woods era's world of floating exchange rates, most countries do not need foreign exchange reserves to maintain pegs to other currencies (though some currencies today in emerging markets are pegged to the dollar or the euro to protect against inflation), but it is a well-known paradox that the global value of foreign exchange reserves has grown steadily since the mid-1970s. There are a number of reasons for this, but principally macroeconomists theorise that it is because credit rating agencies use reserve ratios to evaluate sovereign credit risk. Foreign exchange

reserves are also viewed as prudent measures to stabilise the national economy and to avert balance of payments crises in both current accounts and financial accounts (especially after the Great Financial Crisis), such that central banks are expected to hold foreign currency reserves equal to a country's annual foreign liabilities, and also to hold reserves equal to a quarter, or three months, worth of imports. These are heuristics, which have become embedded in the international monetary system, often in response to crises.

The existence of these heuristics has encouraged central banks to diversify their foreign exchange holdings, which is why the basket of currencies today is so much larger than it was in the past. Of course, these heuristics are not economic laws, but rather conventions determined by international organisations and international agreements, and the World Bank, International Monetary Fund, and Bank of International Settlements were also established by Bretton Woods. Reserve currencies are related to geopolitics, but not in the way conspiracy theorists imagine.

Implications for Globalisation and Geopolitics

Bretton Woods wasn't just about deciding the reserve currency. The key element of the Bretton Woods system was fixed exchange rates, where central banks were committed to maintain exchange rates within pre-set bands. This created a Trilemma or 'Impossible Trinity,' later credited to John Marcus Fleming and Robert Mundell in the early 1960s. The trilemma states that it is impossible to have fixed exchange rates, free capital flows, and sovereign monetary policy at the same time. Any two of the positions are possible, but not all three. In the immediate post-war period, the solution for most countries was to impose capital controls, which is why, as we said, the sterling bloc was so useful to its members. The Soviet bloc notoriously had strict capital controls, with foreign exchange reserves concentrated in the USSR for most of the Cold War. With the globalisation of international capital markets since the end of the Cold War, capital controls have largely fallen out of fashion, although China still uses them.

One very significant reason why China is in no rush to accelerate their internationalisation of the renminbi is the desire to retain capital controls, both to guard against capital flight, on the one hand, and hot money, on the other. What is hot money and why is it a problem? Hot money refers to speculative flows that take advantage of interest rate differentials in government securities or of exchange rate shifts. They can be very destabilising, particularly for a country experiencing both financial deepening (growth in the depth and thus liquidity of domestic capital markets) and financial opening (gradual opening of its financial markets to international investors). This cartoon from 2010 shows Chinese fears of Hot Money from the West in the wake of Quantitative Easing.[vi] It is very easy to imagine that China will become even more fearful as unconventional monetary policy becomes widespread again in the wake of the COVID-19 pandemic.

Some commentators have seen the period from 2016-2020 (with the election of Trump and Brexit and with the election of many right-wing nationalist parties in Europe and the Americas) as heralding a pushback against globalisation. There is a sense in many quarters of declining American influence, which has increased given America's apparent inability to coordinate an effective response to the pandemic, and even more alarmingly given the withdrawal of the United States from various international agreements, including the Paris Agreements on climate change, the World Health Organisation, and, when Trump feels like threatening this, possible withdrawal from NATO or the UN. Trump's rather incoherent economic position, as translated into his foreign policy, has primarily involved him airing the grievance that American competitiveness has been sapped by foreign nations who have lured away manufacturing capacity. But to the extent that American manufacturing has moved abroad, it is largely because the dollar's role as a reserve currency has meant that it is chronically overvalued. China relies on exports to global trading partners, as domestic consumption and consumer markets are growing slowly as poverty alleviation is achieved.

What does China want? Access to strategic resources is certainly part of it, and the renminbi has become increasingly important in certain markets. Since 2015, offshore RMB can be used as cash collateral on the London Metals Exchange, and in 2018, the LME announced it would launch yuan-denominated futures contracts. China also has tried to increase the global share of renminbi-denominated trade through global swap agreements, swap lines, and loan packages through the 'One Belt, One Road' Initiative. Bilateral swap agreements with countries like Pakistan that have chronic trade deficits with China can be very useful, especially to countries with liquidity constraints or the inability to access IMF funding, as most recently with Turkey in June 2020 of this year.[vii] These agreements are as yet limited, and in any case are not included in official figures of foreign exchange reserves, but they suffer from adverse selection. The countries willing to enter swap agreements with China are not necessarily those China would wish.

In any case, despite the odd proposal for wholesale monetary reform, there is little reason to think that there is a global appetite for radical change. When the new IMF Director, Kristalina Georgieva, speaks, as she did last week, of a 'New Bretton Woods Moment', her focus was not on altering international monetary arrangements, but rather on helping to support a sustainable, inclusive recovery from the pandemic.[viii] Her talking points are along those lines.

Significant changes to the architecture of the international monetary system are, in fact, much more likely to come from a different direction entirely, as innovations in financial technology, or fintech, such as those you heard described by Andrew Lewis-Pye's lecture.

Scenarios for the 21st Century

Looking ahead, there are two important strands of this story to pick up: first the importance of geopolitics, and the second role of technology. With respect to the first, as I have suggested, China has neither the appetite nor the financial institutions to assume position as global hegemon any time soon. But China is beginning to lead the way in another area, in the low carbon transition, with a commitment to achieving Net Zero by 2060. Deep decarbonisation will fundamentally transform energy, transport, buildings, agriculture, to name but the most obvious sectors of the economy, and will have knock-on consequences for many more.

The requirements of decarbonisation will create new species of financial assets, in the form of climate and carbon loans, swap agreements, tradeable put options for carbon and methane removal, futures contracts for technological carbon dioxide removal, among others. It is not inconceivable that some types of carbon credits could, over time, be monetised. But that is still some distance away, though it is part of our story.

Far more immediate is the probable effect of the digitalisation of currency and the advent of the blockchain. There are some characteristics of the Blockchain that make it particularly suitable to some of the purposes for which central banks hold foreign currency reserves.

Before getting into this argument in detail, we should briefly review the blockchain, to remind us of what it does. As you can see from the slide, blockchains have essentially four features:

- Blockchains are a form of distributed ledger technology, or really a kind of private database
- This means that 'distributed ledger technologies (blockchains) are a system for storing transactional-ledgers in a distributed manner, thus enabling digitally-supervised markets to operate without a central clearing authority.'[ix] (Lockley, Mi, Coffman 2019).
- They are also 'smart contracts' permitting self-verification, hence are useful in a range of fields

- They operate by three principles: decentralised, transparent, immutable

As the previous lecture explored this in detail, I will not illustrate their functioning but simply note that are three main types of blockchain technology, which have a range of different uses. Public blockchains, like the Bitcoin or Ethereum blockchains, have the virtue of being fully decentralised and tamper resistant, and they use a token, which is usually mined, albeit in ways that are not very sustainable. Private blockchains are more centralised, in that you need permission to join the network, and are visible only to those in the network. These applications are growing very rapidly in that they can be used to form a consortium, say for construction supply chains, or for central bank clearing. And finally, hybrid blockchains are private but can export to public blockchains, which is a new area for development.

There are also different types of protocols, some more suitable than others to public or private blockchains. The proof-of-work protocol, made famous by Bitcoin, involves energy-intensive calculations to mine the coins, and is unlikely to prove a durable model. The proof-of-stake protocol is an alternative, and Ethereum, which is increasingly used by bulge-bracket banks in swap markets, is in the process of switching from proof-of-work to proof-of-stake. Proof-of-space and proof-of-authority protocols are potential alternatives, and there are also digital crypto-currencies such as those created by Ripple Labs and Stellar Labs, which use an iterative consensus ledger that is much less energy intensive. A quick recap of the major competitors can be seen in the following slide.

As yet, it is unclear which of these will win out, but you will have heard some speculations in the previous lecture. For now, I think it is enough to point out that the energy utilisation of Bitcoin is comfortably located between that of Switzerland and the Czech Republic[x] so movement away from proof-of-work is inevitable if crypto-currencies are to survive in a world increasingly concerned about sustainability.

Which brings us to the question of how will digitalisation of money affect central banking. First, as Markus Brunnermeier, Harold James and Jean-Pierre Landau (2019) have recently proposed, one effect will be to unbundle and then re-bundle those three functions of money (unit of account, store of value and medium of exchange), which will cause greater competition among currencies. They reason this will also lead to the creation of Digital Currency Areas, which link currencies to digital networks rather than countries, perhaps Facebook or Wechat. This may lead to a competition between public money (official currencies issued by governments) and private money (token money issued by Amazon or Ali Baba or Facebook), and will cause central banks to issue their own digital currencies to protect their monetary sovereignty.

One of the chief motivators for the founder of Bitcoin was disapproval of fiat currency, hence the elaborate proof-of-work protocol that was meant to emulate mining of precious metals in the physical world. Most private monies these days, on digital platforms, are convertible to public monies, but that may not continue indefinitely. In fact, it seems very likely that at some stage those who work for the underlying firms or are part of their supply chains will be able to elect to receive a certain portion of their wages and salaries in these private monies. Same may already do so.

The unbundling and re-bundling of the functions of money may, according these authors, lead to the development of fierce competition in payment platforms, which will become geographically detached. This is already true to a degree with Visa, Mastercard, and American Express, but these should have a much broader scope than just their payment functions, including perhaps social networks and portfolio management. One option these authors consider is the development of digital synthetic currency, backed by a basket of official currencies. One such proposal is the Libra, which has been proposed by Facebook.

I want to go a step further and suggest that another possibility, if central banks and other official institutions are indeed committed to achieving carbon neutrality, that carbon credit blockchain solutions may represent a significant untapped potential. Work on this has already begun in reference to the Paris Agreement's ambitions to create a carbon market mechanism that will overcome problems with verification and compliance that plague existing carbon markets.

What would this mean in practice? First, one of the attractions of the gold standard was the notion that gold is a precious metal, which, at least until fairly recently, had limited industrial uses, but was nevertheless very desirable. As such, it made an excellent store of value. But mining gold, particularly cyanide leaching of low-grade ores, is terribly toxic to the environment. What the twenty-first century needs is environmental remediation and repair, not just of toxic mining sites, but in almost every area. Carbon offsets are one fairly low tech (and perhaps not very permanent) solution to carbon dioxide emissions, in that afforestation and reforestation does create natural carbon sinks which remove carbon from the atmosphere. There are also technological forms of carbon capture and carbon storage, most of which operate presently at point sources of carbon emissions, such as chemical and petrochemical factories, gas-fired power plants, and mining operations. Direct Air Capture, though thermodynamically not very sensible unless there is clean energy available, would remove carbon dioxide directly from the atmosphere. These technologies would potentially counter the effects of carbon emissions on global warming and ocean acidification, which along with biodiversity loss, are among the most dangerous threats to human societies. Other technologies are also possible, and, as I warned in my last Gresham lecture, are likely to be targets of financial speculation, perhaps even dangerous speculative bubbles.

It is possible, however, for central banks to get out ahead of this train, as they say, and to think about ways of leveraging the power of consensus blockchains to implement a safe, secure, effective, transparent, and reliable market in carbon offsets, both of short-time horizon and of the longer-dated variety. All human societies have a vested interest in combatting climate change, and removing carbon and methane from the atmosphere creates value. Such a crypto-coin would not *replace* the dollar, the euro, or the renminbi as the world's reserve currency. Such a claim would be, as we've seen, absurd, but it would join the mix, and would help keep 'green' the colour of money.

I used to be somewhat sceptical of remediation technologies, but I have come to understand in the last year that we will miss the 1.5C and 2C climate goals. Even the COVID-19 lockdowns, strict as they were, simply returned us to emissions levels experienced in 2006, when there were 6.5 billion people globally rather than 7.5 billion. If such a strategy is implemented at scale, we do have a chance of averting the 4C nightmare scenario that some analysts are predicting.

This is no doubt not what the director of the IMF had in mind when she advocated a New Bretton Woods moment, but such a scenario as I describe could potentially really accelerate meeting global climate targets, and could also improve global cooperation and governance, especially in terms of meeting UN Sustainable Development Goals. Let us hope that the United States does not retreat further into nationalism and isolationism, or try to block progress on fighting climate change. There *is* real potential here to build a better world, and central banks and official institutions can play a positive role as they did after World War II. We hope that this is the scenario that unfolds over the next two decades, as the alternative, which is a return to the beggar-thy-neighbour policies of the interwar period, would be disastrous, and would result in the loss of billions of lives, versus the 80-85 million people killed in World War II.

Further Reading

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[i] Both the cartoons in Slide 1 and 2 are taken from a sensible article from 11 September 2014 on the Finomenon blog, 'Renminbi as a reserve currency', (https://nmimsfinomenon.wordpress.com/2014/09/11/renminbi-as-a-reserve-currency/)

[ii] See the IMF database: (https://data.imf.org/regular.aspx?key=41175)

[iii] For the cartoon in Slide 10, see (https://asiansecurityblog.wordpress.com/2012/06/16/more-on-abusing-americas-exorbitant-privilege-how-long-the-us-can-borrow-to-sustain-hegemony-up-to-a-100-debt-to-gdp-ratio/).

[iv] See Barry Eichengreen, 'International Currencies Past, Present and Future: Two Views from Economic History,' 2014.

[v] For this chart, see (https://www.macrotrends.net/1441/gold-to-silver-ratio)

[vi] For this cartoon, see (http://www.chinadaily.com.cn/business/2010-12/14/content_11711070.htm).

[vii] The TCG (The China Guys) blog offers several interesting use cases of bilateral swaps including the Turkish case mentioned in the lecture: (https://thechinaguys.com/the-rise-of-the-renminbi-the-reality-of-bilateral-swap-agreements/)

[viii] See: (imf.org/en/News/Articles/2020/10/15/sp101520-a-new-bretton-woods-moment) and (https://www.imf.org/en/About/infographics/imf-firepower-lending).

[ix] See Lockley, Andrew, Zhifu Mi, and D'Maris Coffman. 'Geoengineering and the blockchain: Coordinating Carbon Dioxide Removal and Solar Radiation Management to tackle future emissions.' *Frontiers of Engineering Management* 6, no. 1 (2019): 38-51.

[x] See *BBC News*: (https://www.bbc.co.uk/news/technology-48853230)