COUNTERFEIT BANKNOTES

- ***How big is the problem?***
- ***What is the effect of new technologies?***

POST note **77** March 1996

POSTnotes are intended to give Members an overview of issues arising from science and technology. Members can obtain further details from the PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (extension 2840).

Seizures of large quantities of counterfeit banknotes reported in the press suggest that there is a dramatic increase in the scale of currency counterfeiting in the UK. Even though official statistics suggest counterfeiting is still a rare event, the fact that close scrutiny of banknotes is now a familiar experience fuels the public's perception of a worsening problem because of the advances in copying and other counterfeiting technologies.

This note analyses the extent of counterfeit currency in the UK and the policy issues raised.

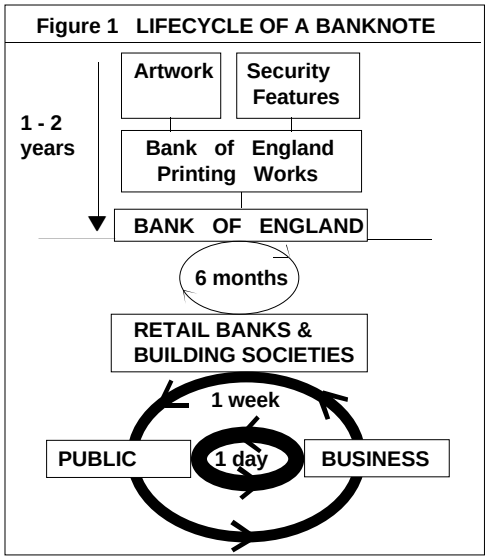
UK BANKNOTES AND CIRCULATION

There are £16B pounds worth of UK banknotes currently in circulation, issued by the **Bank of England (BoE)** and banks in **Northern Ireland** and **Scotland**. The total is growing by about £1B per annum under current monetary policy, under the control of HM Treasury exercised through BoE. Scottish and Northern Irish banknotes are backed by BoE, and can be thought of as 'envelopes' containing BoE currency of equivalent face value.

BoE designs and prints its own banknotes at its works in Loughton, on special paper supplied by Portals Ltd. Designing a new series of banknotes involves the integration of graphic artwork with overt security (quality of paper, watermark, windowed metal strip, quality and texture of print and fine detail) and covert features (see **Box 1**), and building up sufficient stock to recall an old series and release the new notes. From concept to realisation, this takes up to eight years. For instance, work on the current 'Series E', which was launched in the late 1980s, commenced at the beginning of that decade. Small changes to the design of a banknote series are occasionally made (for example the new £10 and £20 notes were altered in 1993 to make them easier to distinguish), but larger changes are only made when a new series is issued. The Scottish and Northern Irish banks use commercial security printers (e.g. De La Rue), with additional security features to BoE notes.

The circulation of currency in the economy is complex, as shown in **Figure 1**, and this affects the ease with which counterfeiting can be detected. Brand new notes enter circulation either direct to the public (over the counter or via an 'autoteller' machine), or via retail businesses. Once in circulation, banknotes pass many times between the public and businesses before finding their way back to BoE - either because they have become soiled or damaged or in the course of routine transfers between the banks and BoE, when a definitive check of authenticity is made. Note life varies with denomination, but for the majority of notes (£10 and £20) it averages about 2 years.

Figure 1 LIFECYCLE OF A BANKNOTE



EXTENT OF COUNTERFEITING

Over the last year, the press have suggested that increasing numbers of banknotes in circulation may be counterfeit. There have also been reports of cash machines dispensing fake notes, which in some cases have been admitted by the banks. Together with the increasingly common use of counterfeit detection tests at retail points, the perception is that counterfeiting is a growing problem.

Hard data on the extent of counterfeiting comes from individual retailers / banks experience. For example, the Cooperative Retail Society (CWS) lost £11,925 through counterfeit currency in 1995 - a small fraction of cash turnover, but 20% up on the previous year. Post Office Counters Ltd, the nation's largest volume retail handler of cash, lost £1.2M due to counterfeit currency in FY94 / 95 (up from £250K in the previous year), compared with net profits of £22M and cash turnover of £127B for the same period, and estimates similar losses for 95 / 96. The British Retail Council (BRC) surveyed 50,000 of its 300,000 Members, and estimates that overall, £1M of counterfeit notes were taken in FY94 / 95 (44% **less** than the previous year), of a total turnover of some £160B.

Another source of data is the counterfeit notes collected by police. The National Criminal Intelligence Service (NCIS) catalogues all counterfeit notes intercepted by police and banks (other than the BoE); in FY94 / 95, police seized £11.8M of counterfeit sterling and US$5.5M before the notes entered circulation, and a further £15.4M of counterfeit currency was discovered in circulation.

In 1995/96, the figures are £20.2M, US$10.5M and £5.2M, respectively.

BoE, which in addition to the notes recovered by NCIS, intercepts counterfeit notes in its automated counting and authentication machines (using the covert security features), does not release figures for the numbers intercepted. However, it supports estimates that "*a very small fraction of 1 pc*" of circulating notes are counterfeit. The Scottish and Northern Irish banks do not release precise figures for counterfeiting of their own notes, but estimate a total of the order of £300K per annum, with fake BoE notes being found in greater numbers.

Overseas, Germany is one of the few countries to publish the number of counterfeits intercepted by its national bank: the number grew from 4,100 notes (value DM327K) in 1990 to 23,000 (DM3.3M) in 1994 (**Figure 2**). The most widely counterfeited currency in the world is the United States dollar, where in 1993, $121M in counterfeit US notes were seized outside the USA, and $20M within it. There is also evidence that large quantities of counterfeit dollars circulate in the global economy - e.g. in Asia, Eastern Europe, the Middle East etc. - without ever returning to the US or other places where counterfeits would be identified.

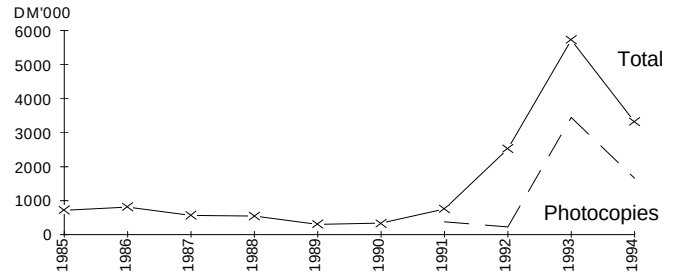
In this context, the Lebanese authorities claimed recently that as much as $2B worth of high quality counterfeits, mostly of US dollars but also of other currencies, has been produced since 1992 by Shia Muslim fundamentalists (believed to be directed by Iran and helped by Syria). Some estimates suggest that as many as one fifth of banknotes in Russia - mainly dollars and roubles - are counterfeits. India is believed to be the source of a wide range of forged documents, which may also include currency.

TECHNOLOGY OF COUNTERFEITING

There are two essential processes in the production of a counterfeit banknote: 'origination' and 'printing'. Until about fifteen years ago, origination took skill and patience: each colour of ink on a banknote required a separate 'plate' copied meticulously from photographs taken using different coloured filters (a process called 'line separation'). Printing used traditional lithography to reproduce the artwork, with various techniques to copy or mimic additional security features such as watermarks and threads.

The introduction in 1989 of higher resolution colour photocopiers transformed the 'art' of counterfeiting. Some currencies, which were particularly easy to copy, suffered a sharp increase in counterfeiting (e.g. the DM - **Figure 2**). While UK banknotes were less susceptible, the Japanese manufacturers of colour copiers introduced a modification to the photocopier's electronics whereby BoE notes are 'recognised' automatically and

Figure 2 RATE OF COUNTERFEITING OF THE DEUTSCHMARK



The reduction from the peak in 1993 coincides with the introduction of a new series of notes with additional security features.

copying is blocked; and BoE estimates that the proportion of counterfeits which are straight photocopies has dropped from 20% a few years ago to a fraction of this.

There are other disadvantages to colour photocopiers for counterfeiting. They produce an image composed of small dots (about 600 per inch) which can be distinguished under a magnifying glass, whereas the Intaglio printing (Box 1) of genuine banknotes forms continuous lines as fine as 0.006". Photocopiers also cope badly with microprinting, aliasing, foil stamps, security threads and other features, cannot produce 'numbered sequences' of notes and are relatively slow.

Some counterfeiters therefore use photocopiers or dedicated 'scanners' to produce a digital image of a banknote which can be manipulated with a computer. In this way, aberrations caused by security features designed to foil copying and scanning are 'whited out', to be added at a later stage; images are 'cleaned up', lines 'sharpened' and serial numbers altered. The digital image may be printed on anything from a desktop colour printer, through a colour photocopier (thus bypassing the automatic 'censor') to a high quality commercial printing machine.

As far as commonly available methods of detection are concerned, there are three methods of identifying possible counterfeits (**Table 1**): 'look and feel', UV lamps and 'detector pens'. 'Look and feel' is the only method recommended by BoE, which maintains that all counterfeits currently in circulation can be spotted by careful examination. However, many businesses view this technique as too slow, and are uneasy about placing the onus on their staff to identify suspect notes.

Both the UV and detector pen systems test the paper. Under a UV lamp, the theory is that the cotton paper on which legitimate banknotes are printed should not fluoresce (i.e. is 'UV dull'), while the paper available to counterfeiters contains 'brightening agents' which give a characteristic blue glow. However, UV dull paper is easily available, any paper can be made UV dull by spraying it with readily available chemicals and UV dull cotton paper can become 'UV bright' through contact, for instance, with recently washed clothing. Thus BoE suggests that there is a high probability that a UV counterfeit detector will pass forged notes ('False

BOX 1 SECURE ('INTELLIGENT') PRINTING

The goal of secure, or 'intelligent' printing is to find features which are prohibitively expensive to counterfeit.

The 'foundation' of banknote security is the paper. **High quality paper** is required for reasons of durability - most countries use cotton paper from a single source, which can be uniquely identified by aspects of its **chemistry** and **microscopic structure,** but importantly also has a characteristic 'feel'. Other features can be added during manufacture, e.g. **watermarks** and **ultraviolet (UV) fluorescent fibres**; the **security thread** (invented by the Bank of England) can be 'windowed' ('stitched' into the paper) and can be engraved with tiny characters.

The next layer of security is in the printed design. **Inks** which are difficult to obtain and work with are commonly used, and designs contain very **fine lines** (e.g. in the image of the Queen's hair) which can only be printed using high quality printers. The texture of the printed surface can also be controlled: the raised writing e.g. on Bank of England notes (**'Intaglio'**) requires special, expensive (£2M to £3M) printing presses. Another graphical security feature is '**registration**', where images printed on the front and back of notes coincide exactly when held up to the light.

'Aliasing' is a special case of fine line printing, where patterns (e.g. on the image of the Queen's face) are designed to produce a visible 'interference pattern' on photocopies and scanned images. There are also several patented aliasing systems which cause printed words (e.g. 'VOID' or 'ILLEGAL COPY') to appear on photocopies and scanned images.

More 'exotic' (and expensive) security features are available. '**Optically Variable Ink (OVI)'**, made exclusively by a US/Swiss company, changes colour depending on the angle of view, and UV fluoresecent inks of various colours are also available. **Thermocromic ink** changes colour, or even disappears to reveal an underlying pattern, when it is warmed slightly, for instance by rubbing it with a finger or on a warm photocopier plattern.

Non-printed features are also increasingly used. **Foil patterns** of various complexity can be stamped onto a note. The simplest ones can prevent straightforward photocopying, while more complex patterns (such as on the newest Bank of England £50 note) can require expensive equipment to produce. More costly non-printed features include advanced optical devices, such as **holograms**, and the **Landis and Gyr Kinegram**. Australia has started issuing **plastic banknotes** which contain clear plastic 'windows' (performing a function similar to watermarks in paper).

In addition to these largely **overt security features**, there are **covert features**, known only to a few key personnel. Covert features provide an 'ultimate' test of authenticity, and examples are inks with special spectroscopic characteristics, magnetic inks, radioactive inks, isotopic composition of the paper and ink, microscopic structure of the paper, etc.

Secure printing is in a state of constant evolution, as counterfeiters learn how to defeat increasingly sophisticated techniques. There is much research into new kinds of security feature - mostly machine-readable- that may prove very difficult to counterfeit. For example, '**biological tagging**' using minute quantities of genetic material (DNA or RNA), and '**phase masks**' which are high security laser-readable devices.

The Table summarises security features used in various countries.

	Special paper	Watermark	Windowed thread	Printed thread	UV thread	UV fibres	Intaglio	Aliasing	Rare colours	Fine lines	UV printing	OVI	Hologram etc.	Registration	Thermocromic ink	Foil stamp
Bank of England	✓	✓	✓				✓	✓	✓	✓						✓
France	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓		✓		
Switzerland	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
USA	✓	✓					✓			✓						
USA new series	✓	✓					✓	✓		✓		✓				

Accept') and reject genuine notes ('False Reject'). The majority of counterfeit notes received by NCIS do pass the UV test.

Detector pens contain iodine which reacts with starch to produce a coloured pigment - the idea is that banknote paper does not contain starch, whereas most other paper does. This is indeed the case in the USA, where the system was invented, but BoE does not guarantee that UK banknotes do not contain starch. Furthermore, as with the UV systems, chemical coatings on ordinary paper can mask the presence of starch. Thus there is some risk of false rejection and, while the majority of counterfeits intercepted in the UK so far have not been 'coated', NCIS and BoE believe that this could soon change, and false acceptance would become a problem.

Table 1 DETECTING COUNTERFEITS

Method	Pros	Cons
Feel of paper	{Recommended	Slow
Watermark	{by	Difficult in
Security thread	{Bank of	poor light
Print quality	{England	Subjective
UV lamp	Fast, easy, ca.£50	Unreliable test*
Iodine pen	Fast, easy, <£10	Unreliable test*
Electronic	Good performance	Slow, >£250, not portable
Covert features	Very reliable	Restricted to BoE

**according to NCIS and BoE*

WHO ARE THE COUNTERFEITERS?

'Nuisance' counterfeiters are individuals using photocopiers, scanners, laser printers etc. to produce small numbers of crude counterfeits; NCIS estimate that they account for about 5% of counterfeit notes, even though many individuals may be involved.

'Professional criminals' working independently or, more usually, as part of organised crime account for 95% of counterfeit notes, largely using high quality image preparation ('origination') and lithographic printing. Access to such equipment and expertise is often gained through ownership, coercion or unauthorised use of legitimate printing businesses. A relatively small number of groups are involved at any one time - NCIS intelligence suggests that as many as 80% of the counterfeits currently in circulation have origins in one criminal group. In October 1995, a clandestine print was closed which has disrupted part of that group but not eliminated it.

'Economic subversives', usually sponsored by unfriendly governments are capable of producing extremely high quality forgeries, which can be identified only by covert features. Their intention may be to undermine a currency for political ends, or to 'print money' to support their own economy or overseas activities, but as yet there is no evidence that the UK currency has suffered such an attack since World War II.

ISSUES

Is there a problem?

As described above, while bulk seizures by police indicate a large increase in the production of counterfeits, the numbers intercepted in circulation have remained fairly constant (£5M p.a.), suggesting that counterfeiting is under control. Yet the public perception is that counterfeiting is becoming a more serious problem, as evidenced by the growth in the use of 'detectors' in shops etc. BoE and NCIS argue that the perception of counterfeiting is enhanced further because counterfeit detectors are liable to mistake genuine notes for counterfeits. This high 'false reject' rate (apart from annoying customers) exaggerates perceptions of the number of counterfeits in circulation.

On balance, few are concerned about the macro-economic effects of the current level of counterfeiting, which represents some 0.03% of the total currency in circulation (or even less if expressed as a fraction of the annual turnover of cash in the economy). Moreover, paper money accounts for only a small fraction of the nation's financial transactions and holdings and the main costs to government are in the incremental costs of enhanced security features and policing.

At the micro-economic level however, effects may be more significant. Even though the level of counterfeiting is low (e.g. 0.001% of cash turnover for PCL), this may still be significant viewed against annual profit (5% in this example). Moreover, a member of the public who finds a 'forged' note may have to forfeit the money, which can be a blow if it is a £20 note in a week's pension. For these reasons, public policy is likely to require levels to be kept at current or lower levels.

Impacts of new technologies

There is a form of technological 'guerrilla war', between the establishment and the counterfeiters who continually seek new ways of defeating security measures. Even though the problem of counterfeiting appears largely contained so far, many (including BoE and NCIS) are concerned that technological developments may be favouring the criminal. Thus, as the price of computers, scanners and printers falls and their performance increases, many more people will have access to equipment which can produce passable counterfeits, so that 'amateur' (nuisance) copying may become a significant problem. Advances in computer technology also make life easier for the professional counterfeiter. Thus, while the sophisticated printing equipment required to produce high quality counterfeits is currently large, heavy and difficult to move or hide, very high resolution scanners and colour printers may soon be small enough to carry around in a car boot.

Other complications arise as printing 'plates' are replaced by a computer file. These can be encrypted or even stored 'on-line' overseas, making them much more difficult for police to discover and impossible to confiscate. Computer files are also easy to pass on, whether in the school yard or over the Internet, so there is a major concern that a global stock of high quality images of banknotes from around the world will develop. Enforcement is much more difficult than when possession of counterfeit 'printing plates' was obvious and provided sufficient evidence for prosecution.

On the side of the authorities, there are new 'intelligent printing' techniques some of which (Box 1) are already being incorporated into banknotes across the world. The question is to what extent the UK should apply all or more of these advanced techniques? At present BoE has adopted a cautious approach to new secure printing techniques. It sees changing banknotes with increasing regularity as unpopular, and early moves to use a suite of security features as pushing up the production cost without any certainty of success.

Others disagree and argue that new technologies should be introduced to ensure counterfeiting does not get out of control with its subversive effects on people's confidence in the currency. One option would be to incorporate 'machine-readable' features for use outside the banks. At present, manufacturers of detectors have to work 'blind', since BoE (understandably) are unwilling to reveal any of their covert features and do not volunteer or guarantee any parameters other than the qualitative 'look and feel' of the notes. Banknote authenticators are thus vulnerable to changes in paper and printing processes, and manufacturers are lobbying for 'commercially covert' features to be added to banknotes.

The other approach would be to control more tightly the technology used by counterfeiters. For instance, BoE is part of an international group of Central Banks collaborating with Japanese manufacturers of colour photocopiers to incorporate banknote 'censoring' systems. However, in the highly competitive and international market of computer printers and scanners, equivalent negotiations would become increasingly complex, and unlikely to be effective. An alternative approach for the longer term is to widen the use of 'electronic cash' (e.g. Mondex). Several countries already have plans to replace up to 30% of paper money within 10 years, but others remain concerned about the security of the 'smart cards' used in these systems.