

DANMARKS NATIONALBANK

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Oversight of the financial infrastructure 2022

- Denmark has a safe, efficient and stable payments infrastructure in which disruptions are rare. The systems and solutions in the infrastructure comply with international standards to a high degree.
- There is persistent and strong focus on the threat from cybercriminals, and the systems and solutions in the Danish payments infrastructure are generally well equipped to counter cyberattacks.
- The most sophisticated hackers are continuously becoming more specialised in their methods, and it is not possible to implement safeguards that provide full protection against their attacks. It is therefore important to continue the work with crisis management planning and the ability to handle serious cyber incidents if or when they occur.

Infrastructure of critical importance to society

Kr. 724 billion

is settled on average on each banking day for payments in the core systems.

[Read more](#)

Collaboration across the financial sector

Increases cyber resilience

with the key players
and broadly in society

[Read more](#)

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Denmark has a safe and efficient payments infrastructure

A well-functioning and safe market infrastructure is a prerequisite for easy and efficient exchange of goods and services. Breakdowns or disruptions in the core payment systems can hurt the economy and, in a worst-case scenario, also threaten financial stability.

The payments infrastructure is a network of different systems enabling consumers, companies and financial entities to exchange payments and securities with each other. The Danish payments infrastructure is described in box 1. In 2022, on an average day, electronic payments amounting to kr. 724 billion were sent through the systems in the Danish payments infrastructure, cf. the flow of payments in box 1.

Because the payments infrastructure plays such a critical role in the economy, Danmarks Nationalbank oversees that the core systems in the infrastructure comply with the requirements for safety and efficiency in the international standards. The oversight also includes the most important payment solutions.

This report presents the main conclusions of the oversight and the key areas of significance to the Danish financial infrastructure in 2022.

The infrastructure is safe, efficient and stable

The conclusion of Danmarks Nationalbank's oversight is that the Danish payment infrastructure is safe and efficient. The core systems and solutions comply to a high degree with the requirements of international standards for organisation, risk management and crisis management, among other areas. On an ongoing basis the owners of the systems and solutions work to strengthen security and comply with Danmarks Nationalbank's recommendations for improvements.

In 2022, there were isolated incidents with problems in regards to the timely settlement of payments, but operational reliability was generally high and disruptions in the exchange of payments and the settlement of securities transactions are rare.

In early 2023, Danmarks Nationalbank and several other organisations in both the financial sector and other parts of society were hit by a series of dis-

Danmarks Nationalbank's oversight

Danmarks Nationalbank oversees that payments and financial transactions in Denmark can be completed safely and efficiently. Its oversight comprises the core systems and solutions in the Danish payments infrastructure:

- Kronos2 (interbank payments)
- the Sumclearing, Intradagclearing and Straksclearing (retail payments)
- Euronext Securities Copenhagen's settlement system (securities transactions)
- Dankort, Betalingservice and credit transfers (the main payment solutions)
- International systems of relevance to Denmark.

Danmarks Nationalbank's oversight is based on international standards and guidelines and is described in its Oversight Policy ([link](#)).

tributed denial-of-service attacks (also called DDoS attacks), where hackers tried to crash the organisations' websites. No parts of the payment infrastructure, either at Danmarks Nationalbank or other organisations, were affected. The attacks merely meant that some users had difficulties accessing the organisations' websites for short periods of time.

Cyber resilience is good, but the sector needs to prepare for security breaches

The Danish Centre for Cyber Security, CFCS, assesses that the threat from cybercrime is very high, and the best hackers are continuously becoming more specialised and sophisticated in their methods. The cyber threat outlook is described in further detail in box 2.

The owners of the core systems and solutions in the Danish payments infrastructure have a persistent and strong focus on the cyber threat, and the Danish payments infrastructure is generally well equipped to counter cyberattacks. However, it is not possible to implement safeguards that provide full protection against errors or security breaches. It is therefore important that the system owners also focus on crisis management and the ability to handle incidents that may occur, for example if cybercriminals succeed in penetrating the external defence.

The Danish payments infrastructure

Box 1

Each banking day,¹ payments averaging kr. 724 billion, corresponding to almost one fourth of Danish GDP, are settled via the Danish payments infrastructure.

Danmarks Nationalbank's payment system, Kronos2, plays a central role in the infrastructure, both when it comes to the settlement of large, time-critical payments between banks (interbank payments) and by virtue of Danmarks Nationalbank's role as settlement bank for other payment and settlement systems.

Retail payments are payments between consumers, companies and public authorities, e.g. by payment cards, mobile phones or as credit transfers. When payments have been initiated and handled by a number of intermediaries, depending on their type, they are finally calculated and reconciled in the Sumclearing, Intradagclearing or Straksclearing system, which are the financial sector's retail payment systems, collectively called 'Detailclearingerne' in Danish. Settlement is subsequently effected through Kronos2 in accounts at Danmarks Nationalbank. The retail payment systems are owned by Finance Denmark.

Securities transactions may be entered into in different types of marketplaces: On the stock exchange, through a multilateral trading facility or bilaterally between the parties through a bank or a stockbroker. The settlement of transactions in Danish-issued securities is handled by the central securities depository Euronext Securities Copenhagen, ES-CPH. Securities transactions between banks and their customers are settled via the ES-CPH settlement, which is ES-CPH's own settlement system, while securities transactions between professional players (including banks) are settled via the pan-European securities settlement platform TARGET2-Securities, T2S, owned

by the European Central Bank, ECB, and the national central banks in the euro area.

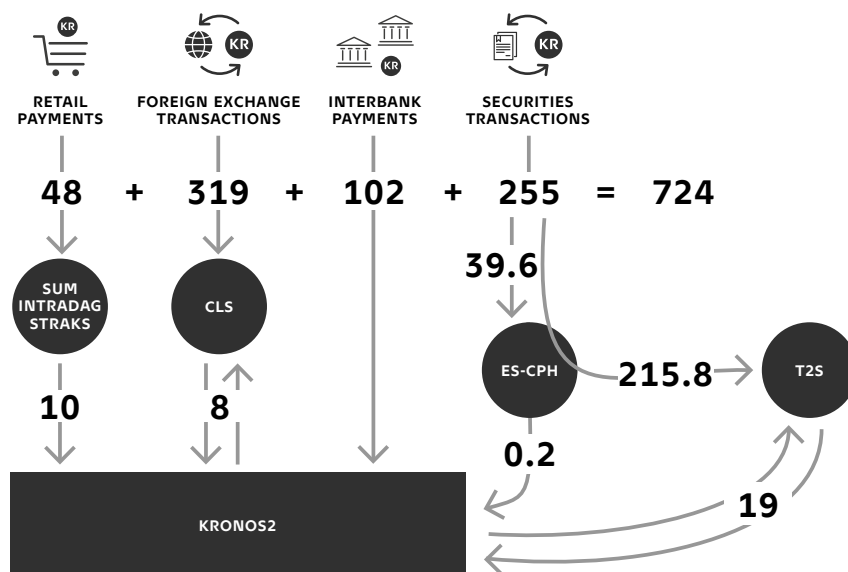
Participation in T2S requires a dedicated cash account with Danmarks Nationalbank and a securities account with ES-CPH, among other requirements. As the central securities depository, ES-CPH is thus responsible for regularly accounting for holdings of all Danish-issued securities on behalf of investors.

Foreign exchange transactions are settled through CLS, an international system for foreign exchange transactions. Danmarks Nationalbank makes accounts available to banks settling transactions through CLS. Participants reserve liquidity for CLS settlement by transferring funds to these accounts. CLS is owned by large international banks.

The three retail payment systems and the ES-CPH settlement settle their participants' net positions through the participants' accounts in Kronos2. Net positions are calculated by offsetting participants' claims and obligations in the respective systems. This so-called netting reduces participants' liquidity requirement for settlement considerably compared with a situation in which all payments are settled individually. For example, netting reduces the daily liquidity requirement for settlement of retail payments from kr. 48 billion to kr. 10 billion, equivalent to a reduction of 79 per cent.

On T2S, settlement of professional players' transactions is also settled through netting. Liquidity for settlement is transferred from participants' dedicated cash accounts with Danmarks Nationalbank. Netting reduces participants' liquidity requirement from kr. 216 billion to kr. 19 billion (reservation of liquidity), equivalent to a reduction of 91 per cent.

Payment flows, kr. billion, averages per banking day in 2022



¹ Some types of payment can be made 24/7/365, others only during bank opening hours. But for all payments, final settlement and exchange of amounts between banks take place on banking days, i.e. when banks are open for business.

According to international guidelines on cyber resilience,¹ the crisis management must comprise specific plans for how serious cyber incidents are to be handled. The plans must address both the ability to ensure a safe recovery of core IT systems and the ability to continue critical business areas during the recovery process, i.e. business continuity. Furthermore, it must be tested on an ongoing basis whether the plans are sufficient for handling extreme, but plausible, cyberattack scenarios.

In its oversight of the payments infrastructure, Danmarks Nationalbank continuously monitors the system owners' work with cyber security and their measures for countering cyberattacks. As part of the oversight, Danmarks Nationalbank also makes assessments of whether the payments infrastructure systems meet the requirements of international guidelines for cyber resilience.

In 2022, Danmarks Nationalbank completed an assessment of the retail payment systems' compliance with the guidelines. The assessment showed that the retail payment systems have a high maturity level and comply with the guidelines in most areas. As part of the assessment, Danmarks Nationalbank gave Finance Denmark, which owns the systems, recommendations on how the work can be strengthened in few, key areas.

In 2020, Danmarks Nationalbank also prepared cyber recommendations for Euronext Securities Copenhagen, ES-CPH, in accordance with the international guidelines. In 2022, ES-CPH has continued its work with the recommendations. Finally, Danmarks Nationalbank has also continued the work to strengthen Kronos2's resilience.

Cross-sector collaboration is actively used to increase resilience

Part of the work to counter the cyber threat takes place at sectoral level in various collaboration forums, cf. box 3.

The owners of the core systems and solutions in the Danish payments infrastructure use the work in the Financial Sector Forum for Operational Resilience, FSOR, to support their own work to prevent and

Cyber threat is evolving and changing nature

Box 2

The Danish Centre for Cyber Security, CFCS, assesses that cybercrime poses a very high threat to the Danish financial sector.¹ As a result of the war in Ukraine, CFCS raised its assessment of the cyber activism threat to high on 31 January 2023.

Tensions between Russia and the West have resulted in a high level of activity among pro-Russian cyber activists, who carry out attacks against targets within a wide range of NATO member countries, including Denmark. This was, for example, seen in connection with the DDoS attacks aimed at Danmarks Nationalbank, other parts of the financial sector and public authorities in early 2023.

CFCS assesses that the threat from destructive cyberattacks against Danish targets is low. However, the nature of the cyber threat can quickly change if the political security situation escalates. State players have the capacity to carry out advanced cyberattacks. So far, there has been no willingness to carry out attacks of this type against Denmark, but that may change.

¹ Centre for Cyber Security: The cyber threat against the Danish financial sector, updated 31 January 2023 ([link](#)).

handle cyber incidents. This is done through a number of activities such as discussion of risks, knowledge sharing and joint mitigating initiatives.

Under the auspices of FSOR's Crisis Management, knowledge about risks and possible impacts on the Danish financial sector was shared in connection with Russia's invasion of Ukraine. In autumn 2022, risks related to the energy situation in Europe were addressed, and, like the rest of the financial sector, the system owners in the payments infrastructure have prepared themselves for the risk of so-called brown-outs. This work has shown that the system owners will be able to handle such a situation with sudden short-term power outages. Finally, through the Crisis Management, knowledge about the repeated DDoS attacks against the financial sector was shared in early 2023. This has helped clarify that the critical parts of the payments infrastructure have not been affected.

¹ CPMI-IOSCO, Guidance on cyber resilience for financial market infrastructures, June 2016 ([link](#)).

FSOR's Crisis Management has been established to ensure coordinated action across the financial sector in the event of a crisis that may potentially threaten financial stability. The FSOR Crisis Management supplements the members' own crisis management and is coordinated with the national crisis management of the Danish National Operative Staff, NOST. By participating in the FSOR Crisis Management and in the biannual testing thereof, the system owners comply with the recommendation in international standards on participation in cross-sectoral tests.

As part of its risk analyses, FSOR has highlighted the need to continue working with data protection and recovery. Against this background, the system owners in the payment infrastructure initiated work under the auspices of the Risk Forum for Interdependencies, RGA, in 2021, aimed at identifying the data that, from a societal perspective, must be particularly protected and where the availability of such data is critical in a recovery situation. In early 2023, RGA has completed a joint overview of relevant data and achieved a joint understanding of the criticality of data, which will serve as a basis for the further work.

In RGA, the system owners have also continued the work from 2021 with joint shutdown and reopening scenarios that support a controlled shutdown of the critical infrastructure in the event of operational incidents such as a serious cyberattack. Roadmaps were drawn up in 2022 and the first joint tests of the plans have been performed.

The core infrastructure systems and solutions are all part of the Nordic Financial CERT, NFCERT, a joint Nordic sectoral collaboration on the collection and sharing of information on cyber threats and cyberattacks. This strengthens their ability to detect, prevent and respond quickly to any cyberattacks. Participation in NFCERT ensures compliance with the recommendations of international standards to participate in this type of cross-sectoral information sharing.

TIBER-DK has tested critical financial sector players

Finally, the system owners in the payments infrastructure also participate in Danmarks Nationalbank's TIBER²-DK test programme. In TIBER-DK, Danmarks Nationalbank coordinates threat-based tests of the

Joint work in FSOR, RGA and NFCERT

Box 3

Since 2016, the **Financial Sector Forum on Operational Resilience, FSOR**, has brought together authorities and key private players in the financial sector in a joint collaboration forum that works to increase the operational resilience of the sector, including resilience to cyberattacks. Read more in FSOR's Annual Report for 2022 ([link](#)).

Danmarks Nationalbank chairs and provides secretariat services for the collaboration forum, which – in addition to the infrastructure systems and solutions – also includes participation by the largest Danish banks, data centres, pension and insurance companies as well as relevant authorities and the Nordic Financial CERT.

FSOR's work is based on a risk analysis that identifies the greatest risks to the sector. It lays down a direction for the work with joint mitigating measures. This includes, for example, a crisis management team tasked with cross-sector coordination in the event of a systemic crisis. Danmarks Nationalbank chairs and provides secretariat services for the FSOR Crisis Management.

Risk Forum for Interdependencies, RGA, is a collaboration forum for cooperation with participation of the parties responsible for the corepayments and settlement systems in the infrastructure, i.e. Danmarks Nationalbank (inter-bank payments), Euronext Securities Copenhagen (securities transactions), Finance Denmark (retail payments) and e-nettet (communications network). RGA identifies and addresses interdependencies and operational risks across the central systems and networks in the infrastructure.

The work in RGA is coordinated with FSOR.

Nordic Financial CERT¹, NFCERT, is a member-driven non-profit organisation, and its object is to strengthen the Nordic financial industry's resilience to cyberattacks and enable Nordic financial institutions to respond quickly and effectively to cyber security threats and online crime. NFCERT collects and shares information about cyber threats and cyberattacks.

1. Computer Emergency Response Team. This is also called Computer Security Incident Response Team, CSIRT.

2 Threat Intelligence Based Ethical Red team.

cyber resilience of critical players in the financial sector, simulating advanced cyberattacks in actual production environments. In 2022, learnings from the TIBER tests has been analysed and shared with the participants to strengthen cyber resilience.

Consolidation of infrastructure in fewer and larger systems continues

In recent years, the owners of the payments infrastructure systems have been working to gather different parts of the infrastructure in larger joint systems. This work continued in 2022.

Increased overheads for the operation of the systems make it increasingly attractive to gather the activities so that the expenses can be shared to a greater extent between more system owners and participants. Consolidation into fewer and larger systems entails a concentration risk in the form of greater dependence on individual systems. The rationale behind consolidation is that this risk is offset by the pooling of resources making it possible to increase security.

Since 2018, some of the securities transactions denominated in Danish kroner have been settled on the pan-European securities settlement platform, T2S. In 2020, based on a preliminary analysis and dialogue with the financial sector, Danmarks Nationalbank decided to migrate all settlement of payments in Danish kroner to the pan-European system TARGET Services. The project is called TARGET DKK. The migration is scheduled for Easter 2025, and the work towards the migration went according to plan in 2022. See box 4, page 13, for a more detailed description of TARGET DKK.

In 2022, the owner of the Danish system for settlement of securities transactions, Euronext Securities Copenhagen, decided to phase out the settlement of transactions in Danish kroner and euro from ES-CPH's own settlement platform. This means that all transactions in securities denominated in Danish kroner and euro that are registered in ES-CPH will be settled in T2S from the end of 2024.

At European level, the ECB completed the planned consolidation of the interbank payment system, TARGET2, and T2S in March 2023. In this connection, TARGET2 was replaced by a new central payments settlement system called T2. The consolidation brings together a number of systems that support T2 and T2S in one joint IT platform called TARGET Services.

The different projects are highly interdependent and closely coordinated between the different system owners, the participants in the systems and other stakeholders.

At the same time, the consolidation of the infrastructure in fewer and larger systems will mean that Danmarks Nationalbank's oversight will increasingly take place in collaboration with the ECB and the other European central banks.

Interbank payments and central settlement of payments in Danish kroner

Danmarks Nationalbank's payment system, *Kronos2*, is one of the most important parts of the financial infrastructure in Denmark. *Kronos2* is the lynchpin in the settlement of payments in Danish kroner – including the large time-critical payments between banks (interbank payments). In addition, *Kronos2* is also used to settle Danmarks Nationalbank's monetary policy operations and net positions from the connected payment and settlement systems concerning individuals' and companies' payments, securities transactions and currency transactions in Danish kroner.³

Use

There were 77 direct participants in *Kronos2* at the end of 2022, mainly Danish banks, mortgage credit institutions and branches of foreign banks.

In terms of both number and value, interbank payments constitute the majority of the transfers between the participants' accounts in *Kronos2*. In 2022, interbank payments with a value of kr. 101.5 billion were settled in *Kronos2* on average per banking day, cf. table 1. The value of interbank payments has increased by 14 per cent since 2021. This increase has been driven by increased payment activity by the two largest participants, Danske Bank and Nordea.

The number and value of monetary policy operations continued to decrease in 2022 due to the adjustment of monetary policy instruments made by Danmarks Nationalbank in March 2021, when the cap on the banks' deposits in current accounts was removed, so that they no longer need to move liquidity by buying and selling certificates of deposit.

Operational reliability

Several incidents affected *Kronos2* during 2022, which means that the operational reliability was not completely satisfactory.

In two cases, Danmarks Nationalbank and the participants were without access to *Kronos2* for 3 hours and 1 hour, respectively. Both times, this was caused by a server set-up error. The functioning and uptime of *Kronos2* itself were not affected.

There have also been problems with Danmarks Nationalbank's collateral system, *Calypso*⁴, where access to the system for Danmarks Nationalbank and the participants was delayed several times at the beginning of the day due to non-updates of servers.

In two cases, there have also been breaches of Danmarks Nationalbank's policy that participants must not be overdrawn at the end of the monetary policy day (the overdrafts were, however, made against collateral). Both incidents led to delays in the closure of the monetary policy day and in the settlement of securities transactions in ES-CPH. In addition, in one case, the settlement of securities transactions in T2S was delayed for both Danish kroner and euro. The cause of the incidents was a lack of liquidity management and inadequate procedures for covering of overdrafts for the participants involved.

Towards the end of the year, *Kronos2* also experienced an unauthorised shutdown lasting more than three hours due to a human error. As this happened around 18:00 on a Saturday evening, the incident did not have any business-related consequences.

Finally, there was an incident where, following a delay in the CLS settlement (see also the section 'Settlement of foreign exchange transactions' on page 28) and subsequent postponement of the closure of the monetary policy day in *Kronos2*, an error occurred in the communication between Danmarks Nationalbank and ES-CPH.

³ See also box 1 on the payments infrastructure in Denmark.

⁴ *Calypso* is the system that Danmarks Nationalbank makes available to the participants in *Kronos2* so that they can provide collateral and obtain a credit line for this which can be used to carry out payments in *Kronos2*.

Transactions in Kronos2

Table 1

| Kr. billion, averages per banking day | 2018 | 2019 | 2020 | 2021 | 2022 |
|--|--------------|--------------|--------------|--------------|--------------|
| Interbank payments | 83.0 | 87.4 | 87.6 | 88.7 | 101.5 |
| - Of which customer payments | 13.6 | 14.0 | 14.0 | 16.6 | 20.7 |
| Monetary policy operations | 36.9 | 48.4 | 34.5 | 6.1 | 0.3 |
| - Of which sales of certificates of deposit | 36.9 | 48.4 | 33.3 | 5.6 | 0.0 |
| - Of which monetary policy lending | 0.0 | 0.0 | 1.3 | 0.5 | 0.3 |
| Reservation of liquidity for settlements | 237.3 | 115.1 | 113.8 | 106.1 | 97.9 |
| - Of which to Sumclearing, Intradagclearing and Straksclearing | 177.2 | 40.5 | 39.9 | 40.6 | 40.1 |
| - Of which to ES-CPH settlement | 40.6 | 46.4 | 41.2 | 38.3 | 35.2 |
| - Of which to CLS | 19.6 | 28.2 | 32.8 | 27.2 | 22.5 |
| Net positions settled | 24.1 | 16.3 | 16.6 | 17.0 | 17.9 |
| - Of which in Sumclearing, Intradagclearing and Straksclearing | 8.1 | 8.3 | 8.3 | 9.3 | 10.0 |
| - Of which in ES-CPH settlement | 9.1 | 1.0 | 0.9 | 0.8 | 0.2 |
| - Of which in CLS | 6.8 | 7.0 | 7.3 | 6.8 | 7.7 |
| Transfers to T2S (Reservation of liquidity for settlements) * | 20.1 | 21.5 | 22.2 | 22.1 | 18.6 |

* Participants' transfers from Kronos2 to T2S are made to reserve liquidity in accounts in T2S to carry out settlements of securities transactions. This corresponds to the reservation of liquidity that takes place in accounts in Kronos2 to carry out settlements of retail payments, securities transactions and foreign exchange transactions. Once the settlements of securities transactions in T2S have been completed, the money is transferred back from T2S to the participants' accounts in Kronos2 every day.

This led to delays in the settlement of securities transactions in ES-CPH and triggered the use of the emergency procedure for re-establishment of liquidity in accounts in Kronos2 for settlement of securities transactions in ES-CPH.

Danmarks Nationalbank's oversight has comprised a review of each course of events above, and the assessment is that the handling and follow-up of the incidents have been satisfactory. This includes technical improvements, enhanced monitoring, procedural measures and a dialogue with participants and other stakeholders.

Liquidity

In 2022, participants continued to have ample liquidity to carry out payments in Kronos2, both interbank payments and payments resulting from settlement instructions from the connected payment and settlement systems (the retail payment systems, ES-CPH and CLS), see chart 1.

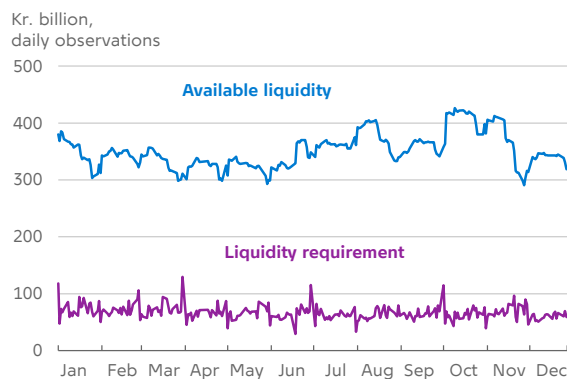
International standards

As described below, in 2022, the work continued with the improvement potentials identified in the oversight assessment of Kronos2 according to the CPMI-IOSCO's Principles for Financial Market Infrastructure, PFMI, in 2021.⁵ The only outstanding matter from the assessment is thus to perform a test of Danmarks Nationalbank's own crisis management and the sector's joint crisis management (FSOR's Crisis Management⁶) simultaneously.

At the beginning of the year, Danmarks Nationalbank's senior management approved an annual plan for operational risk management in 2022. The annual plan specifies the tasks and projects, which are to be pursued and prioritised in order to implement the objectives of Danmarks Nationalbank's Risk Policy – including specific business and IT-related risk assessments, critical projects, tests and IT security initiatives of relevance to Kronos2. The management has subsequently followed up on whether the annual plan for 2022 – and thus the risk policy – has been complied with. The annual plan for operational risk management in 2023 has also been approved.

Disposable liquidity versus liquidity needs of participants in Kronos2 in 2022

Chart 1



Note: The participants' disposable liquidity consists of deposits in their main accounts with Danmarks Nationalbank as well as their opportunity to borrow funds on an intraday basis against collateral.

Source: Danmarks Nationalbank.

In 2022, Danmarks Nationalbank has performed technical risk assessments of all main system components of Kronos2. The process for updating technical risk assessments has been strengthened with more frequent updates of risks and controls. The location of responsibility for updating technical risk assessments has also been made clearer.

Danmarks Nationalbank's emergency solution in the event of a prolonged breakdown in Kronos2 has been tested more extensively – i.e. testing of the Extreme Contingency Facility (ECF), together with the Intradagclearing system. In this connection, it has also been clarified which payments are to be sent to ECF (critical payments only) and the Intradagclearing system, respectively.

More generally, an overview and a compilation of the existing plans for testing (with prioritisation from a business-critical perspective) have been established covering the technical tests, security tests and tests of emergency solutions to be conducted annually.

⁵ Danmarks Nationalbank, Assessment of Kronos2, *Danmarks Nationalbank Report*, no. 4, December 2021 ([link](#)).

⁶ See a brief description of FSOR's Crisis Management at Danmarks Nationalbank's website ([link](#)).

Cyber resilience

In 2022, work has been performed on several IT security initiatives of importance to Kronos2 in connection with the SWIFT CSP⁷ review of the technical platform on which the system runs. This has included vulnerability scans, hardening (with secure zone components) and firewall reviews.

Periodic tests have also been conducted, including of Danmarks Nationalbank's emergency PCs, the internal crisis management and controlled shutdown of critical IT infrastructure. The objective is to ensure that Kronos2 is well prepared in the event of a serious situation such as a cyberattack.

In 2022, Danmarks Nationalbank commenced the work with an assessment of the collateral system for payments in Kronos2, Calypso, in accordance with the CPMI-IOSCO's guidelines for cyber resilience, which elaborates on the more general principles from CPMI-IOSCO, the PFMI. These guidelines are also known as Cyber Guidance.

System updates

There were no major system changes to Kronos2 in 2022.

Work is still ongoing on the planned migration of the settlement in Danish kroner from Kronos2 to the pan-European settlement system, TARGET Services, in Easter 2025, cf. box 4.

Danish kroner on TARGET Services in 2025

Box 4

In 2020, based on a preliminary analysis and dialogue with the financial sector, Danmarks Nationalbank decided to migrate the settlement of Danish kroner from Kronos2 to the new pan-European system, TARGET Services. TARGET Services consists of the central system for settlement of payments, T2, the securities settlement system T2S and the settlement system for instant payments, TIPS. The migration is scheduled for Easter 2025.

Some of the Danish securities transactions have been settled in Danish kroner in T2S since 2018. With the migration of the settlement in Danish kroner to T2 and TIPS in 2025, all settlement in Danish kroner will be grouped on TARGET Services. In continuation of the pre-analysis that resulted in the decision to migrate the settlement in Danish kroner from Kronos2 to TARGET Services, Danmarks Nationalbank initiated an implementation programme, called *TARGET DKK*, at the beginning of 2021.

The programme is implemented in close collaboration and coordination with the ECB and the day-to-day operator 4CB (the four central banks in Germany, France, Italy and Spain). In addition, Danmarks Nationalbank is working closely with the Danish financial sector and the other system owners

in the payments infrastructure. The collaboration has been organised in a reference group and a sector group at senior management level, both of which follow TARGET DKK closely. In addition, working groups have been established with the participation of experts from the sector who contribute to clarifying matters such as the liquidity and technical aspects and to planning and coordinating testing and go-live activities in the sector.

The analysis and design phase of the programme was completed at the end of the 1st quarter of 2023. In relation to TARGET Services, it has been clarified which adjustments are necessary at ECB/4CB to meet Danish needs.

The focus is now more on testing the solutions. Danmarks Nationalbank will start testing against TARGET Services in mid-2023, after which ongoing sector tests will be conducted towards go-live in Easter 2025. There will also be testing of Danmarks Nationalbank's system for monetary policy instruments and collateral (*Calypso*), which is not covered by TARGET Services. In addition, the preparations for the actual migration and the future organisation of the operation and management of the new solutions will continue.

⁷ The SWIFT Customer Security Programme (CSP) includes a number of security controls.

Retail payments

Dankort, international payment cards (VISA and Mastercard), MobilePay, Apple Pay, online banking transfers and Betalingsservice are among the preferred payment solutions for Danish citizens and companies in connection with payments of purchases and bills. Transactions were made using these and other electronic payment solutions for kr. 33.2 billion on average per day in 2022.⁸

Danmarks Nationalbank oversees the most important payment solutions in Denmark. At present, the oversight covers Dankort and Betalingsservice. Credit transfers are overseen as part of Danmarks Nationalbank's oversight of the retail payment systems. Danmarks Nationalbank regularly considers whether targeted oversight of other payment solutions is needed if they have become of greater importance in the Danish market.

In 2022, the average transaction volume for international payment cards was kr. 0.8 billion per day⁹ and kr. 0.5 billion per day for MobilePay.¹⁰ In comparison, the value of payments with Dankort, which is subject to Danmarks Nationalbank's oversight, averaged kr. 1 billion per day.¹¹

Dankort

Danmarks Nationalbank's oversight of Dankort is aimed at Nets, which is the system owner of Dankort.

Since the beginning of 2022, Nets has been part of a group (Nexi Group) formed through a merger of Nets and the Italian companies Nexi and SIA.¹² The new corporate basis for the company and the organisational changes have not been of importance to the

operation of Dankort or Danmarks Nationalbank's oversight.

In 2022, various measures have been implemented that may have an impact on the competitive position of Dankort in the market.

In January, Nets introduced a new and simpler pricing model for merchants that accept payment with Dankort on the Internet.¹³ The new model is particularly an advantage for merchants that perform transactions with a low average amount level.¹⁴

In April, Nets reduced its Dankort charges for merchants engaged in physical trade by 8 per cent as a result of a decision from the Danish Competition and Consumer Authority.¹⁵ In the decision, a lower cap was set for the annual fee that Nets may charge the merchants for their use of Dankort in physical stores.¹⁶

In August, Nets increased and standardised its payment guarantees to the merchants. This means that the merchants are guaranteed payment for an amount of up to kr. 8,000 in the event of a subsequent objection (a claim for reversal of a payment) from a bank due to an insufficient balance on the cardholder's account or a third party's unauthorised use of the card for purchases on the Internet or in a physical store.¹⁷

In October, Danske Bank made it possible for its customers to use Dankort in Apple Pay instead of VISA or Mastercard. This is the first time that Dankort users will be able to use Dankort in Apple Pay for payments.¹⁸ The same month, Nets closed for the

⁸ The value of the transactions in the retail payment systems as calculated per calendar day, see the section *Clearing and settlement of retail payments*.

⁹ Danmarks Nationalbank's Statbank – the DNBSTS table – compared with information from Nets' statistics for Dankort.

¹⁰ MobilePay, MobilePay i rekordår: Passerede 500 mio. transaktioner, 2 January 2023 ([link](#)).

¹¹ Nets' statistics for Dankort.

¹² Nexi Group, Nexi Group's Transformation Path ([link](#)).

¹³ Nets, Tag nemt og billigt imod Dankort på din webshop ([link](#)).

¹⁴ Nets, Nets ændrer prismodel for handel med Dankort på nettet, 16 November 2021 ([link](#)).

¹⁵ The Danish Chamber of Commerce, Lavere priser på Dankort, 30 March 2022 ([link](#)).

¹⁶ The Danish Competition and Consumer Authority, Lavere loft for Nets' dankortopkrævninger hos fysiske butikker, 9 December 2021 ([link](#)).

¹⁷ Payment card agreement for Dankort (cf. amendment on 18 August 2022) ([link](#)).

¹⁸ Nets, Danske Bank to bring domestic scheme, Dankort, to Apple Pay, 12 October 2021 ([link](#)).

possibility of making payments with the Dankort app, stating that Nets will work to ensure that Dankort can instead be used in Apple Pay and Google Pay.¹⁹

Dankort – operational reliability

The Dankort operation was satisfactory in 2022. During the course of the year, there was a single incident of significance for Dankort.

On 21-25 June 2022, there were operational disruptions of NemID. This caused problems with online Dankort payments requiring approval with authentication of the cardholder via NemID.²⁰ Nets does not have a full overview of the consequences of the incident for Dankort. However, Nets' assessment is that the incident had limited impact on card payments.

Subsequently, with the final transition to MitID at the end of October 2022, the use of NemID has been closed. As MitID and NemID are fundamentally different solutions, Nets assesses that a similar incident cannot happen with MitID.

Danmarks Nationalbank has followed up on Nets' handling and reporting of the incident.

Dankort – fraud

In 2022, overall fraud with Dankort amounted to kr. 20.9 million, which is a 17 per cent increase compared to 2021. Relative to the total Dankort-based consumption, fraud constituted 0.06 per mille in 2022 against 0.05 per mille in 2021. According to Nets, the increase in Dankort fraud is mainly attributable to the reopening of society in 2022 after periods with covid-19 restrictions in 2020 and 2021. Dankort fraud amounted to 0.08 per mille in 2019 (before covid-19) and was thus higher compared with 2022.

Most cases of Dankort fraud occur in stores and ATMs due to theft or loss of payment cards. This type

of fraud increased by 28 per cent in 2022 to kr. 16.4 million. After increases in both 2021 and 2022, the level of fraud is thus approximately the same as it was in 2019, when it amounted to kr. 15.9 million.

Dankort fraud in connection with online purchases amounted to kr. 4.5 million in 2022, corresponding to a decrease of 9 per cent in comparison to the previous year.²¹ Seen as a share of online use of Dankort, the fraud level remained unchanged at 0.05 per mille.²²

At the beginning of 2022, Nets introduced the *Dankort Fraud Notification Service*. The purpose of this service is to contribute to reducing fraud in online shops. If Nets has registered fraudulent use of a Dankort and the card has been used for purchases in an online shop, the store will receive an email notification from Nets regarding potential fraud. This will give the store an opportunity to stop the dispatch of the goods.²³

Betalingservice

Danmarks Nationalbank's oversight of Betalingservice is aimed at Mastercard Payment Services Denmark A/S, MPS, which is the system owner of Betalingservice.

In 2022, MPS has taken further steps in the process of taking over the operation of Betalingservice, which they acquired from Nets in 2021. The agreement between MPS and Nets imposes an obligation on Nets to support the operation of Betalingservice for three years until March 2024, which is the deadline for MPS's establishment of the necessary processes and IT infrastructure etc. for the operation of Betalingservice.

In August 2022, MPS entered into an agreement with Kyndryl, on delivery of the system and accompanying services that form the basis of Betalingservice

19 Finanswatch, Nets vil flytte fokus fra app til Apple Pay, 13 September 2022 ([link](#)).

20 Cardholders who had set up MitID or payment validation with password and text message code could use these as alternatives while NemID was down.

21 In connection with online purchases, Dankort can only be used in Danish shops. Hence, when a co-branded Dankort is used for purchases from an online shop abroad, the VISA part of the card is used.

22 Nets' statistics on Dankort fraud. It should be noted that Nets' data on fraud is not directly comparable with Danmarks Nationalbank's statistics on payment card fraud, which cover pure Dankort and co-branded Dankort in Denmark.

23 See a description of the Dankort Fraud Notification Service here ([link](#)).

(formerly a contractual relationship between Nets and Kyndryl). Kyndryl will thus remain the central supplier in relation to Betalingservice.

Danmarks Nationalbank's assessment is that MPS' takeover of the operation of Betalingservice is characterised by continuity, both in regards to technical terms and personnel.

Betalingservice – operational reliability and fraud

There were no breakdowns or other significant incidents in Betalingservice in 2022. Operational stability was thus high in 2022.

There was no fraud with Betalingservice in 2022.

International standards

In 2022, Danmarks Nationalbank had a dialogue with Nets and MPS on the new ECB standards (PISA)²⁴ for payment solutions such as Dankort and Betalings-service. In the Eurosystem, the migration to PISA was formally scheduled for 15 November 2022.²⁵ As PISA to a great extent constitutes a continuation of the requirements in the current ECB standards, including those in the key areas, Danmarks Nationalbank does not see an immediate need for major adjustments at Nets and MPS regarding Dankort and Betalings-service or in Danmarks Nationalbank's oversight.

24 Payment Instruments, Schemes & Arrangements (Eurosystem oversight framework). See also Danmarks Nationalbank, Oversight of the financial infrastructure 2021, box 4, page 13, no. 3, May 2022 ([link](#)).

25 ECB, *Eurosystem publishes new framework for overseeing electronic payments*, November 2021 ([link](#)).

Clearing and settlement of retail payments

The Sumclearing, Intradagclearing and Straksclearing – also called *the retail payment systems or in Danish 'Detailclearingerne'* – are the financial sector's systems for clearing and settlement of Danish retail payments. The systems are owned by Finance Denmark, managed by e-nettet, which is the financial sector's project and management company and supplied by Mastercard Payment Services Danmark A/S, MPS.

The Sumclearing system is used for settlement of, for example, card and Betalingservice payments once a day on banking days.

The Intradagclearing system is used for settlement of credit transfers such as online banking transfers, payroll transactions and public sector payments five times a day on banking days. The banks' net positions – corresponding to the sum of payments to and from the banks' customers – are calculated in the systems at fixed times. The net positions are sent to Kronos2, which exchanges the amounts between the banks.

In the Straksclearing system, credit transfers are executed in a matter of seconds 24/7. This is possible because the banks reserve liquidity in Kronos2 for the transfers beforehand. The actual interbank exchange of liquidity takes place six times a day on banking days. The Straksclearing system is used primarily for online banking transfers and payments via MobilePay.

Use

At the end of 2022, there were 47 direct participants in the retail payment systems and 23 indirect participants, which settle via direct participants. The value of transactions in the systems averaged kr. 48.1 billion per banking day in 2022, cf. table 2.

The number of transactions in the Straksclearing increased in both 2021 and 2022 after an unchanged level from 2019 to 2020, cf. chart 2.

Operational reliability

Operation of the retail payment systems was satisfactory in 2022. However, there were a few minor incidents where payments could not be made for short periods of time via the Straksclearing system.

Value of transactions in the Sumclearing, Intradagclearing and Straksclearing

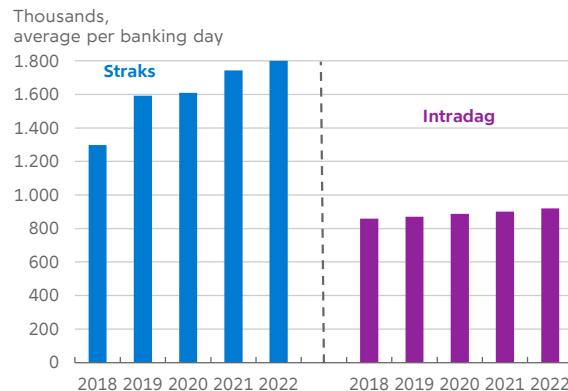
Table 2

| Kr. billion, average per banking day | 2018 | 2019 | 2020 | 2021 | 2022 |
|--------------------------------------|------|------|------|------|------|
| Sumclearing | 18.3 | 19.2 | 18.7 | 20.5 | 21.3 |
| Intradagclearing | 20.1 | 20.8 | 21.9 | 23.9 | 25.0 |
| Straksclearing | 1.2 | 1.4 | 1.6 | 1.7 | 1.8 |
| Total | 39.6 | 41.4 | 42.2 | 46.1 | 48.1 |

Source: Mastercard Payment Services Danmark A/S, MPS.

Number of transactions in the Intradagclearing and Straksclearing, 2018-2022

Chart 2



Source: Mastercard Payment Services Danmark A/S, MPS.

One of these was due to technical problems in a data centre, which resulted in some customers not being able to send instant payment transfers.

Liquidity

The banks reserve liquidity in accounts in Danmarks Nationalbank for settlement of their net positions. If a participant does not reserve sufficient liquidity, the participant's settlement will be postponed, and new net positions are calculated for the other participants, which thereby risk not receiving the expected liquidity.

Most of the banks use the automated tools of the retail payment systems for liquidity management and there have not been any incidents in 2022 in which participants' settlements were postponed due to a lack of liquidity.

In the Straksclearing, there is no liquidity risk between the participants. This is because the Straksclearing is a real-time settlement system in which the participants reserve liquidity in the form of collateral in advance for payments that are settled via the customers' accounts as they are made. If sufficient liquidity has not been allocated, the payments are rejected.

Cyber resilience

Finance Denmark is working continuously to strengthen the cyber resilience of the retail payments infrastructure. A central part of this work is a cyber security handbook for the retail payment systems, which was introduced in 2021. In the handbook, Finance Denmark lays down requirements for IT security at MPS and the participating banks, who have to evaluate and report their compliance with the requirements to Finance Denmark on an annual basis.

In early 2022, Finance Denmark followed up on the first reporting and conducted a dialogue with the participants on the provisions of the handbook. The dialogue resulted in an updated version of the handbook with more detailed specifications.

The latest reporting according to the cyber security handbook, which was performed at the end of 2022, shows satisfactory cyber maturity. Based on the participants' reporting, Finance Denmark has identified a number of topics that the participants and their data centres are recommended to continue working with in order to increase their cyber maturity further.

International standards

In May 2022, Danmarks Nationalbank completed an assessment of the compliance of the retail payment systems with CPMI-IOSCO's guidelines for cyber resilience (Cyber Guidance). The assessment showed that the retail payment systems have a high maturity level and comply with the Cyber Guidance in most areas. However, there are few, but key, areas in which the retail payment systems do not fully comply with the international guidelines. Danmarks Nationalbank has recommended Finance Denmark to strengthen the work in these areas, and Finance Denmark has drawn up a plan for how they will comply with the recommendations.

System updates

Finance Denmark is working to increase the threshold in the Straksclearing system. The threshold is currently kr. 500,000, but, according to Finance Denmark, the banks are experiencing an increasing need to execute large payments in real time.

Finance Denmark has prepared a number of requirements for the banks' use of the Straksclearing, which must be complied with before the threshold can be increased. These comprise of requirements for differentiated thresholds for sending instant payments, including via customer segmentation. There are also requirements for monitoring payments to detect suspicious transfers and for the possibility of quick revocation of transactions.

Danmarks Nationalbank has also recommended to Finance Denmark that an analysis be prepared of the risk of criminal transactions and potential cyber risks that may result from an increase in the threshold. Finance Denmark is still working on preparation of the risk analysis and expects that the change in the threshold can take effect during 2023.

MPS's takeover of the operation of the retail payment systems

In 2021, MPS acquired and took over the areas of Nets' infrastructure that cover operation of the retail payments systems. In 2022, MPS received conditional consent from Finance Denmark to initiate a data centre relocation, so that the operation of the Intradag-clearing and Straksclearing systems will be moved from Nets' data centres in Norway to new data centres in Norway and Sweden, respectively.

The new data centre setup will consist of a primary establishment with a duplicated setup in two phys-

ically separate data centres and a secondary establishment in another country, which means that, in practice there will be three data centres in total. In parallel, the operation of the Sumclearing system will be migrated from Nets' production environment at Kyndryl to MPS's production environment at Kyndryl.

The relocation of the data centres, including the time for this, has been coordinated with the TARGET DKK project and the sectoral programme for the future payments infrastructure, see below.

The future retail payments infrastructure

In 2018, six Nordic banks²⁶ set up the company P27 Nordic Payments in Sweden and chose MPS as IT supplier for the accompanying payment system. In 2021, the overall Danish sector decided to work towards replacing the existing retail payments systems (the Sumclearing, Intradagclearing and Straksclearing) with P27's Nordic retail payment system. P27 was scheduled to go live with Danish kroner in Easter 2025 concurrently with the system joining TARGET DKK. Due to delays, a collective Danish sector decided in March 2023 to integrate the existing retail payment systems, the Sumclearing and Intradagclearing, into TARGET DKK instead. At the same time, it has been decided that the existing Straksclearing system will be closed down in Easter 2025, after which instant payments can be settled directly in TIPS on TARGET Services.

The work with the future retail payments infrastructure is anchored in a sector programme under Finance Denmark's Board of Directors, and a steering committee has been set up with broad sector representation. The programme is run by e-nettet in close collaboration with Finance Denmark. The programme is closely coordinated with Danmarks Nationalbank's TARGET DKK project.

Legal basis for retail payment systems

In January 2022, a new Danish act entered into force aimed at regulating companies handling clearing and settlement of retail payments in Danish kroner and at operators of retail payment systems.²⁷ The act has two main objectives:

- 1) To ensure that Danmarks Nationalbank can always oversee foreign payment systems under Danish law.²⁸
- 2) To ensure that the Danish Financial Supervisory Authority has the legal authority to conduct IT audits of an operator of a retail payment system. As the current operator of the retail payment systems in Denmark, MPS received official permission from the Danish Financial Supervisory Authority in October 2022 to handle the current IT operation of the retail payment systems. This was a statutory procedure following MPS' takeover of Nets' clearing infrastructure.²⁹

²⁶ The banks behind this initiative are Danske Bank, Nordea, Handelsbanken, SEB, Swedbank and OP Financial Group. DNB was part of the initiative but withdrew from the project together with the Norwegian sector in March 2019.

²⁷ Act no. 2382 of 14 December 2021: *Danish Act to amend the Danish Financial Business Act, the Danish Capital Markets Act, the Danish Act on Investment Funds etc. and various other acts.*

²⁸ It follows from section 180 of the Danish Capital Markets Act that Danmarks Nationalbank exercises supervisory powers for systems covered by Danmarks Nationalbank's oversight.

²⁹ See Danmarks Nationalbank, Oversight of the financial infrastructure 2021, *Danmarks Nationalbank Report*, no. 3, May 2022 ([link](#)) for further information about MPS's acquisition of the clearing infrastructure.

Securities settlement

Securities transactions can be concluded in different ways: on the stock exchange, through a multilateral trading facility or bilaterally between the parties through a bank or a stockbroker. The final settlement of the transactions, i.e. where money and securities are exchanged between the participants, takes place in two central securities settlement systems in the Danish and European financial infrastructure, respectively, as well as in Kronos2.

In legal terms, the final settlement of all transactions securities issued in Danish kroner takes place on accounts maintained by the central securities depository *Euronext Securities Copenhagen*, ES-CPH,³⁰ i.e. the registration of changes in the holdings of securities takes place in the participants' accounts with ES-CPH.

Securities transactions between the professional participants (including banks) – both their own transactions and transactions concluded on behalf of their clients – are technically settled in accounts in *TARGET2-Securities*, T2S, to which ES-CPH has outsourced the settlement process (the 'T2S settlement'). Changes to securities accounts in T2S are subsequently mirrored on accounts in ES-CPH's systems.

Securities transactions between banks and their customers are settled in ES-CPH's own settlement system (the 'ES-CPH settlement').

The settlement of the payment side of the transaction takes place in accounts in Kronos2 for trans-

actions processed in the ES-CPH settlement and in accounts in T2S for transactions processed in the T2S settlement. Every day, participants therefore transfer liquidity to their settlement accounts in Danish kroner in T2S.

ES-CPH is also responsible for handling periodic payments, issues, redemptions etc. and is the only company in Denmark with permission from the Danish Financial Supervisory Authority to issue and hold securities.

Use

ES-CPH has 88 participants, of which 40 are foreign market participants, including four CCPs³¹. 48 of the participants in ES-CPH also have an account with Kronos2 in order to transfer liquidity to their settlement account in T2S. Non-participants in Kronos2 can also transfer liquidity to settlement accounts in T2S.

In the summer of 2022, J.P. Morgan became a direct participant in ES-CPH instead of using an indirect connection through another participant. There is a general trend for large global custodians to become directly connected to the local central securities depositories in the EU, where so-called subcustodians have previously been used.³² One of the reasons for this is the standardisation among European central securities depositories that has taken place together with the entry into force of the pan-European regulation of central securities depositories, CSDR, which has reduced the need for subcustodians with knowledge of local conditions³³.

³⁰ Until November 2020, ES-CPH was called VP Securities. VP Securities was then acquired by the pan-European stock exchange and the market infrastructure group Euronext Group. The change of names is only commercial, and the Danish company is still registered as VP Securities A/S in the CVR register.

³¹ The four foreign CCPs in ES-CPH are Cboe Clear Europe N.V, LCH Clearnet and Six X-clear, respectively, which clear equities transactions, while Nasdaq Clearing clears repo transactions. The regulatory supervision of the CCPs is conducted in so-called supervisory colleges, where the Danish Financial Supervisory Authority participates in the supervision of Cboe Clear Europe N.V and Nasdaq Clearing AB.

³² Subcustodians are banks or other market participants that are already connected to the central securities depository and have typically had better knowledge of local conditions in the specific country. The general harmonisation of central securities depositories in the EU has now reduced the importance of local conditions.

³³ Regulation (EU) No 909/2014 of the European Parliament and of the Council of 23 July 2014 on improving securities settlement in the European Union etc., abbreviated CSDR (*link*), aims to harmonise times and behaviour in connection with securities settlement as well as the rules applicable to the central securities depositories (CSDs) that operate the settlement infrastructure.

In 2022, an average of 91,300 transactions were settled in Danish kroner per day through the ES-CPH settlement and T2S, which is a decrease of approximately 10 per cent compared with 2021, cf. table 3. This is mainly due to a decrease in the number of equities transactions. However, with a daily average of kr. 255.4 billion, the value of the settled transactions was the highest ever for securities denominated in Danish kroner. This is particularly due to an increase in the value of bond transactions of kr. 31 billion per banking day on average.

Between 2018 and 2021, the market value of securities held in custody in ES-CPH increased by almost 50 per cent, cf. chart 5. This was primarily due to the value of Danish-issued equities nearly doubling during that period. In 2022, there was a slight drop in the market value of the securities held in custody, which was correspondingly due to the general price drops in Danish-issued securities in 2022.

Equities, investment fund shares and bonds settled in ES-CPH, averages per banking day

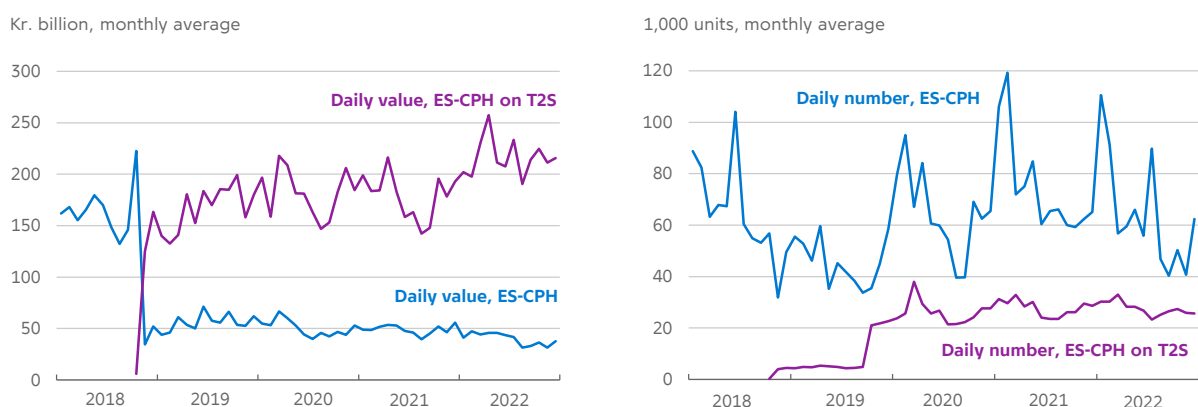
Table 3

| Year, average per day | Total | | Bonds | | Equities | | Investmentfund shares | |
|-----------------------|----------------------------------|--------------------|----------------------------------|--------------------|----------------------------------|--------------------|----------------------------------|--------------------|
| | Number of transactions, thousand | Value, kr. billion | Number of transactions, thousand | Value, kr. billion | Number of transactions, thousand | Value, kr. billion | Number of transactions, thousand | Value, kr. billion |
| 2017 | 66.9 | 162.7 | 2.7 | 118.4 | 32.4 | 36.6 | 31.8 | 7.7 |
| 2018 | 65.5 | 168.5 | 2.6 | 119.0 | 29.4 | 40.8 | 33.5 | 8.8 |
| 2019 | 67.0 | 223.1 | 4.2 | 180.7 | 33.0 | 34.8 | 29.8 | 7.6 |
| 2020 | 90.5 | 231.5 | 3.8 | 178.1 | 49.0 | 43.5 | 37.7 | 9.9 |
| 2021 | 101.7 | 226.4 | 3.9 | 163.6 | 49.1 | 51.0 | 48.7 | 11.8 |
| 2022 | 91.3 | 255.4 | 5.2 | 194.6 | 39.6 | 51.3 | 46.5 | 9.5 |

Note: The number and value of transactions have been calculated collectively for ES-CPH and ES-CPH on T2S. Values have been calculated on the basis of the securities leg of a transaction, i.e. the market value of the securities transferred from the seller to the buyer.
Source: ES-CPH.

Number and value of securities transactions

Chart 3



Note: The left-hand chart shows the number of transactions settled, while the right-hand chart shows the value of transactions, calculated based on the market value of the securities transferred from the seller to the buyer.
Source: ES-CPH.

Operational reliability

Operational reliability in the settlement of Danish securities transactions in the ES-CPH settlement was satisfactory in 2022 and without major incidents. During the year, there were a few minor incidents that have not significantly affected the operation of the ES-CPH settlement.

In T2S, the introduction of the new trans-European sanctions system³⁴ in February 2022 posed several challenges and caused a number of minor incidents in the system. This resulted in lower operational stability in ES-CPH's settlement in T2S in February and March 2022. The problems were resolved, and operational stability was normalised for the rest of the year.

Settlement ratio

The settlement ratio indicates the percentage of the transactions settled in a timely manner.

According to Article 5 of the CSDR, securities transactions must be settled two days after they have been concluded.

Chart 6 shows the settlement ratio for ES-CPH's own system and for ES-CPH's settlement in T2S, respectively. In this regard, it is positive that there has generally been a trend towards an improvement in the settlement ratio during 2022, both in the local ES-CPH settlement and in T2S.

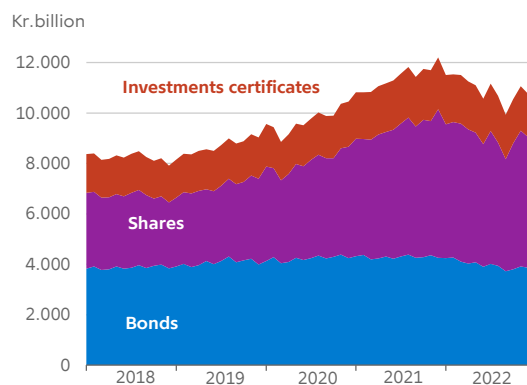
International standards

Danmarks Nationalbank oversees that the settlement of Danish securities transactions in ES-CPH and T2S meets international standards for financial market infrastructures such as securities settlement systems.

The oversight of T2S is performed in collaboration with all the central banks connected to the platform, with the ECB as the main overseer and coordinator, see the section on payments and securities settlement in euro.

Market value of securities held in ES-CPH

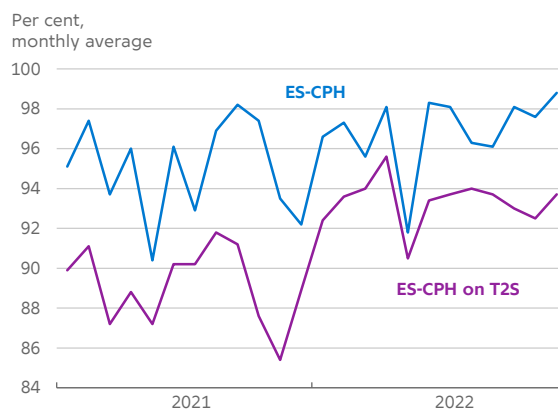
Chart 4



Source: ES-CPH.

Settlement ratio

Chart 5



Note: In the chart, the settlement ratio is based on the number of transactions (trading volume). Due to data breaches, data is not available dating back further than 2021.

Source: ES-CPH.

³⁴ If a participant's transactions are not settled in a timely manner, this may cause problems for that participant's counterparties, which may not be able to meet their obligations as a result thereof. In February 2022, a new trans-European sanctions system was therefore introduced as part of the CSDR. The system is designed to sanction participants whose transactions cannot be settled in a timely manner due to a lack of securities or liquidity.

Danmarks Nationalbank's oversight of ES-CPH is coordinated with the Danish Financial Supervisory Authority, which supervises compliance with the requirements of the EU legislation, including the CSDR. To the extent that there is an overlap between oversight standards and statutory requirements, documentation from the Danish Financial Supervisory Authority on compliance with statutory requirements is included in Danmarks Nationalbank's oversight.³⁵

Cyber resilience

In 2020, Danmarks Nationalbank completed an assessment of ES-CPH's compliance with the CPMI-IOSCO's Cyber Guidance. This assessment shows that ES-CPH has a high level of maturity and complies with the Cyber Guidance in most areas. However, there are also a few, but key, areas in which ES-CPH does not fully comply with international guidelines. In 2022, ES-CPH has continued its work to comply with the recommendations from Danmarks Nationalbank, which remain open.

In November 2022, ES-CPH received orders from the Danish Financial Supervisory Authority in connection with an IT inspection conducted in spring 2022. Danmarks Nationalbank participated in the inspection as an observer. According to the Danish Financial Supervisory Authority's order, ES-CPH must ensure a better method for maintenance of its IT crisis management and ensure that the IT response is supported by procedures. In addition, the Danish Financial Supervisory Authority issued an order that ES-CPH must strengthen its processes and methods for management of its IT crisis management and ensure clear coherence across the crisis management planning and reporting.

Danmarks Nationalbank expects that ES-CPH's work to comply with the Danish Financial Supervisory Authority's orders will also contribute to compliance with Danmarks Nationalbank's recommendations in accordance with CPMI-IOSCO's Cyber Guidance.

Danmarks Nationalbank and the Danish Financial Supervisory Authority coordinate ES-CPH's follow-up on the issued orders and recommendations.

System updates

Following the introduction of Danish kroner to T2S in October 2018, an increasing share of transactions with Danish-issued securities are settled in T2S, cf. chart 4.

On this basis, ES-CPH has chosen to phase out the settlement of transactions in Danish kroner and euro from the ES-CPH settlement. This means that, from the end of 2024, all transactions in Danish kroner and euro will be settled in T2S. Settlement of securities transactions via the local ES-CPH settlement will then only take place in Swedish kronor or as so-called Free-of-Payment transactions (FoP)³⁶.

At the same time, the so-called auto-collateralisation, used for provision of collateral for intraday credit in Kronos2, will be phased out.³⁷ The change is made possible by a number of elements, including that the participants' need for provision of collateral for settlement in T2S is today covered by T2S' own system for auto-collateralisation, where T2S handles the provision of collateral for settlement credit.

³⁵ Danmarks Nationalbank is the relevant authority for ES-CPH, cf. Article 12 of the CSDR, and must therefore be notified of matters relating to the central securities depository's compliance with the requirements in the Regulation.

³⁶ In Free-of-Payment transactions, only the security is exchanged between the seller and the buyer, and there is no money involved in the settlement of the transaction. However, if the transaction has been entered into between a customer and the customer's own bank, it can still be concluded at the same time as the exchange of money (so-called Delivery-versus-Payment, DvP), as the payment leg, which is exchanged internally in the bank, will not require money settlement in Kronos2.

³⁷ Using auto-collateralisation, a participant provides collateral in the form of securities deposited in one or more designated custody accounts with ES-CPH. Unlike normal auto-collateralisation or another traditional pledge, the auto-collateralisation system in Kronos2, called "Sikkerhedsretten", only collateralises the overall custody account and does not tie up specific assets in a custody account as collateral.

Payments and securities settlement in euro

TARGET Services is used by Danish banks to settle payments and securities transactions in euro. TARGET Services consists of T2 (formerly TARGET2),³⁸ TARGET Instant Payments Service (TIPS) and TARGET2Securities (T2S). The systems are owned by the European Central Bank (ECB) and the national central banks of the euro area and are operated by 4CB (the four central banks of Germany, France, Italy and Spain) with the ECB as coordinator.

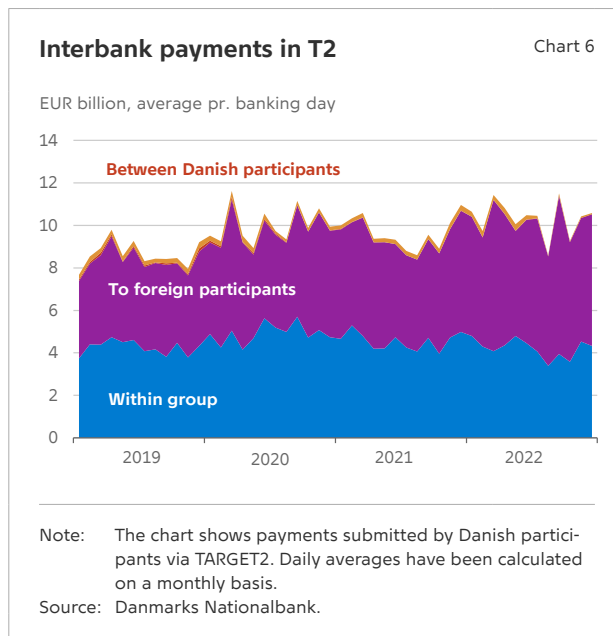
T2 is the trans-European RTGS system, which is used for settlement of large time-critical payments in euro. In T2, participants can also transfer liquidity for settlement in other euro systems, including T2S. T2S is the pan-European system for settlement of securities transactions in euro and in Danish kroner.³⁹ TIPS is used to make instant payments in euro.⁴⁰

Oversight of TARGET Services is performed in cooperation with the ECB and the other central banks connected to T2 or T2S. Danmarks Nationalbank participates in the joint oversight headed by the ECB, which takes place in working groups with participation of the national central banks.

Use

There are 21 Danish participants in T2. In 2022, Danish participants' daily interbank payments averaged EUR 10.2 billion. Danish participants use T2 mainly for intergroup payments and payments to foreign participants, cf. chart 6. Exchange of euro mostly takes place with participants in Finland, Germany, France and Belgium.

A total of 19 central securities depositories with activities in 20 EU member states are connected to T2S, including ES-CPH. A bank may settle securities transactions via T2S as either a direct participant, if the



bank has a so-called Dedicated Cash Account, or as an indirect participant via a direct participant's access.

A Dedicated Cash Account for T2S settlements is set up through one of the central banks in the EU, including Danmarks Nationalbank. 11 Danish participants hold a Dedicated Cash Account for T2S settlements via Danmarks Nationalbank for payment in or receipt of euro in connection with T2S settlement. Other Danish participants may have set up a Dedicated Cash Account for T2S settlements via other EU central banks.⁴¹

Operational reliability

The operational reliability of the local T2 components for which Danmarks Nationalbank is responsible was satisfactory in 2022.

38 In March 2023, TARGET2 was replaced by the new RTGS system T2, as part of the consolidation in TARGET Services (see under 'System changes' for a more detailed description).

39 T2S can handle multiple currencies. Besides the euro, Danish kroner is the only other currency connected to T2S. Read about the settlement of securities transactions in Danish kroner in the section Securities settlement.

40 No banks in Denmark currently use TIPS.

41 As euro cannot be deposited permanently in Dedicated Cash Accounts, banks must also have access to a T2 account to which euro can be transferred at the end of the settlement day. Most of the Danish banks have concluded agreements with correspondent banks, while some of the largest banks have established a T2 account through their branch with a central bank in the euro area.

However, as described in the section on securities settlement, the commissioning of a new sanctions system in T2S affected the operational reliability of the system in February and March 2022. The ECB's oversight has followed up on the problems together with the national central banks.

Back in 2020, there were five serious IT-related incidents (not cyber incidents) which affected the settlement of payments and securities transactions in T2 and T2S. As a follow-up to the incidents, the ECB commissioned an external investigation by Deloitte, and the ECB's oversight and internal auditors also followed up on the incidents. This resulted in recommendations on how the ECB can strengthen its risk management work in several areas, including change management, business continuity, governance etc.⁴² Against this background, the ECB drew up an action plan containing a number of actions.⁴³ In 2021 and 2022, the ECB has initiated and implemented measures aimed at addressing most of the recommendations. The main part of the measures in the action plan have been implemented and the ECB expects the work with the action plan to be finally concluded in the course of 2023. Danmarks Nationalbank participates in the ECB's follow-up on the action plan under the auspices of the joint oversight of TARGET Services, see below.

International standards

In early 2022, the ECB concluded an assessment of T2S against the Cyber Resilience Oversight Expectations (CROE) – the ECB's implementation of the CPMI-IOSCO's Cyber Guidance. Danmarks Nationalbank has participated in the work. The assessment has led to a number of recommendations that T2S is now working to address.

System updates

In 2016, the ECB initiated a major project aimed at modernising the European payments infrastructure and has since then been working to consolidate T2, T2S and TIPS on a single IT platform. The aim is to meet new market requirements and optimise participants' liquidity management across all TARGET Services.

The consolidation was scheduled to be launched on 21 November 2022, but was postponed to 20 March 2023. System unreliability and temporary unavailability of the test environment meant that all participants had not adequately tested the new system before the scheduled launch in November 2022. The launch was therefore postponed. On 20 March 2023, all central banks and participants migrated to the consolidated platform, TARGET Services, as planned.

42 ECB, ECB publishes an independent review of TARGET incidents in 2020, Press release, 28 July 2021 ([link](#)).

43 The action plan has had a broad scope and covers measures in change and release management, business continuity management, fail-over and recovery tests, communication protocols, governance and data centres and IT operations.

Settlement of foreign exchange transactions

Globally, the foreign exchange market is the biggest of all financial markets in the world in terms of turnover. Foreign exchange transactions in Danish kroner can either be settled through correspondent banks or through the international settlement system for foreign exchange transactions, CLS.

A foreign exchange transaction consists of two opposite payments in two different currencies. If the two payments are not concluded simultaneously, the parties to the transaction incur a settlement risk. The settlement risk is the risk that one party to a foreign exchange transaction make payment as agreed but does not receive the purchased currency, which may result in significant losses and potentially lead to systemic consequences.

In connection with settlement through correspondent banks, the two payments in a foreign exchange transaction are not settled simultaneously, which means that the parties to the transaction are exposed to a settlement risk. If payments in different currencies are to be exchanged across time zones, the payments may be in transit for many hours or days, resulting in a significant settlement risk.

The settlement risk can be reduced by settling both sides of a currency transaction simultaneously⁴⁴ (Payment-versus-Payment, PvP), which is possible in, for example, CLS. CLS currently settles foreign exchange transactions in 18 connected currencies, including Danish kroner, euro and US dollar. Only foreign exchange transactions in which both currencies in the transaction are connected to CLS can be settled in CLS. Every day, on average, foreign exchange transactions totalling more than 6 trillion US dollar are settled in CLS.

The settlement risk can also be reduced by bilateral netting of mutual payment obligations before settlement. CLS offers a bilateral netting calculation service in 120 currencies that provides users with a comprehensive overview of their net payment obligations. Netting reduces the settlement risk in

Oversight of CLS

Box 5

Oversight of CLS is carried out by a joint CLS Oversight Committee¹, which is a forum for collaboration between the central banks of the participating currencies, through which they can handle their national oversight responsibilities. Danmarks Nationalbank participates in this work, which is organised by the Federal Reserve (the FED), which is also the supervisory authority for CLS. Danmarks Nationalbank's oversight is focused on matters of importance to the settlement of transactions in Danish kroner.

Oversight of CLS is based on the CPMI-IOSCO principles for safe and efficient payment systems (Principles for Financial Market Infrastructures, PFMI). CLS published its most recent description of how the system complies with CPMI-IOSCO's principles in September 2022.²

1. Federal Reserve System, Protocol for the Cooperative Oversight Arrangement of CLS ([link](#)).
2. CLS, Principles for Financial Market Infrastructures (PFMI) Disclosure, 2022 ([link](#)).

foreign exchange transactions, as netting reduces the amounts that are to be exchanged between the parties to foreign exchange transactions.

Danmarks Nationalbank participates in joint oversight of CLS together with central banks for the other connected currencies, cf. box 5.

Use

The Danish krone is the 20th most traded currency in the world. Global transactions in Danish kroner have increased by more than a third in the past three years and amounted to an average of kr. 378 billion per banking day in April 2022. One of the reasons for the increase is increased volatility in the financial markets, for example in connection with the coronavirus pandemic and the war in Ukraine.⁴⁵

⁴⁴ See FX settlement risk: an unsettled issue, BIS Quarterly Review, December 2022 ([link](#)).

⁴⁵ See Danmarks Nationalbank, Survey of foreign exchange and derivatives markets, 2022, Statistics – Insight, 12 December 2022 ([link](#)).

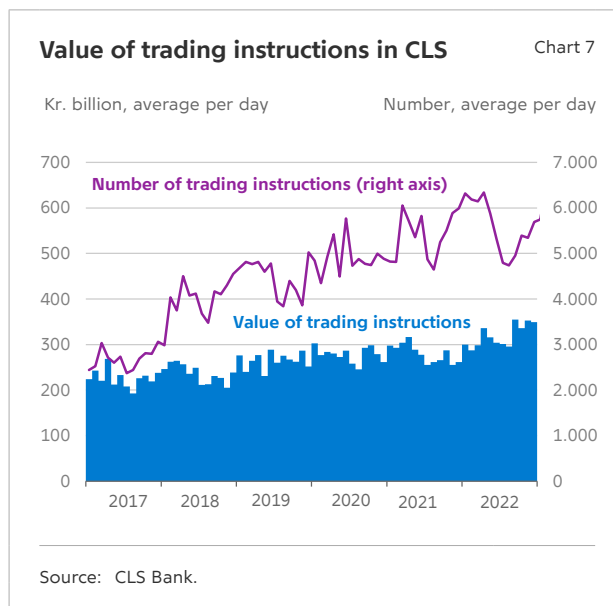
For Danish kroner, approximately 90 per cent of all foreign exchange transactions with Danish kroner as one leg of the transaction are settled in CLS.⁴⁶ The average daily value of transactions in Danish kroner in CLS was kr. 319 billion in 2022. This is an increase of 14 per cent relative to 2021, cf. chart 7.

Both Danish banks and companies can settle foreign exchange transactions via CLS. One Danish bank participates directly in CLS settlement. Those who are not direct participants can settle foreign exchange transactions in CLS via one of the domestic and foreign participants that offer indirect participation to the Danish market. A number of Danish banks and companies make use of this.

Operational reliability and liquidity

CLS settlement takes place during a relatively short defined window when all RTGS systems of the participating central banks – across time zones – are open at the same time. Pay-ins and pay-outs related to CLS are made via the connected central banks' RTGS systems. For Danish kroner, this means through Kronos2. The operational reliability of CLS is therefore dependent on the reliability of the connected RTGS systems. And because of the interdependencies between CLS and the RTGS systems for the 18 connected currencies, an incident in one RTGS system can spread to other systems.

In 2022, there were no incidents in Kronos2 that affected CLS settlement, and the Danish participants reserved sufficient liquidity for CLS settlement. In one case, however, an incident in another central bank's RTGS system had consequences for the settlement in Danish kroner, as problems arose with payments from CLS. As a consequence, the closing of the monetary policy day in Denmark had to be postponed. See also the section 'Interbank payments and central settlement of payments in Danish kroner' on page 10.



⁴⁶ Estimate based on BIS Triennial Central Bank Survey 2022, OTC foreign exchange turnover in April 2022, Bank for International Settlements, October 2022 ([link](#)) and data from CLS Bank.

PUBLICATIONS



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News offers quick and accessible insight into an Analysis, an Economic Memo, a Working Paper or a Report from Danmarks Nationalbank. News is published continuously.



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Working Papers present research projects by economists in Danmarks Nationalbank and their associates. The series is primarily targeted at professionals and people with an interest in academia. Working Papers are published continuously.

The report consists of a Danish and an English version. In case of doubt regarding the correctness of the translation the Danish version is considered to be binding.

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