

# EURO BANKNOTES: FIRST YEARS OF EXPERIENCE

## ARTICLES

Euro banknotes:  
first years  
of experience

*This article discusses the developments in the issuance, production and counterfeiting of euro banknotes since their introduction, and the key issues related to research and development. The number and overall value of euro banknotes in circulation are continuing to rise, mainly due to ongoing hoarding and the increasing international role of the euro. The banknote circulation is characterised by increasing migration of euro banknotes between euro area countries, a fall in the overall return frequency rate for banknotes being returned to NCBs and some deterioration of the quality of the low-value banknotes. In order to ensure the quality of the banknotes in circulation, the ECB has introduced minimum sorting standards for the processing of the euro banknotes by NCBs, credit institutions and other euro area institutions engaged in the sorting of banknotes and their distribution to the public as a professional activity. Furthermore, key steps towards a single euro payment area (SEPA) have been taken, including the introduction by NCBs of a common approach towards fee policy, basic services, opening hours, debiting and crediting, and packaging rules. As a global currency, the euro has also attracted the attention of counterfeiters. After rising very strongly during the first two years of the euro's life, there are now indications that the rate of counterfeiting has stabilised.*

## I THE ISSUANCE OF EURO BANKNOTES

### DEVELOPMENTS IN THE EURO BANKNOTE CIRCULATION

During the run-up to the cash changeover, the stocks of hoarded legacy banknotes fell, which led to a 29% decrease in value terms in the circulation of legacy currencies in 2001.

Since early 2002 the circulation of euro banknotes has risen strongly, in particular in terms of value. The end-2000 level was reached again in mid-2003, and the growth in holdings has continued without any clear signs of a slowdown. The average circulation rose by 20.3% (in terms of value) and 10.5% (in terms of volume) in the period January-June 2004 in comparison with the corresponding period of the previous year. The main reasons for this strong growth include the ongoing hoarding of euro banknotes and the increasing international role of the euro.

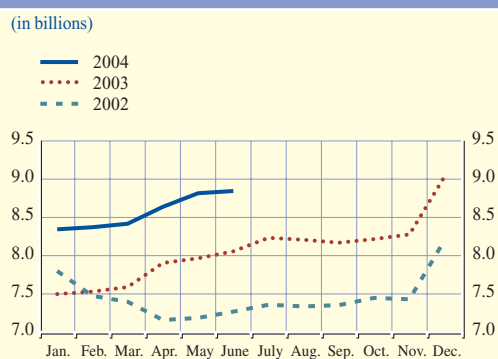
The availability of high-denomination banknotes in all euro area countries has increased the use of currency for hoarding purposes. The convenience of using euro banknotes that are legal tender in 12 countries and the fact that they are widely accepted in Europe have increased the demand for euro banknotes by travellers to most European countries in comparison with the legacy

currencies and with other major international currencies. In addition, the appreciation of the euro against the US dollar since 2002 may have played an additional role in fostering the non-resident demand for euro banknotes. There is some indication that demand for euro banknotes is emerging in countries where there was no substantial demand for the legacy currencies (e.g. in Russia). Moreover, an increased expectation in the new EU Member States that the euro will become their legal tender in the foreseeable future might also have contributed to foreign demand for euro banknotes. However, at the same time, the economic stabilisation and recovery in eastern and south-eastern Europe has led to a decrease in the use of foreign currencies for hoarding.

At the end of June 2004, around 9 billion euro banknotes with a value of €450 billion were in circulation. According to the estimate of non-resident holdings presented in the ECB publication entitled "Review of the international role of the euro" (December 2003), around €50 billion of euro banknotes (about 10-12% of euro currency in circulation) are circulating outside the euro area.

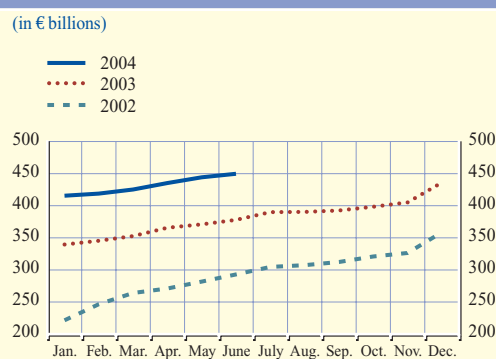
The circulation has shifted towards the higher-value denominations. The share of the denominations ranging from €50 to €500 had increased from the initial 25% (in terms of

**Chart 1 Total number of euro banknotes in circulation at period-end**



Source: ECB.

**Chart 2 Total value of euro banknotes in circulation at period-end**



Source: ECB.

volume) and 69% (in terms of value) to 46% and 86%, respectively, by early 2004. Consequently, the average euro banknote value has gradually increased. In November 2003 the highest average legacy banknote value reached in December 2000 (the equivalent of €49 for the Deutsche Mark) was surpassed. Since February 2004 the average value of euro banknotes has exceeded €50. Charts 1 and 2 show the developments in the circulation of euro banknotes from January 2002.

A salient feature of the euro banknote circulation is the increased migration between the euro area countries, which is a natural consequence of the introduction of the single currency. In addition to the general public, banks and other economic agents have started to use euro banknotes on a cross-border basis within the euro area. For instance, foreign businesses can buy and sell euro banknotes in whichever euro area country they prefer. This greater migration of euro banknotes is reflected in negative net issuance figures recorded by a few NCBs for certain denominations. These negative figures imply a net inflow of a given denomination to the NCBs concerned. These developments had already been observed in 2002 and, since then, more NCBs and more denominations have been affected. A framework for the management of the Eurosystem's banknote stock has therefore been established, which addresses the impact of

migration by redistributing excess logistical stocks by means of bulk transfers between NCBs.

On the whole, euro banknotes are returned less frequently to the NCBs than in the past. The latest overall return frequency rate<sup>1</sup> stands at 3.4 per year for the period from July 2003 to June 2004, 6% lower than for the corresponding period one year earlier. In addition, this rate varies, according to the denomination, between 0.6 and 4.7 per year. The highest figures were observed for the €10 and €20 denominations (see Table 1).

**Table 1 Banknote return frequency rates**

(July 2003 to June 2004)

€500	€200	€100	€50
0.6	0.8	1.1	3.0
€20	€10	€5	Total
4.6	4.7	3.3	3.4

Source: ECB.

<sup>1</sup> Defined as the total number of banknotes returned to NCBs between July 2003 and June 2004 divided by the average number of banknotes in circulation during this period.

### STEPS TOWARDS A SINGLE EURO PAYMENT AREA

The Eurosystem has been in the process of defining common principles and objectives regarding its role in the cash cycle.

In addition, the banking industry and other commercial parties concerned (e.g. cash-in-transit companies) have requested that the Eurosystem ensures a level playing-field for euro cash services. This would help individuals and enterprises to fully reap the benefits of EMU and the Single Market in general.

At the same time, NCBs have been reviewing the range of cash services they provide, as well as their own organisation and role in the cash cycle.

These parallel developments have highlighted the need to define more precisely the Eurosystem's responsibilities/tasks in the medium and long term with regard to its statutory task of issuance of the euro, as laid down in Article 106 (1) of the Treaty establishing the European Community (hereafter referred to as the Treaty). It is, however, not envisaged to design a "one-scheme-fits-all" policy for NCB cash services. In line with the decentralised structure of the Eurosystem, it will be up to the NCBs, in consultation with the parties concerned, to decide on how to implement the responsibilities and objectives defined in this context. The NCBs will need to take into account inter alia the respective national economic situation and banking structure, the existing NCB branch network and the relative share of cash payments. In addition, technological developments, such as the use of cash-recycling machines, require thought to be given to the most efficient use of resources in the cash cycle.

Given its prominent role in the cash cycle, the Eurosystem should provide continuity and stability to facilitate the planning of the actors in the cash cycle (e.g. banks, cash-in-transit companies). To this end, the ECB has liaised with banks and other interested parties to

discuss ways to enhance the efficiency of the cash supply system, recently in particular the framework for the detection of counterfeits and fitness sorting by credit institutions and other professional cash handlers.

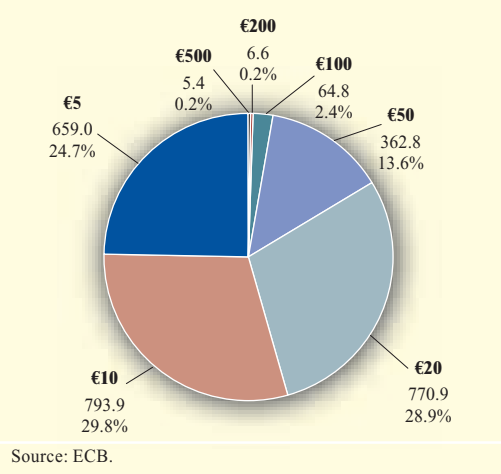
### MEASURES TO ENSURE AN ACCEPTABLE QUALITY OF BANKNOTES IN CIRCULATION

To maintain the quality of euro banknotes in circulation, the Eurosystem developed a common minimum sorting standard in 2001, which has been applied by all Eurosystem NCBs since the introduction of euro banknotes in 2002. When banknotes return from circulation, NCBs carefully check the quality of all euro banknotes deposited by their customers. The quality control is carried out by sophisticated sorting machines against the common standard, with thresholds for a number of fitness criteria such as soiling, tears and other damage. These operations ensure that only banknotes that are fit for use are reissued and defective banknotes are removed from circulation.

Another objective of the common minimum sorting standard is to help ensure that the euro banknotes in circulation used as a daily means of payment by the general public of the euro area are of a consistent quality. In the course of 2003, however, there were first indications that in some euro area countries the quality of the low-value denominations in circulation, notably the €5 banknotes, has deteriorated markedly and fallen below an acceptable level. Analyses have revealed that in the countries where the quality is not satisfactory, the €5 banknotes are mainly circulating within the retail sector and their return frequency to NCBs via credit institutions is accordingly low. This phenomenon can be partly explained by the fact that the €5 banknotes are only supplied to a marginal extent (if at all) via automated teller machines (ATMs) to the public and the circulating banknotes are needed by retailers for giving change and therefore not returned to the credit institutions for processing. Consequently, the €5 banknotes stay in circulation longer and are exposed to more wear and tear. Furthermore,

**Chart 3 Replacement of unfit banknotes in 2003**

(in millions of pieces; as a percentage of total unfit banknotes)



the €5 and €10 banknotes might be treated by the public less carefully than the higher denominations due to their lower value.

The NCBs of the countries experiencing quality problems have tried to improve the circulation quality, e.g. by adjusting their sorting policy and/or by issuing temporarily only new banknotes in 2004. Additionally, initiatives have been taken in cooperation with the banking sector to increase the return frequency of the low-value denominations to NCBs so that larger amounts of unfit banknotes can be withdrawn from circulation. Currently, the Eurosystem is conducting a representative sample survey covering all euro area countries in order to evaluate the impact of these short-term measures. For the longer term, the Eurosystem is working on projects aimed at enhancing the durability of euro banknotes.

In 2002 NCBs replaced 750 million unfit banknotes with new and fit ones. This represented only 9.2% of the average number of euro banknotes in circulation during that year because of the newness of the banknotes. In 2003 the total number of unfit banknotes amounted to 2,663 million, which represented 33.1% of the average number of banknotes in

circulation in 2003. The denominational breakdown of the replacement of unfit banknotes for the year 2003 is shown in Chart 3. In 2003 the highest ratios of unfit banknotes were observed for the €10, €20 and €5 denominations, which together accounted for 83.5% of all unfit banknotes.

## 2 PRODUCTION OF EURO BANKNOTES

The production of banknotes for the launch was a very demanding task, including the coordination of 15 printing works in 12 different countries printing the same banknotes with the same designs and the same level of visual and technical quality. The peak production rate was achieved in 2001, with approximately 1 billion banknotes being produced per month. Now that the production requirements are determined by the number of banknotes necessary to accommodate the increase in circulation and to replace unfit banknotes that have been destroyed, the production requirements have fallen significantly to approximately 3 to 4 billion banknotes per year (see Table 2). This fall has provided the Eurosystem with an opportunity to reflect upon and review the working practices and controls that are being applied to manage the printing and distribution processes. After more than five years of production and two-and-a-half years of circulation of the current euro banknote series, a wealth of experience has been gained. It has been used to refine technical standards and the quality management system and has also provided the basis for the production of future euro banknote series.

During the production of the launch stocks, there was a great deal of concern about the ability of the different printing works to produce high volumes of banknotes to a common standard. To meet this common standard, the quality controls and the visual checking processes that were applied had to be very strict. Following the introduction of euro banknotes, the feedback from the general public and the cash-handling community has

Table 2 Production volume and allocation of euro banknote production in 2005 <sup>1)</sup>

Denomination	Quantity (in millions of banknotes)	Value (€ millions)	NCBs commissioning production
€5	530.0	2,650	FR
€10	1,020.0	10,200	DE, GR, IE, AT
€20	700.0	14,000	ES, FR, NL, PT, FI
€50	1,100.0	55,000	BE, DE, ES, IT, NL
€100	90.0	9,000	IT
€200	-	-	
€500	190.0	95,000	DE, LU
<b>Total</b>	<b>3,630.0</b>	<b>185,850</b>	

Source: ECB.

1) It should be noted that the stocks of €200 banknotes are sufficient, so there is no need to produce this denomination in 2005.

demonstrated that the banknotes are being produced to acceptable quality standards.

The technical specifications describe the technical requirements for the production of the banknotes. The technical specifications for the current series have been progressively improved over the last few years. In late 2003 it was decided that they had reached a sufficient level of maturity to be frozen until the launch of the second series of euro banknotes.

#### DEVELOPMENT AND MAINTENANCE OF THE TECHNICAL STANDARDS

Visual consistency is monitored by collecting “production reference banknotes” and evaluating them. A small sample of all production batches/lots is then collected and a team of experts periodically compares these production samples with each other and with the reference banknotes. This ongoing comparison concerns both the visual appearance and other characteristics and has confirmed that the production of euro banknotes has stabilised in terms of consistency and the variations in visual quality are now very small.

All main producers involved in the production of euro banknotes are regularly informed and/or consulted via liaison meetings about any matter related to euro banknote production. Several groups representing the banknote users are also regularly informed and consulted about any matter related to the circulation of the euro banknotes. This helps the Eurosystem to

monitor the performance of the current banknote series and prepare for a future series.

#### DEVELOPMENT AND MAINTENANCE OF THE QUALITY MANAGEMENT SYSTEM

To achieve a common banknote quality at all printing works, it is essential that a common quality management system is also in place. Coordination and maintenance of this system is an important Eurosystem role. The quality management system that was devised in 1997 before the start of euro banknote production has been significantly upgraded since the launch, taking into account the experience gained. A key change has been the shift from relying on final quality checks to monitoring the processes to achieve quality levels and reduce the cost of waste.

As part of the general improvement programme and to improve communication in the supply chain, all printing works, paper mills and other key material suppliers are periodically audited by the ECB to ensure compliance with the quality management system requirements. All manufacturing sites now work according to the most stringent industrial standards. The common requirements concern in particular the banknote production documentation, the quality control process (inspection of raw materials, process checks and final inspection) and the quality control standards (common limits for acceptance and rejection).

## **BANKNOTE PROCUREMENT AND SUPPLY CHAIN ANALYSIS**

The desire to enhance overall efficiency within the Eurosystem has led to a review of the current procurement rules and proposals for a future banknote procurement strategy. The basis of this future strategy will be a common tendering procedure. This will promote competition and consequently reduce the cost of banknotes. This future strategy is currently being developed, with the objective of the new system being in place by 2008 and fully implemented by 2012.

In 2003 an in-depth analysis of the supply chain for euro banknotes and raw materials was undertaken with the objective of determining the level of risk to supply continuity. The study was structured to identify all key materials used in the euro banknotes (e.g. paper, foil, security thread, inks, chemicals) along the supply chain. The result was a comprehensive analysis of the suppliers and their interdependencies. The study confirmed that there is no significant risk to the supply of euro banknotes. More importantly, it has provided some principles to be considered and incorporated into any future design and development processes to manage the future risks to the supply chain. These may include more use of techniques and concepts such as functional requirement development, supply chain development and simultaneous engineering.

The targets are to improve overall efficiency, improve the quality management system and operate a well-managed and transparent supply chain with more structured communications with all partners and customers in the banknote production environment.

### **3 COUNTERFEITING**

#### **DEVELOPMENTS IN EURO BANKNOTE COUNTERFEITING**

Since the launch of euro banknotes in January 2002, the quantity of counterfeited banknotes has increased slowly from a zero base. The ECB

recently announced that around 307,000 counterfeit banknotes were recovered from circulation during the first six months of 2004. This figure is of the same order of magnitude as the number recovered during the previous six-month period (311,000), indicating that the rate of counterfeiting may now have stabilised. Whilst these figures may seem high, they must be seen in the context of the number of genuine banknotes in circulation (approximately 9 billion), the population of the euro area countries (approximately 300 million) and the number of cash transactions involving banknotes (estimated to be approximately 120 billion per year). Comparison of these figures with those for other currencies is misleading since no other currency has, or has had, the same circulation pattern or equivalence in denominational values and split. Now that the euro has become an established currency, the most valid comparison would be with past developments in euro counterfeiting. A very small number of counterfeit euro banknotes are of good quality, but the vast majority of counterfeits can be readily distinguished from genuine notes by using the simple feel-look-tilt method described in the Eurosystem's information material. Even well-made counterfeits can be detected by carefully applying this test. If in doubt, another good test of authenticity is to compare a suspect note with one that is known to be genuine.

The ECB has updated its communication materials, which can be used by the NCBs to help banknote users to distinguish counterfeit notes from genuine ones.

Reports that counterfeit euro banknotes have been dispensed by ATMs in Germany have appeared in the press recently. However, this should not happen on account of an agreement that obliges German credit institutions to feed ATMs only with banknotes that have been previously authenticated by the Deutsche Bundesbank. The Bundesbank has followed up all claims that an ATM has dispensed a counterfeit and it has not substantiated any of these claims.



### COUNTERFEIT DETERRENCE

The competence to issue banknotes (Article 106 of the Treaty and Article 16 of the ESCB Statute) includes a right for the ECB and the NCBs to take all necessary measures to maintain the integrity of the euro, including measures to combat counterfeiting of euro banknotes. In this respect, the measures taken so far by the ECB include the establishment and management of the Counterfeit Analysis Centre (CAC) in order to centralise the classification and analysis of technical data relating to counterfeit notes, and of the Counterfeit Monitoring System, which is the repository of technical and statistical information on euro counterfeiting.

A group – the Central Bank Counterfeit Deterrence Group (CBCDG) – has been established under an agreement between the Governors of the central banks of the G10 countries. This group is mandated to investigate emerging threats to the security of banknotes and to propose solutions. It has now developed a system that will prevent the reproduction of banknotes using standard PC hardware and software. The ECB recently announced a public consultation in connection with its desire to see EU-wide legislation implemented that would make it mandatory for manufacturers and importers of PC hardware and software to incorporate the CBCDG's counterfeit deterrence modules in their products.

### COOPERATION WITH LAW ENFORCEMENT AGENCIES AND OTHER RELEVANT INSTITUTIONS

The ECB cooperates closely with Europol, the European organisation with specific responsibility for fighting cross-border and organised crime within the European Union. Europol has access to the Counterfeit Monitoring System and CAC experts have participated in police investigation teams. The ECB also has cooperation agreements with the International Criminal Police Organisation (Interpol), the European Commission and the competent national authorities of neighbouring and third countries regarding the exchange of information and the provision of training.

In conclusion, whilst the level of counterfeiting of the euro appears to have reached a plateau, one should never be complacent about the future threat. The ECB believes, however, that there is now an effective infrastructure in place to combat counterfeiting.

## 4 RESEARCH AND DEVELOPMENT

The banknote R&D strategy approved by the Governing Council stresses the need for the euro banknotes to defend themselves. When addressing the counterfeit threat, the European approach has traditionally focused on the banknotes, putting as many technical obstacles as possible in the way of counterfeiters rather than relying heavily on law enforcement. This European approach, which is included in the current euro R&D strategy, was also part of the strategies for most of the legacy currencies.

Banknote R&D is crucial in protecting the integrity of the euro. When designing the euro banknote series, the 15 EU NCBs were involved, each contributing R&D resources. Faced with the challenge of the launch, the NCBs shared the R&D portfolios that they had built up over the years. During these early times, the NCBs together with a number of private organisations devoted very significant human resources to designing and producing the common currency. There was a pioneering spirit whereby everybody wanted to meet the historical challenge and to play a part in this key achievement.

At the end of 1999 the Eurosystem identified the need to adopt a more structured approach to R&D to prepare for future euro banknote upgrades and the second series. The new structure had to accommodate ongoing R&D as “business as usual”. It also had to contribute to maintaining the integrity of the current and future euro banknotes and to ensure a level playing-field for all suppliers. The Governing Council approved the organisation of euro R&D as a decentralised network coordinated by the ECB. The system then developed to include, in

addition to the ECB, the NCBs and their long-term suppliers, other industry players, thereby enhancing the innovative capability. Accordingly, the system is now open to all companies willing to propose ideas and projects, opening the way for the innovation that a global currency such as the euro needs. The Eurosystem has defined the policy and created the procedural framework to assess and select projects for funding in order to develop the euro R&D portfolio. This set of procedures was assessed and certified under the ISO 9001:2000 norm.

Security features in all banknotes are degraded over time: initially a newly designed feature will perform well, then as it becomes known by legitimate users and as the counterfeiters' technology advances it is eventually emulated and needs to be replaced. It is up to R&D to provide the replacement features. Security features are developed in order to enhance the banknotes' technological foundation; development activity programmes better define the requirements for a set of security features and look at compatibility issues; finally, industrialisation programmes identify potential problems during the production phase and allow the definition of the technical specifications of the new security features. Only when all the stages are successfully completed can a security feature be included in the euro banknote specifications.

Banknotes are essentially products with a technical performance to deliver. The definition of the functional requirements relies on marketing-based techniques. The derived specifications are used to initiate product design programmes for banknote design upgrades and new banknote series. The focus is on the different kinds of customers and users: the general public (including visually impaired people), cashiers, vending machines, banknote processing machines, cash handlers, law enforcement authorities and the note-issuing authority itself. Each has different needs in terms of convenience, authentication, efficiency, resilience and cost, and these needs

also differ for low, medium and high-denomination banknotes.

R&D activities are divided into the long-term R&D work, which provides the technology that enables the new features necessary to stay ahead of the counterfeiters, and the specific R&D project activities that support the development of the respective design projects. Striking a balance between these two areas of activity is vital to a smooth long-term banknote design programme. One example of an area of research is the field of nanotechnology where new material development/processing could give rise to new unique optical properties and/or behaviours that could be used in banknotes. The banknote R&D strives to exploit such new developments by converting new technologies into security features that could be used efficiently by the general public to verify the authenticity of the euro banknotes, but pose insurmountable difficulties for the counterfeiters in their attempt to emulate the security features.

## 5 CONCLUSION

Progress is continuing to be made with regard to the euro banknotes and the new currency is maturing well. After more than five years of production and two-and-a-half years of circulation of the current euro banknote series, the wealth of experience gained is being used to refine technical standards and the quality management system. It also forms the basis for the production of future euro banknote series.

The focus is now shifting to the management of the banknote circulation, the future entry of new countries to the euro area and the wider international use of the euro. A major challenge will be the introduction of the second banknote series, which is expected towards the end of this decade.