

# CURRENCY NEWS™

SPECIAL SUPPLEMENT – ISSUE 3 – JULY 2020

## Protecting Cash, Safeguarding the Public Against COVID-19 – Part 3

It is just over a month since we published the first Currency News Special Supplement on coronavirus.

Everyone is now aware of the panic spread following a statement by the World Health Organisation (WHO) that advised against the use of banknotes and coins on the basis that they could carry and transmit COVID-19. Despite a retraction in a statement by WHO saying it had not advocated avoiding cash, indicating instead that the risk posed by banknotes was no greater than touching any other common surface., the implication remained that cash could carry the virus and that contactless payments may be a safer option.

This perception among the public persists, even though some central banks, the cash industry and others have stated that cash carried no specific risk and that cash payments are safe if used with the same precautions taken for any other surface.

The first supplement reviewed some of the scientific research into whether cash, and in particular banknotes, does carry bacteria and viruses and, if so, whether they present a risk to people through contagion. This was followed by a review of the options available to treat cash prior to its issue in order to prevent, or eliminate, infection on banknotes, and so prevent contagion.

No specific conclusions could be drawn for a number of reasons – first no research of relevance had been carried out on banknotes with the SARS-CoV-19 virus. Also, most of the existing research on the infection of, and possible contagion from, cash was old and consequently out of date given the range of new substrates and coatings/varnishes now in use for banknotes.

(We can now, however, report that some progress is being made through research from the ECB into the extent to which cash, both banknotes and coins, can hold a virus on the surface and the extent to which they could pass these to humans by contact. See page 7).

From that supplement we moved to Part 2, which looked at the topic of cash in a COVID-19 world from the five commercial organisations that deal with cash in circulation and what steps they are taking, or propose, to deal with the crisis.

In this third supplement, we continue the theme of cash and COVID-19 post-issue, this time from the perspective of issuers – ie. central banks and monetary authorities – and what measures they either are or could be taking – foremost among them clean note policies – to ensure public trust in the safety of cash.



An example of a Brazilian 2 reais note and its degradation over time.



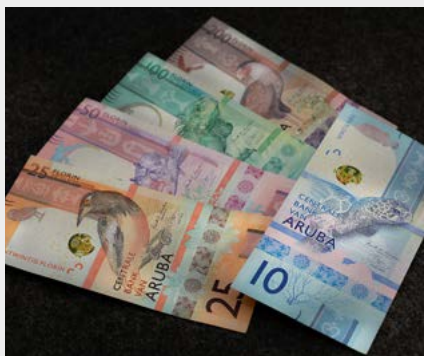
A selection of dirty, damaged banknotes. A good clean note policy would eliminate virtually all of these.

# The Importance of a Clean Note Policy

The importance of appearance, and in particular cleanliness, in the perception of an item is very important. We are taught this from childhood by our parents and in school and so it becomes ingrained in our minds. We also learn by experience.

Contamination of food with anything that is not clean, and is likely to bring the risk of sickness, disease and possibly even death, will stop us eating it. We would not eat anything that looks or smells 'off', and conversely learn to recognise edible substances by looks – colour, shape, size – but also by smell and, finally, taste.

Those involved in banknote concepts and design seek to do something similar, creating notes with a clear, memorable identity. Central banks spend much time and effort in the design and creation of their banknote series, doing their best to ensure they are not only secure and functional but are appreciated, liked and known by the public. The design may represent the flora and fauna of the country, its geography, some of its famous people (kings and queens, politicians, painters, scientists, engineers etc...), its landmarks, its technical achievements etc.



The point is, whatever is on the banknotes is both recognised and appreciated by those using them. It must be self-explanatory, and this is best achieved if the banknotes are not only visually and aesthetically attractive but have a clean look, feel and sound about them.

The fresh appearance and functionality of banknotes decline with use. Wear and tear vary according to many factors – climate, environment, infrastructure, industrial development and how hard the notes work in circulation being the main ones.



However today there is another factor – the substrate – the main one being cotton, but also polymer, with hybrids (or composites, namely a combination of paper and polymer) representing a third category.

Banknotes whose substrate is cotton (referred to as paper), or a cotton/cellulose blend, absorb sweat from hands as well as picking up dirt and other substances during use. The rate at which this takes place is reduced by the use of pre and/or post applied varnishes or lacquers and this is now normal practice. As paper notes are used they become limp as the fibre structure breaks down and they can become degraded by being torn, crumpled etc – the extent of degradation by these factors is considered when deciding to withdraw a banknote from circulation and replace it with a new note.

Polymer and hybrid notes with a polymer outer layer are impervious to moisture and dirt and deteriorate in use predominantly by ink wear and tears.

Polymer notes are generally expected to last at least 2.5 times as long as cotton based notes, and although their deterioration in use differs in appearance and time taken, both substrates when worn are unpleasant to use, present a poor image of the central bank and country, and engender negative feelings in the user.

In comparison, clean, crisp to the touch, fresh looking and aesthetically pleasing banknotes create a positive feeling. Although it is not feasible for all banknotes to be new or virtually new – single-use would be cost prohibitive – a positive user experience can be achieved through a well-executed central bank clean note policy.

## What is a Clean Note Policy?

Unlike coins, central banks work on the premise that their banknotes will be returned for reissue during their lives. This gives the central bank the opportunity to assess those notes and to decide whether they are fit to be reissued. A threshold has to be determined, beyond which a note is regarded as unfit and, therefore, to be destroyed. How that decision is made is laid down in what is known as the clean note policy.

The clean note policy is a critically important aspect of the cash cycle – ie. the storage, issuance, circulation, inspection for removal of counterfeit or unfit notes (determined by the clean note policy), recirculation of fit notes and removal from circulation and destruction of unfit notes.

Central banks have a clean note policy for several reasons. For example, if note standards are low, it can be harder to differentiate between counterfeit and genuine notes; notes that are in poor condition are more likely to jam the mechanism when handled by machines; the public dislike dirty notes, particularly notes that are limp; and poor quality notes give a poor impression of the nation they represent. Although notes are often claimed to spread disease, there is no hard evidence to support this from actual circulation, although laboratory tests suggest there could be.



# What Determines Note Quality and ‘Cleanliness’ in Circulation?

Circulation velocity plays a key role in determining how quickly notes become unfit, whether due to mechanical damage or soiling. Circulation velocity is how many times notes change hands in a given period of time. Denominational structure plays a significant part – if it is efficient in fulfilling the roles of a banknote, ie. settlement (change), payment and as a store of value, then that minimises note usage.

In contrast, if the high value note is too low a value, then the public needs a lot of notes to make a simple everyday purchase, increasing the number of notes used and how frequently they are used.

For notes that are actually used in settlement or payments, as opposed to those that are used as a store of value, the number of notes of a denomination in circulation also makes a difference. In the US, the \$1 bill has a long note life, significantly longer than a €5 note.

A contributory factor is likely to be that there were 34.6 \$1 notes per person compared with 5.7 notes per person in the Eurosystem area.

Note availability and a smooth flow of notes around a country are part of this note velocity story.

The term ‘currency eddy’ was used in conjunction with the UK’s £5 note in the 2000s. The £5 was the lowest denomination and was not used in ATMs. The Bank of England observed that the quality of the note was deteriorating. It established that because it was no longer used in ATMs and the role of the note had become one of settlement rather than payment, it was not being returned to cash centres and, consequently, was staying in circulation too long. One part of the solution was an initiative with the commercial banks to re-start a managed programme of re-introducing £5 notes into selected ATMs.

As machine handling increases in circulation, whether counting machines, bill acceptors, teller cash dispensers or sorters, clean notes become more important and, simultaneously, easier and more complex to achieve.

Easier, because at least some degree of fitness assessment is now common on these machines, and more complex because of the challenge of implementing a standard across devices out of the control of the central bank. Their very existence, though, helps since very poor quality notes are more likely to be returned to the banking system.

The process of implementing a clean note policy depends on whether the central bank has implemented a process to manage note quality, the frequency of note return, whether the central bank has allowed and/or encouraged the decentralisation of note sorting out of the central bank and how it is managing that.



## How are Clean Note Policies Implemented?

Historically notes were returned by the banking system to the central bank for authentication and fitness checking. Although manual checking still occurs, it is now normal to use high speed sorting machines that both authenticate and fitness check notes at up to 40 notes per second.

These machines use an array of sensors that are set up to deliver the desired quality level determined by the central bank. To achieve the desired standard consistently, a number of elements need to be controlled.

**Return of notes:** systems need to be in place to encourage, or require, commercial banks, CIT companies and even large retailers to return notes to the central bank. The supply and return arrangement for notes needs to be contractually agreed and monitored.

**Sorter set up:** surprisingly, the manufacturers of high-speed sorters do not lay out the monitors to a set template in their machines and this can affect the fitness decision-making process. Different suppliers use different sensor technology, parameters and metrics.

The sensors themselves need to be calibrated at regular intervals because the readings change over time.

As a result, the central bank will need to use notes from circulation to decide exactly where the fit/unfit threshold is. It will create sets of notes that can be used to set up and calibrate sensors and sorters. Some central banks have their own systems to do this. For example, the ECB established a comprehensive system to cover all machines – it checks that machines meet the standards initially and at regular intervals.

Once the machines are in use, they will need regular testing to make sure the standard has remained constant. Where a central bank has allowed notes to be fitness checked by other organisations, it will need a systematic method of ensuring that their fitness standards are consistent with those of the central bank. Some central banks have testing programmes in these organisations.

Alternatively, central banks can require samples of fit and unfit notes to be supplied to them for testing or just test notes sent for destruction to see what level they are at.

**Serial number tracking:** the arrival of low-cost serial number tracking on sorters allows central banks to understand note life in fine detail. For example, if the central bank knows that on average notes are destroyed on the fourth time they are seen in a sorting centre, it could decide that all notes will be destroyed the third time they are returned. That way the central bank knows that it won’t have unfit notes in circulation. No central bank has adopted this approach, yet.

**Managing recirculation:** many central banks now encourage the authentication and fitness checking of banknotes at the point of use. This reduces the transportation of notes with all the security and environmental costs associated with that.

There are different ways to manage this. The ECB’s approach, for example, has been only to allow recirculation using approved types of equipment. It also has an active programme of visiting to check that these machines are functioning correctly. This should become more straightforward in future since remote data feeds of the fitness performance of these machines is increasingly possible.

# Managing Cash and Cash Centres

Running a cash centre in a pandemic has brought new challenges. In this section we record some of the changes and approaches taken by central banks.

The first priority is likely to be safeguarding staff handling cash in volume. We are unaware of any research about risks associated with the bulk handling of cash and whether this brings additional risks. Clearly all of the steps which are now so normal in the business environment around hand washing, social distancing and personal protective clothing should be in place.

## Initial response

As was covered in the first COVID-19 supplement, some central banks now leave banknotes returned to them for a period before processing them. This allows time for the virus to 'die', and so the contagion risk from re-issued notes should be zero.

Others have investigated using UV light, heat or other approaches to 'disinfect' the notes before or after processing to achieve the same goal.

A few decided only to issue new notes, rather than re-issue sorted fit notes, to the public, presumably as a short term policy given the cost and supply implications. And one central bank, China, is using *Aeris*™ to both clean and disinfect its banknotes (see 5).

## Policy response

Banknotes are not going to disappear over night. No economy is ready to function without them. Central banks face a significant policy challenge, therefore, to restore public and merchant confidence in using cash.

It is important to frame this policy challenge in the context of all payments. Assuming we accept for now that the risk of infection from a contaminated surface applies to all common objects equally, including banknotes, then it can be argued that the touch screens used in all self-serve devices in retail outlets or the PIN pads on card payment devices are also high risk surfaces given how much they are touched. These devices are not all being cleaned between customers so the risk from banknotes needs to be assessed accordingly.

Public education about the risk of contamination and the efficacy of washing hands, cleaning your hands after touching any common surface, not touching your face and using appropriate personal protective equipment when in public places remains the most effective response to the virus. This message, and any public education campaign, must include all payments, not just cash, both because there is a genuinely shared risk and to stop cash being singled out as peculiarly risky to use.

Increasing note supply, working with ATM host organisations to clean the PIN pads, and raising the clean note standard and ensuring it is implemented in sorting centres and equipment outside of the central bank will help reduce any risk and significantly increase the confidence of the public and merchants in using cash.

## Product response

In the longer term there are options to consider – varnishing paper notes is an obvious one in conjunction with a more stringent clean note policy as clean banknotes create positive feelings.

Moving to polymer notes will provide visually cleaner notes for longer, and they are easier to wipe clean than paper banknotes. But until more research is conducted we do not know whether paper or polymer banknotes harbour the COVID-19 virus longer, or if one or both allow contagion, and if so, how easily.

The question of coatings and treatment for future note orders was covered in our first supplement. These specially developed treatments from Oberthur, Goznak, Intace and Inovink undoubtedly offer protection if used, but their detailed benefits eg. their ability to eliminate bacteria and viruses and for how long (useful life) and ability to prevent contagion, especially in regard to COVID-19, will only be established from further research.



# Cleaning Notes

A completely novel approach to the clean note policy is that developed by Spectra Systems Corporation with its AERIS™ system for cleaning soiled banknotes prior to re-issue, which was launched in 2014.

It involves the use of carbon dioxide in a supercritical fluid phase – the state of a substance in which two of its phases (eg. a liquid and vapour) have the same temperature, pressure and volume.

The solvating power of supercritical fluids increase exponentially with small changes in temperature and pressure, to an extent far greater than would be expected from calculations. In its supercritical state at 72.9 atmospheres (= 72.9 times atmospheric pressure) and at 304.25K (31.1o C), carbon dioxide exhibits a density near that of a liquid but has the space filling properties of a gas.

It is this state that allows its 'penetration' of banknotes and its ability to extract certain molecules, in a process that could be described as 'washing with gas'. It removes oxidised oils and other contaminants leaving a dry banknote, whilst maintaining the integrity of the substrate, printing and all security features. The process has no effect on the physical properties of the cleaned banknotes while having the added benefit of removing harmful micro-organisms.

The AERIS process was initially tested successfully with enteroviruses, E-coli and pesticides. Now AERIS is being



Examples of Indian Rs 500 notes before the AERIS treatment (below) and afterwards (above).

tested at Brown University for the deactivation of coronaviruses and other RNA encapsulated viruses and at Boston University for COVID-19, Ebola and MERS, as the latter has special facilities for the most deadly pathogens. We expect to report the results in Currency News in about three to four months.

AERIS machines come in three sizes – the largest the AERIS 400, has a 400 litre cleaning/decontamination chamber and can clean and/or disinfect 120,000-150,000 banknotes per hour using large bundles straight from sorting machines. The two smaller machines, the AERIS 40 and the AERIS 20, can process 15,000 and 7,500 notes per hour respectively (these smaller machines were developed in response to enquiries from distributed operations, primarily commercial banks and casinos).

Banknotes can be repeatedly cleaned in this manner without detriment to their physical properties; so cleaned notes can simply be re-circulated. The greatest benefits are gained where soiling, and not physical degradation, is the main reason for declaring banknotes unfit.

Following the launch of AERIS in 2014 numerous trials took place involving central banks in North America, Central America, Europe, Africa, and the Middle East. Although there are currently no permanent installations, it is no surprise that the pandemic has changed attitudes with the company reporting intense interest. New enquiries have also been received from previously interested central banks, primarily in Africa and the Middle East. China's central bank is currently testing AERIS. Spectra is in discussions with possible distribution partners.



## Conclusion

Implementing an effective circulation strategy and clean note policy will reduce the risk and perception of contamination from banknotes to some degree and give people confidence to keep and resume using them.

However, until we know more specifically about COVID-19, public confidence will only be achieved by convincing the public that all possible action has been taken to reduce the risks and this, in conjunction with abiding by safeguarding practices, will ensure that banknotes are safe to use.





# What is the Future for Cash?



There can be no doubt that the future for cash will be different from what it would have been had the world not experienced COVID-19.

We consider the implications at a time when there is still much not known about the virus, or stated another way, there is still much to learn.

## Against Cash

It is possible that the effects of the pandemic will reduce the usage of cash even after it itself is (we hope) a distant memory. The evidence for this is:

- Cash use fell in lockdowns because even habitual cash users were forced in some cases to adopt alternative payment methods and they may not return to the same level of cash usage – for example, people have had to shop online for products to be delivered or collected, and for items normally available in the non-essential shops not allowed to open in lockdown. Payment in virtually all cases has been digital. It is expected that many will continue to shop like this after shopping returns to normal.
- Hygiene – the perception that cash could cause contamination has led people and organisations to direct payment by cards and mobile phones. It will be a major task to reverse this perception and new behaviour.
- Contactless payments substituting for cash may have formed new habits. Contactless card limits being increased by c. 50% will remain, increasing the opportunity and inclination to pay with them.
- Access to cash will be reduced as bank branches and ATMs decline in number.
- The correlation between cash transactions and GDP is high. The economic impact of the pandemic is likely to reduce GDP.
- Contactless/digital payments will continue to be highly promoted for both convenience and safety from infection.
- As cash usage declines the cost of providing cash will increase – access to cash will decline forcing a move to other forms of payment.
- Legislation may be required to ensure cash remains available, but government funding may also be required.

## For Cash

There are also reasons why cash use may stabilise or even increase:

- During the pandemic, and even if a vaccine is developed in the next six months, there is going to be a recession and high unemployment, even in those countries with the highest GDP. Cash has been proven to be the best way to manage household and other personal budgets in a crisis, and many will adopt it out of necessity.
- It is probable that cash will be shown either not to be a hygiene risk for COVID-19 or to offer less risk than the use of plastic cards.
- The current focus globally is defending and improving the rights of minority groups, socially deprived and people on low incomes. A large number of these people use cash for their daily transactions – governments will not wish to institute policies harmful to them.
- A high percentage of commerce takes place in informal markets in under-developed and developing countries. Cash is essential in these circumstances – as they recover and grow, so will cash (until digital becomes more acceptable).

## Forecast

Taking these factors into account, there are a considerable number of logical scenarios regarding the future of cash. The most likely are:

- Cash will remain as a widely used form of payment, not least because the poorest people in rich countries, and most people in poorer countries, currently depend on cash. This is unlikely to change in the near future, so cash will remain in use globally, but especially in low GDP countries, as a major form of payment for at least 10-15 years.  
It may decline globally afterwards but it is too soon to predict the rate of decline, not least because it will vary from country to country and the impact of digital currencies, including those of central banks, is too soon to predict.
- Digital payments will continue to increase their market share. Cash will continue to decline as a form of payment. It will decline to as low as 10% of transactions in the most developed countries within 10 years, but will continue to be the prime form of payment in the least developed countries for at least 15 years.
- Governments may have to subsidise or fund the use of cash where its use has declined below commercially viable levels.

# New Research from the ECB

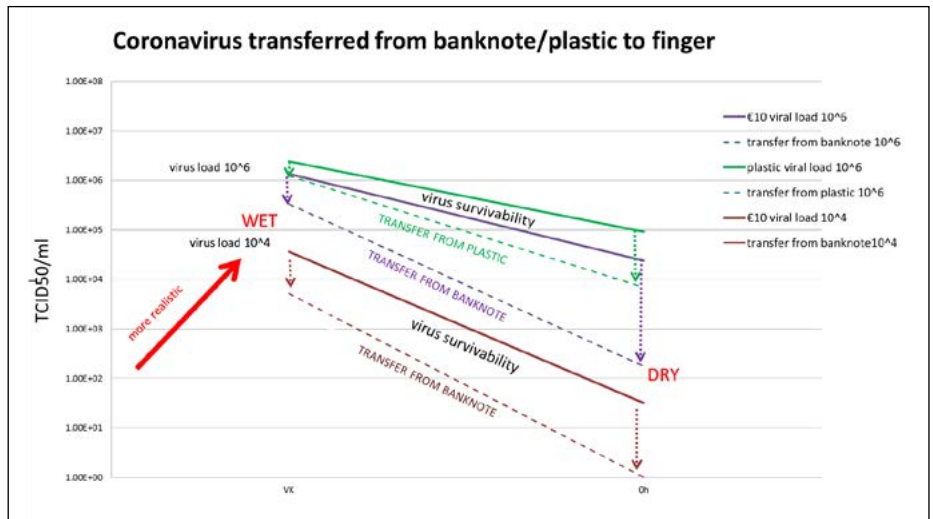
The ECB is funding a research programme into whether cash is a carrier of COVID-19 in two separate laboratories and whilst this remains a work in progress, Ton Roos, Director of Cash Operations at the ECB presented some preliminary findings in a recent seminar hosted by Currency Research.

The objectives of the research are to measure how long the virus (in this case viruses having similar properties to COVID-2 – SARS) survives on different surfaces, and how transferable it is from those surfaces. One method involves droplets of the virus, ie. a high quantity equivalent to somebody sneezing. The other is where somebody has spread the virus by touching the surface, so it is not so concentrated.

The tests are repeated at regular intervals, allowing the virus to dry out on the test surface over time, and the transferability is measured after each interval. The banknote tested to date is a standard €10 denomination, ie. cotton based with varnish, along with a 10 euro cent coin.

Preliminary findings indicate that banknotes and coins exhibit markedly different results compared with plastic (PVC, as used for transaction cards) and stainless steel. The virus experiences more desiccation on banknotes than it does on plastic and stainless steel.

Also, there is a physical interaction with banknotes where the wet virus penetrates the porous substrate, and there is a chemical reaction on coins where the copper element of coins reacts with the virus.



Touch transfer test – banknote to finger (© ECB).

The virus survives on banknotes for only a few hours, the wet virus (high concentration) for longer than the dry (lower concentration), and although during those few hours the virus is transferable, the transferability decreases with time and the amount transferred is much less for the dry (more likely) amount of virus than the higher concentration wet version.

As an indication, there is virtually no transfer of the dry/lower concentration version after around three hours or the wet version (less likely in normal circumstances) after approximately six hours.

In comparison, the transfer from plastic (PVC) is possible over a much longer time – presumably because the virus, and in particular the high concentration version, sits on its surface and so is more easily picked up on a finger and transferred. Similarly, coins have much less transferability than steel, which gave the highest transferability results.

Although these results are preliminary, the indication is that the likelihood of contagion from banknotes and coins (copper) is relatively low, and much less likely than from plastic surfaces such as transaction cards, keys on transaction pads or from steel.

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