BANK OF CANADA
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Bank of Canada Oversight Activities for Financial Market Infrastructures

2019 Annual Report

May 2020

Executive summary

Financial market infrastructures (FMIs) are a critical component of the financial system. They support economic activity by providing a platform to transfer funds and settle transactions. Since financial transactions are concentrated in FMIs, FMIs are a potential source of risk to the financial system. The Bank of Canada (the Bank) oversees those FMIs operating in Canada that have the potential to pose systemic or payments system risk to ensure that the risk is adequately controlled. Oversight of designated FMIs contributes to the Bank's broader mandate of promoting the stability and efficiency of the Canadian financial system.

The *Bank of Canada Oversight Activities for Financial Market Infrastructures 2019 Annual Report* outlines how the Bank fulfills its mandate for oversight of designated FMIs. The report highlights key issues about the safety and soundness of designated FMIs. It also specifies the Bank's expectations regarding the risk-management enhancements to be pursued by designated FMIs in 2020–21.

Designated FMIs continued to make significant progress in their risk-management practices throughout 2019 to address the Bank's oversight expectations. The Bank expects progress to continue in 2020 and beyond.

This report also discusses initiatives undertaken by the Bank that are related to FMI risk management.

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The Bank's approach to oversight of financial market infrastructures

Financial market infrastructures (FMIs) play an important role in the stability of the financial system. The services provided by FMIs are critical for individuals and firms to safely and efficiently purchase goods and services, invest in financial assets and manage financial risks. Given their central role, FMIs require strong risk-management practices and must be resilient to shocks.

Regulatory framework

The Bank's powers to oversee FMIs stem from the *Payment Clearing and Settlement Act* (PCSA), which provides the Governor of the Bank of Canada with the authority to designate an FMI if it is deemed to have the potential to pose systemic risk or payments system risk in Canada. [1] The PCSA further stipulates that the Bank is responsible for oversight of these designated FMIs. In this role, the Bank coordinates with other federal and provincial authorities that also have regulatory authority over designated FMIs. [2] Formal agreements between the Bank and the relevant federal and provincial authorities have been established to guide this collaboration.

The Bank's responsibilities also include the designation and oversight of foreign-domiciled FMIs that have the potential to pose systemic risk to the Canadian financial system. To fulfill this responsibility, the Bank relies on co-operative arrangements that take the form of oversight colleges or committees. These co-operative arrangements are led by the FMI regulator in the jurisdiction where the foreign FMI is domiciled.

The Bank must ensure that FMIs adequately control their risks because they operate infrastructure that is essential to the Canadian financial system. To achieve this, the Bank assesses the FMIs against its Risk Management Standards for Systemic FMIs and Risk-Management Standards for Prominent Payment Systems. [3] These standards were established by the Bank based on the principles

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[1] The federal Minister of Finance must agree that designation is in the public interest. See the glossary in Appendix 2 for a full definition of systemic risk and payments system risk.

[2] The Canadian Depository for Securities (operator of CDSX) and the Canadian Derivatives Clearing Corporation (operator of CDCS) are recognized and regulated by the Autorité des marchés financiers, the British Columbia Securities Commission and the Ontario Securities Commission. The Minister of Finance shares the responsibility to oversee Payments Canada (operator of LVTS and ACSS).

[3] For more details, see the Bank of Canada's Risk-Management Standards for Designated FMIs and the Criteria and Risk-Management Standards for Prominent Payment Systems.

and key considerations of the Principles for Financial Market Infrastructures (PFMI), which were developed by the Committee on Payments and Market Infrastructures (CPMI), together with the International Organization of Securities Commissions (IOSCO). [4]

The designated FMIs, listed in Table 1 and described in further detail in Appendix 1, include both domestic and foreign-domiciled FMIs that are central to the Canadian financial system.

Table 1:
Financial market infrastructures designated for Bank of Canada oversight[*]

Domestic designated FMIs	
CDCS	The Canadian Derivatives Clearing Service (CDCS) is a central counterparty operated by the Canadian Derivatives Clearing Corporation (CDCC) that clears transactions in all derivatives trades on the Montréal Exchange and certain fixed-income securities, repurchase agreements and over-the-counter (OTC) equity derivatives. CDCC is a wholly owned subsidiary of the Montréal Exchange. The Montréal Exchange is a wholly owned subsidiary of the TMX Group.
CDSX	CDSX is a system operated by the Canadian Depository for Securities Limited (CDS) that consists of a securities settlement system, a central securities depository for equities and fixed-income securities, and a central counterparty service for eligible Canadian exchange-traded and OTC equities. CDS is a wholly owned subsidiary of the TMX Group.
LVTS	The Large Value Transfer System is an electronic funds-transfer system operated by Payments Canada that settles large-value and time-critical payments.
ACSS	The Automated Clearing Settlement System is a retail payment system operated by Payments Canada that clears cheques and electronic items, such as pre-authorized debits, direct deposits and Interac debit payments.
Foreign-domiciled designated FMIs	
CLS Bank	CLS Bank is a special-purpose bank offering the settlement of foreign exchange transactions, including those involving the Canadian dollar.
SwapClear	SwapClear is an LCH clearing platform for interest rate swaps and other OTC interest rate derivatives denominated in multiple currencies, including the Canadian dollar.

[*] Except for the ACSS, all FMIs listed in this table are subject to the Bank's risk-management standards for systemically important systems. The ACSS is subject to the standards for prominent payment systems.

[4] The PFMI establish minimum expectations for risk management for systemically important FMIs to preserve and strengthen financial stability. See CPMI-IOSCO's web page for more information on the PFMI and CPMI-IOSCO.

The Bank's FMI oversight framework

The Bank regularly monitors and assesses designated FMIs to ensure that they are adequately controlling their risk. Central to this process are annual core assurance reviews that focus on FMIs' controls and risk-management practices in specific areas. Under this approach, all the Bank's risk-management standards are covered in depth over a three-year cycle. The Bank then sets key priorities for each FMI based on the enhancements that are most relevant to the safety and soundness of the FMI and the broader financial system.

The year 2019 marked the first full year of the Bank's focused, in-depth oversight framework centred around core assurance reviews. Findings identified in core assurance reviews are presented to the Bank's Oversight Risk Advisory Committee (ORAC), which is comprised of Deputy Governors as well as senior Bank staff with expertise in FMIs, risk management and financial stability. Once findings are approved by ORAC, they become priorities to be addressed by the FMIs. These priorities are generally expected to be addressed within the following 12 months, though some are multi-year initiatives (e.g., modernization programs).

Progress on past key oversight priorities for FMIs

This section provides an update on FMIs' key oversight priorities identified in 2019 or previous years as well as any completed priorities. Whereas some priorities relate to both Payments Canada and TMX Group systems, others are specific to only certain systems. These priorities are as follows:

- modernization (Payments Canada and TMX systems)
- liquidity risk management (TMX systems)
- model risk management policy (TMX systems)
- business risk and recovery plan (Payments Canada)

Modernization

Canada's domestic designated FMIs continue to modernize their core clearing and settlement systems.

Payments Canada is working toward transforming its payment systems by introducing:

- Lynx as the replacement for the Large Value Transfer System (LVTS)
- the new Real-Time Rail (RTR) for faster, data-rich retail payments
- enhancements to, and eventually a replacement for, the Automated Clearing Settlement System (ACSS)

Throughout 2019, Payments Canada made substantive progress on its modernization initiatives.[5] In early 2019, it selected IBM Canada as its technology service provider for hosting and systems integration services to deploy and operate Lynx. Payments Canada also progressed in its planning for the adoption of ISO 20022 for Lynx to be in line with global SWIFT requirements. The new standard will be implemented after the initial launch of Lynx in 2021. As well, public consultation on the Lynx policy framework, which is important for the overall risk design of Lynx, was completed in November 2019.[6, 7]

Payments Canada made important progress on the procurement for RTR, which will introduce a retail fast payment system in Canada and a future platform for competition and innovation. It advanced its plans to engage with service providers for the design, build and operation of the RTR system, including the completion of a request for information.

[5] See Payments Canada Modernization Delivery Roadmap for more information.
[6] For more information on the selection of IBM Canada, see this Payments Canada news release.
[7] More details on the policy framework can be found in this Payments Canada news release.

Since the replacement system for ACSS will be delivered at later stages of the modernization program, Payments Canada made interim enhancements to the retail batch system to bring the system closer to meeting the Bank's risk-management standards. Their initiatives focused on the Bank's standards for credit risk and access. Payments Canada is also exploring opportunities to refresh the ACSS application without impeding progress on other modernization initiatives.

The modernization of the TMX systems—CDSX and the Canadian Derivatives Clearing Service (CDCS)—aims to enhance risk management by replacing aging technological infrastructure and strengthening financial risk models. This project will contribute to the overall resiliency of these FMIs and the financial system.

Modernization of these systems will occur in two phases. The first phase was the deployment of the new risk system for the Canadian Derivatives Clearing Corporation (CDCC). After several years of planning, the new system was successfully launched in July 2019. It brings several enhancements to CDCS, including the reduction of manual processes, enhanced margin methodology and additional stress scenarios for sizing the default fund.

The second phase of the modernization initiative is to introduce a new core clearing, settlement and depository platform for the Canadian Depository for Securities Limited (CDS). Following several missed milestones, CDS reaffirmed its commitment to the modernization initiative. TMX systems modernization will remain a key priority until the final implementation.

Liquidity risk management

The PFMI require a central counterparty (CCP) to maintain sufficient liquid resources to meet intraday and multiday payment obligations under a wide range of potential stress scenarios, including the default of a participant and its affiliates that would generate the largest aggregate liquidity obligation for the FMI in extreme but plausible circumstances. This is known as the "cover 1" liquidity requirement. In 2019, both CDS and CDCC worked toward meeting the cover 1 PFMI liquidity standard. Both systems implemented changes in early 2020 to meet the cover 1 liquidity requirements.

CDS operates the Continuous Net Settlement Service (CNS), a CCP for eligible Canadian equities, and sponsors participation in the National Securities Clearing Corporation (NSCC) through its New York Link (NYL) service. [8] The liquidity coverage for these services had been sized based on a potential default occurring during normal market conditions. But under stressed market conditions, liquidity requirements rise significantly, especially during peak activity periods such as

[8] CDS participants use the NYL to clear and settle over-the-counter trades with US broker-dealers through the NSCC.

triple witching. [9] Therefore, in 2018, CDS developed a plan to collect additional cash from participants as a means of supplementing its current liquidity coverage.

In 2019, CDS addressed the liquidity shortfall in CNS by collecting additional money in Canadian dollars and depositing the funds with the Bank of Canada in an interest-bearing account. The interest will be redistributed to clearing members by CDS. Additional cash in US dollars will also be collected to close the liquidity gap in the NYL service.

Over 2018–19, CDCC conducted additional analytical work on liquidity coverage, including implementing enhancements to address additional guidance provided in the CPMI-IOSCO report "Resilience of Central Counterparties (CCPs): Further Guidance on the PFMI." This work identified a cover 1 liquidity gap. The issue was not the aggregate amount of collateral, but CDCC's ability to convert it into cash in time to meet the obligations of a defaulting clearing member under stressed conditions. CDCC addressed this by modifying its clearing fund to include only cash and depositing the additional funds with the Bank of Canada in an interest-bearing account. As with CDS, the interest will be redistributed to clearing members.

Model risk management policy

Model risk management (MRM) involves confirming and testing the validity of a financial model's underlying assumptions and parameters, theoretical underpinnings and empirical results. In 2018, the Bank identified gaps in CDS and CDCC's MRM frameworks.

In 2019, CDS and CDCC successfully implemented their enhanced MRM policies. For CDS the enhancements include an updated model validation framework and documentation, enhanced stress testing and a model inventory with risk assessments. For CDCC they include a monitoring program and review schedule to conduct more frequent analysis in response to market developments and clearing members' position changes, as per the PFMI.

Business risk and recovery plan

In 2019, the Bank conducted a review of Payments Canada's general business risk, including its recovery plan. The review found that Payments Canada has arrangements in place to manage business risk and a recovery plan that outlines tools available in a recovery scenario. However, the recovery plan could be

[9] Triple witching (TW) occurs when the contracts for index futures, index options and stock options all expire on the same day. This occurs four times per year, specifically on the third Friday of March, June, September and December. Several CNS participants have significantly increased volumes of activity and, in particular, more outstanding equity positions submitted for CNS settlement because of their trading behaviour associated with TW.

improved by providing further details to demonstrate that it can be executed effectively and on a timely basis.

Payments Canada subsequently made several enhancements to its recovery plan that were approved by the Payments Canada board in November 2019. The revised plan includes more details on the potential financial impacts of various stress scenarios and how various recovery tools would be deployed. While substantive findings were addressed, the Bank expects all FMIs to continually review and update their recovery plans, at a minimum on an annual basis.

Future key oversight priorities for FMIs

The priorities in this section include both unmet or ongoing priorities from previous years and newly identified ones from recently conducted core assurance reviews. Some oversight priorities in this section relate to both Payments Canada and the TMX Group, while others are specific to certain systems. Addressing these priorities is crucial to ensure the resiliency of the designated FMIs and the financial system as a whole. Therefore, the Bank will monitor and engage with the designated FMIs to ensure that the following priorities are addressed on a timely basis:

- modernization (Payments Canada and CDS)
- default management (Payments Canada and TMX systems)
- business, custody and investment risk (TMX systems)
- cyber security (TMX systems and Payments Canada)
- liquidity risk management (CDS)
- credit risk management (Payment Canada)

In 2020 to mid-2021, the Bank will complete core assurance reviews for each domestic designated FMI on the following topics:

- enterprise risk management and governance
- access and tiered participation

In addition, the Bank will conduct core assurance reviews on liquidity risk for the TMX systems and on credit risk for the Payments Canada systems. The credit risk review will consider enhancements to the ACSS credit risk model that are planned for 2020.

Modernization

CDS and Payments Canada are expected to continue to make progress on their respective modernization initiatives. For CDS, clearing and risk system enhancements continue to be an important objective in 2020. CDS is expected to remain committed to its revitalized modernization initiative. An important aspect of this process will be proper engagement with participants and regulators.

Modernization of Payments Canada's systems is a significant, multi-year initiative. Lynx remains a top priority since it will be the core infrastructure for the payments system underlying the Canadian economy and financial system. Lynx will be released in two phases: the first release will launch the new real-time gross settlement (RTGS) system with existing SWIFT message formatting in 2021, while the second release, planned for a later stage, will allow for ISO 20022 message formatting. [10] Several key milestones are planned for 2020, including completion of the Lynx application, significant progress on the Lynx legal framework, and planning for industry-wide testing and implementation.

The current planning assumption for the launch of RTR is 2022. Key priorities for RTR this year include working with authorities and industry stakeholders to make progress on participant requirements, which will eventually form the RTR bylaws and rules. Payments Canada is also expected to make progress on procuring the exchange and clearing and settlement solutions while ensuring that these solutions can meet the Bank's risk-management expectations and other public policy objectives.

The Bank also expects to be engaged throughout the ACSS refresh project. The project aims to maintain some of the existing ACSS functionalities but will rewrite the ACSS application based on modern technology and architecture. The implementation date for the new application will be determined in consultation with industry stakeholders so as not to impede progress on other modernization initiatives. The Bank still expects Payments Canada to develop a replacement system for ACSS at a later stage of modernization.

Default management

An FMI should establish appropriate default-management plans and procedures to ensure that the default of a participant is well managed in a timely manner and that its effects on the FMI, other participants and the broader financial system are contained.

The goal of the default-management core assurance review for the Payments Canada and TMX systems was to gain a deeper understanding of the procedures and processes for managing a default in each of the systems, and to ensure that the default-management frameworks satisfy the Bank's standards. Furthermore, international work on default auctions identified some best practices for assessing CCPs. The priorities developed following the core assurance review will help place CDCC in a good position to respond to these developments. [11]

The review in 2018 found that Payments Canada's default-management framework for LVTS and ACSS is well designed for an orderly management of a participant default. However, ACSS's default rules and procedures could be improved by providing further clarity on how certain payments submitted by a defaulter would be treated to ensure that all the defaulter's obligations are managed appropriately. Payments Canada has been working with industry to clarify the treatment of unsettled payment items to ensure that there is a shared

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[10] More information on the 2020 milestones can be found in Payments Canada Modernization Delivery Roadmap. Payments Canada lists the benefits of adopting ISO 20022 standards on its website.
[11] For more information see the CPMI-IOSCO discussion paper on central counterparty default management auctions.

understanding of potential exposures. This will enhance the default management process.

The review found that CDS's default-management rules and procedures allow CDS to take timely action to meet its obligations. CDS should continue to enhance its procedures for managing defaults from its cross-border services, however. The Bank expects CDS to develop a default management plan for a linked participant default in the DTC Direct Link by mid-2020.

Regarding CDCC, the review found that while the FMI has relatively comprehensive default-management rules and procedures, the auction process could still be improved. Priorities for 2020 and 2021 include automating internal processes, conducting a cost-benefit analysis of developing tools to facilitate participant bidding, enhancing participant testing and training, and considering the benefits and feasibility of developing a framework for client participation in auctions.

Finally, the review found that there is scope for both CDS and CDCC to formalize the planning of their default simulations. In 2020, the FMIs should develop a comprehensive framework for testing default management that documents all aspects of default management that should be tested. The framework should also outline a medium- to long-term plan for steadily increasing the scope and realism of default simulations.

Business, custody and investment risk

In 2019, the Bank completed a core assurance review of the TMX systems for business, custody and investment risk. FMIs are expected to manage general business risk and hold sufficient liquid net assets funded by equity to cover potential business losses to ensure continuity of operations.

There is growing debate at the international level over non-default-related losses (e.g., losses due to poor implementation of new technology, operational losses or cyber-related losses), and in particular how those losses should be allocated to various parties. Non-default losses are potentially large and would not be covered by the financial resources an FMI would typically rely on to cover default-related losses, such as margin requirements or participants' default fund contributions. Internationally, some clearing members of CCPs have suggested that CCPs need significantly more capital to cover these potential losses.

In 2020, the Bank expects the TMX systems to take stock of and share with their participants details of the full range of scenarios that could lead to non-default losses and the tools they have in place for dealing with those losses. This is aimed at increasing transparency and enabling the FMIs to respond to evolving international requirements. Additionally, the Bank expects CDS and CDCC to provide detailed evidence confirming they already hold sufficient liquid net assets to implement recovery plans. They are also expected to enhance their recapitalization plans to ensure that they can continue to meet regulatory requirements following recovery.

Cyber resilience

The Bank continues to view cyber security as a key vulnerability in the financial system. In 2019, the Bank completed its first cyber core assurance review of the TMX systems. The review was completed in accordance with CPMI-IOSCO's Guidance on cyber resilience for financial market infrastructures. The guidance provides supplemental details beyond those set out in the PFMI to ensure that FMIs have sufficient cyber resilience capabilities.

The 2019 cyber core assurance review involved oversight staff as well as the Bank's own cyber security experts. The TMX systems displayed increased maturity toward meeting the CPMI-IOSCO cyber security guidelines. Specific recommendations were communicated directly to the designated systems.

Oversight staff have completed the Payments Canada core assurance review and are in the process of identifying priorities for 2020 and beyond. Specific recommendations will be communicated to Payments Canada directly. The Bank is also working toward developing supplemental cyber security guidelines.

Liquidity risk management

In 2018, the Bank prioritized introducing a central ledger to CDS's CCP service, CNS. This will enable CDS to achieve same-day settlement of payment obligations in the event of a default. CDS plans to implement a permanent solution as part of its modernization initiative by late 2021. CDS presented an intermediate solution to the Bank in 2019. The intermediate solution would allow CDS to meet same-day settlements.

Credit risk management

In 2018, Payments Canada implemented a credit risk model for ACSS that requires participants to pledge collateral ex ante to cover the single largest credit exposure with a high degree of confidence. As the model was only recently implemented, the Bank has closely monitored its performance to identify where enhancements or recalibrations may be needed.

The Bank observed that performance could be improved by recalibrating the model to consider the impact of settlement exchange transactions (SETs). These transactions are a useful liquidity management tool that can reduce end-of-day exposures in ACSS. However, participants may not be able to execute SETs if they experience operational events or financial stress.

Going forward, the Bank expects Payments Canada to enhance the credit model to factor in the impact of SETs. The enhancements are expected to improve coverage of observed credit exposures. The Bank also expects Payments Canada to develop and implement ways to improve the reporting of SETs data by participants. The Bank will review the effectiveness of these changes as part of its core assurance review on credit risk.

Foreign-domiciled designated FMIs

The Bank participates in co-operative oversight arrangements for the foreign-domiciled designated FMIs, including the CLS Oversight Committee (led by the Federal Reserve) and the LCH Global College (led by the Bank of England). This section focuses on key aspects that are of recent interest to the Bank's oversight.

CLS Bank

Of particular interest to the Bank in 2019 was the launch of CLSNow, which provides settlement of same-day foreign exchange transactions involving the US dollar, the euro, the pound sterling and the Canadian dollar. Following the launch, the Americas Same-Day Settlement service for US and Canadian foreign exchange transactions was decommissioned in October 2019.

CLSNow is designed to settle transactions bilaterally on a trade-by-trade (gross) basis throughout the day. This continuous settlement approach has the benefit of recycling liquidity throughout the day and supporting settlement during overlapping RTGS systems' hours.

Two global banks adopted CLSNow, with more prospective participants on the horizon. Future growth of CLSNow is expected through increased adoption and expansion to additional currencies.

SwapClear

SwapClear is a global system operated by LCH for the central clearing of over-the-counter (OTC) interest rate derivatives denominated in multiple currencies, including the Canadian dollar.

Through the LCH Global College process, the Bank will continue to focus its oversight efforts to ensure that the FMI's risk-management frameworks meet global standards and support Canadian participation in the SwapClear service. The Bank will continue to closely monitor LCH's planning surrounding the withdrawal of the United Kingdom from the European Union.

Bank of Canada activities

In addition to ongoing monitoring of the risk-management practices of designated FMIs, the Bank is involved in several other activities related to its oversight mandate. These activities are described in this section:

- building the Bank's FMI resolution regime
- reviewing the scope of prominent payment systems
- contributing to international efforts
- strengthening cyber resiliency
- researching and monitoring trends in the FMI landscape

Building the Bank's FMI resolution regime

Despite the Bank's oversight efforts, there is potential that an FMI could face circumstances so severe that it is unable to continue providing its critical functions to the financial system. Although it is highly unlikely that a designated FMI would ever fail, it is still important to be ready and have the tools to respond if necessary.

The Bank is now the resolution authority for the domestic designated FMIs. The legislative amendments to the PCSA establishing a resolution regime for FMIs received Royal Assent in June 2018. Regulations that accompany these amendments were finalized a year later following public consultation. The regime came into force in June 2019.

As resolution authority, the Bank is responsible for developing plans to respond to the failure of a Canadian designated FMI. The Bank can also take temporary control of a failing FMI to limit the impact of its failure on the Canadian economy and financial system.

The Bank is establishing internal policies and procedures to support the new regime. It will publish a guideline to communicate to FMIs, their participants and the public about how the Bank expects to act on its resolution powers and carry out this mandate. The Bank has established a federal FMI resolution committee, which is chaired by the Governor of the Bank of Canada and includes senior officials from the Department of Finance Canada, the Office of the Superintendent of Financial Institutions (OSFI) and the Canada Deposit Insurance Corporation. In most resolution scenarios, it is likely that FMI participants, many of which are federally regulated financial institutions (FRFIs), would be affected. Thus, the Bank will engage through this committee with its federal partners on resolution matters that could affect FRFIs.

The Bank is developing initial resolution plans for the FMIs under the regime and will consult with provincial and federal authorities as well as the FMIs and their participants. This resolution planning work will continue beyond 2020.

Reviewing the scope of prominent payment systems

Over the years, as payment systems have evolved, new risks have emerged and the Bank has taken on a greater oversight role for payment systems to ensure that systems critical to the proper functioning of the economy are operated in a safe and sound manner. As noted in previous oversight reports, the Bank regularly monitors market developments and reviews its scope of oversight to determine whether new or existing systems warrant Bank oversight. With the adoption of digital payments in Canada at an all-time high and with the increasingly concentrated reliance on a few retail payment systems, the Bank is currently undertaking a more focused review to ensure that all systems with the potential to pose payment systems risk are designated appropriately.

Contributing to international efforts

The Bank regularly collaborates with international committees, including the Financial Stability Board (FSB) and CPMI-IOSCO, to promote and uphold international risk-management standards for systemically important FMIs. The discussions and resulting guidance help shape the risk-management standards that the Bank applies to Canada's designated FMIs.

The Bank is part of an FSB working group on FMI Cross-Border Crisis Management (fmiCBCM). In 2019, the fmiCBCM completed its consultation on "Financial Resources to Support CCP Resolution and the Treatment of CCP Equity in Resolution." In addition, authorities used the process described in this paper to assess their CCPs' financial resources. The fmiCBCM plans to finalize guidance in this area by the end of 2020, taking into consideration the consultation responses as well as the experience of authorities in evaluating financial resources.

In late 2018 and early 2019, Bank staff participated in the drafting of the CPMI-IOSCO discussion paper on central counterparty default-management auctions. A default-management auction is a critical tool allowing CCPs to re-establish a matched book in the event a participant defaults. The report is intended to enhance a CCP's ability to successfully execute a default auction while facilitating the exchange of ideas and existing best practices. Comments on the report were submitted by August 2019.

Through its participation in the CPMI, the Bank is contributing to the G20 financial regulation agenda (under the Saudi Arabian presidency) of enhancing cross-border payments. Since late 2019, the Bank has been involved by helping to identify current challenges to cross-border payments in the Canadian context and working with other members to assess potential solutions. The work will contribute to a road map for improving cross-border payments. It is also expected to form part of an FSB report for the meeting of the G20 finance ministers and central bank governors in October 2020. [12]

The Bank contributed to the "Wholesale Digital Tokens" report that was released by the CPMI in December 2019. This report focuses on the role of digital tokens as a means of settling wholesale transactions. The report discusses potential design choices and questions that token developers might need to consider, when releasing a wholesale digital token, to ensure that the token arrangement is deployed in a safe and efficient manner.

The Bank also helps international organizations, including CPMI-IOSCO and the IMF, in their reviews of Canada's financial sector policy frameworks. The IMF concluded its third assessment of Canada under the Financial Sector Assessment Program; results were published in the IMF's Financial System Stability Assessment in June 2019. A component of the assessment reviewed Canada's systemically important FMIs against international standards and the oversight of the FMIs. A corresponding technical note was published in January 2020. It concluded that the oversight of FMIs is effective and of high quality.

The assessment provided some recommendations, such as continued improvement of cyber resiliency in line with international guidance, and tightened compliance with endpoint security by FMI participants. In addition, further enhancements to liquidity and operational risk management were recommended to help ensure the robust functioning of the FMIs. This includes monitoring intraday liquidity risk for the modernized wholesale payment system on an RTGS platform.

Strengthening cyber resiliency

The Bank of Canada and other private and public sector institutions view cyber threats as a key vulnerability of the financial system. A cyber attack on an FMI or a financial institution could severely disrupt the affected institution and compromise its ability to deliver its financial services. Given the interconnectivity of the financial system, an attack on a single entity could potentially disrupt the financial system.

The Bank is committed to promoting the cyber resiliency of the domestic designated FMIs as well as the financial system. In 2019, the Bank published its 2019–21 Cyber Security Strategy. This strategy focuses on the cyber resiliency of

[12] For more information see FSB work programme for 2020.

the financial system, with the resiliency of the domestic designated FMIs playing a crucial role in the Bank's overall strategy. As a result, the Bank is focusing on efforts to implement its strategy.

In 2019, the Canadian Securities Administrators (CSA) proposed amendments to National Instrument 24-102 (Clearing Agency Requirements), including amendments to clarify what clearing agencies are required to report in relation to a cyber incident. These amendments were finalized in early 2020. This year the Bank will implement a cyber incident reporting framework for domestic designated FMIs that is expected to align closely with the CSA's new framework. The Bank will also develop supplementary guidance on cyber resilience for domestic designated FMIs. This guidance will build upon the CPMI-IOSCO's Guidance on cyber resilience for financial market infrastructures.

In June 2019, the Bank announced the launch of the Canadian Financial Sector Resiliency Group (CFRG), a federal public-private partnership to strengthen the resilience of Canada's financial sector in the face of risks to business operations, including cyber incidents. The CFRG replaces the Joint Operational Resilience Management Program, which played a similar role. The CFRG is led by the Bank of Canada, and membership includes the Department of Finance Canada, OSFI, Canada's systemically important financial institutions, as well as the TMX Group and Payments Canada. This group is part of the Bank's broader cyber strategy. The CFRG will help coordinate a sector-wide response to systemic-level operational incidents. It will also support ongoing resiliency initiatives such as information sharing, crisis simulations, crisis coordination and benchmarking exercises.

As part of the Cross-Border Coordination Exercise in June 2019, the G7 Cyber Expert Group (CEG) executed scenarios established from the G7 Cyber Incident Response Protocol. The Bank participated in this exercise. This protocol is intended to facilitate coordination and communication among G7 financial authorities in the event of a large-scale cross-border cyber incident or threat affecting the financial sector.

Presently, the Bank is involved in two CEG work streams to address the findings from the 2019 exercise. One work stream is examining available policy tools to address cyber risk. This group will itemize jurisdictions' most relevant policy tools that may be used in the event of a cyber incident and then examine the cross-border implications of using these tools. The other work stream will publish a set of fundamental elements of cyber exercises. The intent is to improve upon the jurisdictions' ability to design, conduct and evaluate cyber exercises that test the incident-management capabilities of their financial sectors.

Researching and monitoring trends in the FMI landscape

The Bank of Canada's oversight activities include research into areas of FMI risk management and financial stability.

In 2019, oversight staff conducted research into the future use of RTR, Settlement Optimization Engine (SOE) and Lynx once they are in place. [13] They estimate that a substantial portion of payments that are currently processed in ACSS and LVTS might find their way to RTR because of changing end-user behaviour. Analysis also suggests that, in the long run, banks might potentially migrate a considerable amount of their transactions currently processed in LVTS to either SOE or RTR. The findings provide a good starting point for future research on the risk and welfare implications of the new payment infrastructure. [14]

Oversight staff also published research on systemic risk and the adequacy of collateral in central counterparties, evaluating the collateral levels needed to buffer systemic risk in Canada's futures market. [15] This research explores the question of whether central counterparties could, under stress, become systemic risk propagators (rather than mitigators) because of their risk-sharing features. The results suggest that, even under implausibly large stress, risk mutualization in CCPs results in negligibly small systemic risk spillovers that do not materially increase the systemic risk of participating institutions.

For many firms, cyber risk is difficult to quantify, and vulnerabilities are continuously advancing. Therefore, staff examined public information on past cyber incidents to better understand the current risk landscape. [16] They found that a holistic view is needed to fully grasp the nature of cyber risk.

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[13] The SOE will replace ACSS as part of Payments Canada's modernization initiative.
[14] A. Kosse, Z. Lu and G. Xerri, "Estimating Demand for Payment Instruments and Systems: An Application to Predicting Payment Migration in Canada," Bank of Canada Staff Working Paper (forthcoming).
[15] R. Raykov, "Systemic Risk and Collateral Adequacy: Evidence from the Great Crisis," Bank of Canada Staff Working Paper No. 2019-23 (June 2019).
[16] N. Chande and D. Yanchus, "The Cyber Incident Landscape," Bank of Canada Staff Analytical Note No. 2019-32 (December 2019).

Appendix 1 | Overview of financial market infrastructure

LVTS (payment system | designated systemic FMI 1999)

The Large Value Transfer System (LVTS) is a Canadian electronic funds-transfer system operated by Payments Canada that settles large-value and time-critical Canadian-dollar payments.

Measure	2017	2018	2019
Daily average value settled	$173 billion	$181 billion	$189 billion
Daily average volume settled	36,000	38,000	40,000
Daily average collateral pledged	$37 billion	$38 billion	$40 billion
Number of direct participants	17	17	16

CDSX (securities settlement system, central securities depository, central counterparty | designated systemic FMI 2003)

CDSX is a Canadian system operated by the Canadian Depository for Securities Limited (CDS). It consists of a securities settlement system, a central securities depository and a central counterparty service for Canadian exchange-traded and over-the-counter (OTC) equities.

Measure	2017	2018	2019
Daily average value of equity and fixed-income securities cleared and settled	$541 billion	$578 billion	$692 billion
Daily average volume of equity and fixed-income securities cleared and settled	1.7 million	2.1 million	1.9 million
Average value of securities held at the central securities depository	$5.4 trillion	$5.2 trillion	$5.8 trillion
Number of direct participants	95	94	98

CDCS (central counterparty | designated systemic FMI 2012)

The Canadian Derivatives Clearing Service (CDCS) is a Canadian central counterparty operated by the Canadian Derivatives Clearing Corporation (CDCC) that clears transactions in certain fixed-income securities, OTC repurchase agreements (repos), OTC equity derivatives and all derivatives traded on the Montréal Exchange.

Measure	2017	2018	2019
Daily average value of OTC repos cleared	$17 billion	$18 billion	$25 billion
Daily average notional value cleared (exchange-traded derivatives)	$134 billion	$139 billion	$144 billion
Daily average notional value cleared (OTC derivatives)	$13.3 million	$10.6 million	$8.6 million
Number of direct participants	34	38	38

ACSS (payment system | designated prominent payment system 2016)

The Automated Clearing Settlement System (ACSS) is a retail payment system operated by Payments Canada that clears paper items such as cheques and electronic items, such as pre-authorized debits, direct deposits and Interac debit payments.

Measure	2017	2018	2019
Daily average value settled	$28 billion	$28 billion	$29 billion
Daily average volume settled	30 million	32 million	33 million
Number of direct participants	12	12	12

CLS Bank (payment system | designated systemic FMI 2002)

CLS is a special-purpose bank that offers the settlement of foreign exchange transactions, including those involving the Canadian dollar.

Measure	2017	2018	2019
Daily average foreign exchange settlement (total)	US$5,185 billion	US$5,830 billion	US$5,877 billion
Daily average Canadian-dollar foreign exchange settlement*	Can$199 billion	Can$216 billion	Can$217 billion
Settlement members	69	73	70

* The methodology for calculating the daily average Canadian-dollar foreign exchange settlement was revised to remove data points equal to zero on Canadian holidays.

LCH SwapClear (central counterparty | designated systemic FMI 2013)

SwapClear is an LCH clearing platform for interest rate swaps and other OTC interest rate derivatives denominated in multiple currencies, including the Canadian dollar.

Measure	2017	2018	2019*
Notional outstanding OTC interest rate swaps, in all currencies, as at December 31	US$292 trillion	US$309 trillion	US$316 trillion
Notional outstanding OTC interest rate swaps, denominated in Canadian dollars, as at December 31	Can$12.1 trillion	Can$18.4 trillion	Can$17.5 trillion
Number of direct participants	105	109	110

* Five new currencies were added for clearing in 2019: the Columbian peso, the Brazilian real, the Chilean peso, the Thai baht and the Taiwanese dollar.

Appendix 2 | Glossary of terms

central counterparty (CCP)	An entity that interposes itself between counterparties to contracts traded in one or more financial markets, becoming the buyer to every seller and the seller to every buyer, thereby ensuring the performance of open contracts.
central securities depository	An entity that provides securities accounts, central safekeeping services and asset services, which may include the administration of corporate actions and redemptions. A central securities depository plays an important role in helping to ensure the integrity of securities issues (that is, it ensures that securities are not accidentally or fraudulently created or destroyed or their details changed).
clearing	The process of transmitting, reconciling and, in some cases, confirming transactions before settlement, potentially including the netting of transactions and the establishment of final positions for settlement. On occasion, this term is also used (imprecisely) to cover settlement. In the context of futures and options, clearing also refers to the daily balancing of profits and losses and the daily calculation of collateral requirements.
clearing fund	A collection of assets prefunded by a CCP's participants that may be used to cover the financial losses or liquidity pressures during a participant default. Clearing funds are typically sized to cover extreme but plausible circumstances.
collateral	An asset or third-party commitment that is used by a collateral provider to secure an obligation for a collateral taker.
credit risk	The risk that a counterparty, whether a participant or other entity, will be unable to fully meet its financial obligations when due or at any time in the future.
default	Generally, an event related to the failure to complete a transfer of funds or securities in accordance with the terms and rules of the system in question.
default-management auction	A default-management auction is one of the tools a CCP may use to transfer a defaulted participant's positions, or a subset thereof, to a non-defaulting participant, thereby removing the position and risks from the CCP and restoring it to a matched book.
designated system / designated financial market infrastructure	A financial market infrastructure designated under the *Payment Clearing and Settlement Act* for oversight by the Bank of Canada.

financial market infrastructure (FMI)	A multilateral system among participating institutions, including the operator of the system, used to clear, settle or record payments, securities, derivatives or other financial transactions.
liquidity risk	The risk that a counterparty, whether a participant or other entity, will have insufficient funds to meet its financial obligations as and when expected, although it may be able to do so in the future.
payment system	A set of instruments, procedures and rules for the transfer of funds between or among participants. The system includes the participants and the entity operating the arrangement.
payments system risk	The risk that a disruption to or a failure of an FMI could cause a significant adverse effect on economic activity in Canada either by impairing the ability of individuals, businesses or governments to make payments or by producing a general loss of confidence in the Canadian payments system.
payment-versus-payment (PvP)	A settlement mechanism that ensures that the final transfer of a payment in one currency occurs if and only if the final transfer of a payment in another currency or currencies takes place.
recovery	The ability of a financial institution, including an FMI, to resume operations after a threat to its viability and financial strength so that it can continue to provide its critical services without authorities having to use resolution powers. More specifically, in the context of an FMI, recovery is defined as the actions of the FMI that are consistent with its rules, procedures and other ex ante contractual arrangements to address any uncovered loss, liquidity shortfall or capital inadequacy, whether arising from participant default or other causes (such as business, operational or other structural weaknesses), including actions to replenish any depleted pre-funded financial resources and liquidity arrangements, as necessary, to maintain the FMI's viability as a going concern and the continued provision of critical services.
resolution	The set of actions that a resolution authority can take when recovery efforts have been unsuccessful or when authorities deem recovery measures to be insufficient to return the financial institution or FMI to viability.
securities settlement system	An entity that enables securities to be transferred and settled by book entry according to a set of predetermined multilateral rules. Such systems allow the transfer of securities either free of payment or against payment.
systemic risk	The risk that the inability of a participant to meet its obligations in an FMI as they become due or that a disruption to or a failure of an FMI could, by transmitting financial problems through the FMI, cause: • other participants in the FMI to be unable to meet their obligations as they become due

	• financial institutions in other parts of the Canadian financial system to be unable to meet their obligations as they become due • the FMI's clearing house or the clearing house of another FMI within the Canadian financial system to be unable to meet its obligations as they become due • an adverse effect on the stability or integrity of the Canadian financial system
US Dollar Bulk Exchange	The US Dollar Bulk Exchange (USBE) is a parallel system to the Retail System. The USBE is used for payment items in US dollars, drawn on a US-dollar account at financial institutions in Canada, but settled in the United States.

Appendix 3 | Abbreviations

ACSS	Automated Clearing Settlement System
CCP	central counterparty
CDCC	Canadian Derivatives Clearing Corporation
CDCS	Canadian Derivatives Clearing Service
CDS	Canadian Depository for Securities Limited
CEG	Cyber Expert Group
CFRG	Canadian Financial Sector Resiliency Group
CNS	Continuous Net Settlement
CPMI	Committee on Payments and Market Infrastructures
CSA	Canadian Securities Administrators
FMI	financial market infrastructure
fmiCBCM	FMI Cross-Border Crisis Management
FRFIs	federally regulated financial institutions
FSB	Financial Stability Board
IOSCO	International Organization of Securities Commissions
LVTS	Large Value Transfer System
MRM	model risk management
NCSS	National Securities Clearing Corporation
NYL	New York Link
ORAC	Oversight Risk Advisory Committee
OSFI	Office of the Superintendent of Financial Institutions
OTC	over-the-counter
PCSA	*Payment Clearing and Settlement Act*
PFMI	Principles for Financial Market Infrastructures
PPS	prominent payment system

PvP	payment-versus-payment
RTGS	real-time gross settlement
RTR	Real-Time Rail
SOE	settlement optimization engine
TW	triple witching