Checks Processed by the Federal Reserve in 2021
Report of the Check Sample Survey
Appendix B: Technical Appendix

Federal Reserve Bank of Atlanta

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Abstract: This technical appendix provides details about survey design, sampling, and analysis used for the 2021 Check Sample Survey (CSS) and accompanies the report *Checks Processed by the Federal Reserve in 2021*, data tables (appendix A), and questionnaires used by analysts to collect the data (appendix C).

All data resources are available for download at frbatlanta.org.

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Introduction

This technical appendix provides details about survey design, sampling, and analysis used for the 2021 Check Sample Survey (CSS). It accompanies the data report *Checks Processed by the Federal Reserve in 2021* and technical appendices A (data tables) and C (questionnaires used by analysts to collect the data). All data resources are available for download at frbatlanta.org.

The technical appendix is organized into five sections. Section 1 describes the survey objectives. Section 2 discusses the sampling plan. Section 3 looks at the data collection. Section 4 tells how those data were used to classify the counterparties as business or consumer and to categorize the items sampled by purpose. Section 5 provides additional information.

Survey objectives

The Federal Reserve's Check Sample Survey (CSS) estimates the shares of collected and returned checks processed in the United States by payer, payee, and purpose. Collected checks (also called forward checks) are checks deposited to the Federal Reserve that the Fed clears and presents to the paying banks for collection. Return checks are checks that have been returned unpaid to the bank of first deposit or its designee. The survey examines the use of checks by US consumers, businesses, and government to give some insight into consumers' and businesses' evolving use of checks. This information can help check processors, financial institutions, payment businesses, and regulators plan for the use of checks.

This report, like the report of the 2018 CSS, is based on checks cleared through the Federal Reserve System. For 2015 and prior years, the CSS used a sample of checks processed by large institutions. The 2018 and 2021 samples of checks processed by Federal Reserve Financial Services include data from the whole spectrum of institutions: large and small credit unions and savings institutions as well as large and small banks. The sample does not represent the full population of checks paid in the United States in 2021, however. It excludes checks written and paid to account holders of the same financial institution ("on-us" checks) and checks settled directly between two banks or through a private clearinghouse.

Sample

The CSS uses a convenience sample of checks processed by the Federal Reserve that is not representative of all checks written in the United States. The Fed's forward check processing volumes are estimated to be approximately 34 percent of total checks paid in the United States. The Fed's return check processing volume is approximately 51 percent of returns.[1] The 2021 CSS continues the use of a population and sampling plan first implemented with the 2018 CSS.

Population: Federal Reserve collected and returned checks

The 2021 CSS estimates were based on random samples of forward checks and return checks processed by the Federal Reserve during calendar year 2021.[2] The population of forward checks is comprised of checks paid—that is, all the forward

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[1] The Federal Reserve processed approximately 3.6 billion forward checks in 2021 compared to an estimate of 10.7 billion checks paid in the United States in 2021, according to the McKinsey Global Payments Map. The Federal Reserve processed approximately 19 million return checks in 2021 compared to an estimate of 41 million total return checks. Based on the 2019 Federal Reserve Payments Study, returns are approximately 0.35 percent of checks paid, which equates to 37.6 million out of 10.7 billion checks paid (https://www.federalreserve.gov/paymentsystems/files/frps_2019_data_final.xls).

[2] For the years 2000 through 2015, a sample of checks was gathered primarily from large commercial banks. The 2018 and 2021 data include the wide range of institutions that use the Federal Reserve for processing, including large and small credit unions and savings institutions as well as large and small banks.

checks were written as checks and paid as checks, and none were converted to an ACH transaction. All forward checks processed, excluding Treasury checks, savings bonds, and postal money orders, were eligible for sampling. All return checks processed were eligible for sampling.

1   Reference Period

A 12-month reference period of January 1, 2021, to December 31, 2021, was chosen to mitigate seasonal variation in check writing during the year.

2   Sample Size

A sample size of approximately 25,000 forward checks and 10,000 return checks was sufficient to accurately characterize the population of checks processed by the Federal Reserve with the margin of error 0.6 percent or less. The final sample sizes are 24,957 forward checks and 9,938 return checks.[3]

Table B-1: Overall Federal Reserve and sampled volume, January 2021–December 2021

Fed Check Volume, 2021 (numbers of items)	Forward files	Forward items	Return files	Return items
All	1,471,650	3,635,729,959	862,181	19,080,660
Daily sampling	5,039	15,570,956	1,764	65,431
Final sampling	-na-	24,957	-na-	9,938

Source: 2021 CSS.

3   Sample Selection

A two-step process was used to arrive at the sample for forward checks:

1. **Daily sampling.** Each processing day, 20 forward image cash letter files sent to the Federal Reserve for processing were randomly selected and set aside. Of the 20 files, two were large files (that is, containing 10,000 or more items) and 18 were small files (fewer than 10,000 items). Over the 12 months of 2021, approximately 15,570,956 forward checks were set aside for final sampling (table 1).

2. **Final sampling.** The 15,570,956 forward checks were randomly sampled to arrive at the final sample of 24,957 forward checks. The final sample was selected to mirror the Federal Reserve's processing volume in each month by file size. Two relationships were considered: seasonal variation and file size. First, the proportions of forward sample checks by processing month were selected to match the proportions of total Federal Reserve forward processing volume by month.[4] Second, the proportion of forward sample checks that were sourced from large files (which are more likely to be associated with large financial institutions) was selected to match the proportion of checks from large files in the overall forward check population (table 2).

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[3] Section 1.4.5 describes how some of the checks in the original sample were excluded in the final sample.

[4] This is a change from the sampling method used for 2018, when weights were applied after the fact to match the distributions by seasonality and for file side. See the 2018 technical appendix at https://www.atlantafed.org/-/media/documents/rprf/publications/2020/07/30/2018-check-sample-survey/appendices/b-technical-appendix.pdf.

Table B-2: 2021 Shares of Federal Reserve forward check processing volume

Month	Calendar Year Shares by Month (Column sums to 100%)	Monthly Shares by File Size (Rows sum to 100%)	
		Large file (>10k)	Small file (<=10k)
January	8.07%	8.82%	91.18%
February	7.34%	8.10%	91.90%
March	9.37%	8.54%	91.46%
April	8.53%	8.26%	91.74%
May	7.42%	8.71%	91.29%
June	9.04%	8.56%	91.44%
July	8.15%	8.15%	91.85%
August	8.53%	8.11%	91.89%
September	8.14%	8.01%	91.99%
October	8.13%	8.44%	91.56%
November	8.41%	8.52%	91.48%
December	8.87%	8.17%	91.83%

The same two-step process was used to arrive at the sample for return checks:

1. **Daily sampling.** Each processing day, seven return check image cash letter files sent to the Federal Reserve for processing were randomly selected and set aside. Unlike for the forward checks, the files were not categorized by size because the number of return items is small, regardless of institution size. Over the 12 months of 2021, approximately 65,431 return checks were set aside for final sampling.

2. **Final sampling.** The 65,431 return checks were randomly sampled to arrive at the final sample of 9,938 return checks. To account for seasonality, the proportions of return sample checks by processing month were selected to match the proportions of total Federal Reserve return processing volume by month (table 3).

Table B-3: Shares of Federal Reserve return check processing volume

Month	Calendar Year Shares by Month (Column sums to 100%)
January	8.41%
February	7.52%
March	8.84%
April	6.94%
May	6.23%
June	8.29%
July	8.22%
August	8.39%
September	9.38%
October	8.80%
November	8.89%
December	10.08%

Data collection

The CSS aims to identify checks based on the flow of funds from payer to payee—that is, who initiated the check (payer) and who ultimately received the check (payee). The parties to a check payment were classified as consumer (an individual, household, or small business[5]) or business (a private-sector or government entity).

A very small business, such as sole proprietorships, could resemble a consumer, so payers and payees are assumed to be consumers unless information from the checks indicates otherwise (table 5). The distinction between business and government is immaterial for evaluating the potential to substitute other payment methods for checks, because government entities can accept or initiate payment types that a business might also accept or initiate. Therefore, these entities are grouped.

Table 4 shows the information collected to identify payer, payee, and purpose of checks. No personally identifiable information was retained after data from analysts were validated and summarized.

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[5] Some small business owners (such as sole proprietorships) used their personal checking accounts for business purposes and likely could not be distinguished from consumers based on data from their checks alone.

Table B-4: Information considered for payer/payee classification and check purpose category

Objective information observable from the image of the check	
Payer or payee*	• Payer name, address, and ZIP code • Descriptive titles or abbreviations: e.g., trustee, estate, attorney, Corp., Inc., LLC, LTD • Topical words or abbreviations: e.g., church, insurance, service(s), MD, DDS • Key phrases paired with "check": e.g., cashiers, official, WIC, payroll
Check (front)	• Date • Serial or check number • Dollar amount • Signature characteristics • Handwritten elements: e.g., driver's license, state initials, phone number
Check (back)	• Same as for payer-/payee-specific items noted above, appearing in the endorsement section of check • Handwritten endorsement (or not) • Endorsement perpendicular or parallel to text on the face of check
Analyst's subjective conclusions	
Payer or payee	• Consumer, business, or government
If business payer or payee	• Business type (utility, grocery, charity, etc.)
If business payee	• Bill or POS
Scanned image metadata	
Check	• Serial numbers • Dollar amount • Payer and payee banks' transit routing numbers • External processing code field • Indicators of image replacement document (IRD), auxiliary on-us field, remotely created item • Items from MICR line, including transit number and field identifiers (including auxiliary on-us field in the leftmost position of the MICR line)
Returns	• Return reason codes

* For the complete list of payer and payee data, see the analyst questionnaires (Appendix C).

Questionnaire changes for 2021

The analysts' questionnaires for 2021 included minor changes to assist in the identification of businesses and of industry type (table 5). Some items were removed from the questionnaire because that information was captured from the scanned images.

Table B-5: Changes to 2021 CSS questionnaires

New questions
Identify the industry type of payers. In 2018 and earlier years, this question was provided only for payees.

If the payer is a business or government, mark which type:
   1. Utilities: e.g., power, phone, water authority, garbage, cable, internet
   2. Banking services: e.g., loan, mortgage, credit card
   3. Insurance: e.g., health, car, and home insurance
   4. Subscription: e.g., homeowners' association, member, club
   5. Rental and leasing: e.g., Post Apartments, self-storage facilities
   6. Charitable organization: e.g., church

7. Public administration: e.g., state of, county of, IRS, city of, US Treasury, federal government, municipalities, hunting/fishing licensing
8. Education: e.g., school, university
9. Health care: e.g., hospital, doctor's office, ambulatory care, nursing and residential care facilities
10. Construction and household services: e.g., plumbers, electricians, painters
11. Professional services: e.g., photographers, vets, lawyers, interior designers, H&R Block
12. Suppliers and manufacturers: e.g., machinery, textile, food production, beverage, apparel manufacturing, printing
13. Grocery and drug store: e.g, Walmart, Publix, CVS, Quik Trip
14. Retail store: e.g., department store, clothes shop, Best Buy, Home Depot, motor and vehicle parts dealers, music stores, bookstores
15. Arts, entertainment, and recreation: e.g., museums, amusement parks, independent artists
16. Transportation and mail courier: e.g., USPS, post office, FedEx, UPS, airlines, trucks, Port Authority
17. Cannot determine

Facilitate the lookup of a business to determine industry type (utilities, insurance, etc.) and purpose (bill or point of sale).

If the payee is a business or government entity:
- Record the full name.
- Record the address (if present).

Improve ability to identify payer or payee as a business.
- Does the payer (payee) name (or address) have the term "DBA" (doing business as)?

Identify a government payee with the business type "transportation and mail courier."
- Does the payee endorsement have the words "postal service, e.g., USPS, post office, United States Postal Service"?

Purpose: Gather information about fraud prevention tools.
- Does the front or back of the check include a QR code?

Revised response options

Help analysts identify government entities (payee or payer).
- Updated the description of public administration identifiers to include "IRS, city of, US Treasury, federal government, municipalities, fishing/hunting license."

Differentiate consumers from businesses such as law firms or financial institutions
- Created two categories to differentiate (1) "trust (no affiliation with bank name)" and "trustee" from (2) "estate, attorney, law firm associates" in the list of identifiers in the payer field, payee field, or payee endorsement.

Eliminate redundant choice.

Deleted response option "Not government—either business or consumer" for the subjective designations of payers and payees because it is redundant with the response option "inconclusive."

Deleted questions

Eliminate redundant data collection; information can be gathered from metadata.
- Does the following sentence appear to the left of the image, "This is a LEGAL COPY of your check. You can use it the same way you would use the original check."
- Date of check
- Dollar amount of check
- Enter the 9-digit transit routing number. This number is in the bottom most row of numbers between the |: and |: symbols
- Does the number 6 appear directly to the left of the leftmost |: symbol?
- Input the number (typically NINE digits) found on the back of the check that exists between the ">" and "<" symbols. In the event that more than one set of "><" symbols appear, first look for the endorsement with a bank name associated with it and enter that number. If each set has a bank name associated with it, then choose the set that has the earliest date. The date will appear next to or just below the number between the "><" symbols.

Analyst training and quality control

Analysts were trained in person and practiced gathering data from sample checks. At least two analysts viewed each sampled check, and two data collection forms ("CSS long form" and "CSS short form") were used (appendix C). The first analyst used

the CSS long form, with 18 objective and five subjective assessments, and the second used the short form, with five subjective assessments of payer, payee, and purpose. If the subjective conclusions of the two analysts did not match, a third analyst completed the short form and broke the tie. This procedure was used to correct keying errors, to improve confidence in the categorization of each check, and to reconcile differences in classifications and purpose categories. The quality of the information collected was tracked, and additional training was conducted as necessary.

Process for classifying counterparties and categorizing purpose

Checks are categorized according to five purposes.

1. Bill payment. Payments from any type of payer to a business payee for bills or invoices, including the following:
   a. Regular recurring payments, such as utility bill payments, insurance premiums, telecommunications charges, credit card bill payments, and loan payments
   b. Nonrecurring retail bill payments, which are irregular payments made for products or services rendered for consumer consumption that include medical bill payments, payments to service providers such as plumbers, and attorneys
   c. Commercial bill payments, which are occasional B2B payments not made at the point-of-sale, including for purchases of raw materials, office supplies, finished goods from wholesalers, or professional services
2. Point-of-sale (POS) payment. Payments from a business or consumer to a business payee that occurred in a retail storefront (that is, traditional in person), such as a department store, gas station, or dry cleaner
3. Business-indeterminate payment. Check payments written from a business or consumer to a business payee with insufficient available information, so the analyst cannot conclude whether the category is bill payment or POS payment[6]
4. Casual payment. Payments made from one person to another, including all consumer-to-consumer payments.
5. Income. Payments to an individual from a business (as noted above, the "business" class includes government entities), including all business-to-consumer and government-to-consumer payments. Income payments include the following: payroll, pension, benefits/entitlements, rebate/promotional/refund, expense reimbursement, tax refunds, investment disbursements, bill payments to small businesses that are indistinguishable from consumers. [7]

An objective of the survey is to document the distribution of check payments by purpose. Table 6 illustrates the intersection of the two payer classes, two payee classes, and five purpose categories.

Table B-6: Summary of check purpose categories

Payer	Purpose
Business payee (B2B, C2B)	
Business	Bill
Consumer	
Business	Point of sale (POS)
Consumer	

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[6] Business indeterminate was referred to as bill payment/POS (BP/POS) in previous CSS.
[7] Dividend payments to corporate shareholders are categorized as B2B bill payments because from a substitution perspective—that is, the ability to substitute electronic for paper payments—such dividend payments are indistinguishable from business-to-business bill payments.

Business	Indeterminate
Consumer	
Consumer payee (B2C, C2C)	
Business	Income
Consumer	Casual

Payee classification 2B/2C

Information on the front and back of a check— payee line, the endorsement, and any other writing/stamp/print on the check (for example, information on the memo line—determined its payee classification. Analysts used the payee line to identify any obvious signs of a business payee, for example, "Inc.," or "Corp." Analysts recorded the presence of unique printing or stamps that might indicate a POS transaction, such as a driver's license number or store number. The payee endorsement was also a significant determinant of payee type. Business payees tended to stamp or machine-print their endorsements. Lockbox transactions (that is bill payments) tended to be endorsed parallel to text on the face rather than perpendicular to text on the face.

Payer classification C2/B2

Information on the face of a check determined its payer classification. Checks were typically categorized as written by a business payer based on the characteristics of the MICR line (for example, a federal government check's MICR line begins with 000 and many business checks include an auxiliary on-us field), whether the check was machine-printed or hand-written, the method used to frank the check (for example, typed or machine-printed "signature"), and the characteristics of the payer name and address. The payee line was useful in some cases because business payers, unlike consumers, sometimes include the full mailing address of the payee on the face of the check.

Checks classified as written by a consumer payer included checks without characteristics in the MICR line or in the name/address field to suggest a business. Small businesses that are difficult to distinguish from consumers have similar payments preferences to consumers' and face many of the same payment choices; therefore, it is acceptable to classify these payers as consumers.

Purpose categorization

Endorsement or other information added to the check by the business payee was used to identify payments at the retail point of sale, including a store number or customer's driver's license number. Lockbox endorsements indicated a bill payment. If the distinction between bill payment and POS could not be determined through the data collected in the survey, the model classified the check as business indeterminate.

For business counterparties, industry classification

For business payers or payees, the analyst selected one of 16 industry options, spanning several broad categories (table 5). Information on the front of the check was used to classify business payers. When a business payee's industry category could not be determined, an online search was used to gather further information.

Additional information

Return reasons

Return reason codes (included in the check metadata) were aggregated into four categories: nonsufficient funds (NSF), possible fraud, account administration, and other (Table 7).

Table B-7: Return reasons

Description	Code
Nonsufficient Funds (NSF)	
NSF	A
Uncollected funds hold	B
Account Administration	
Stop payment	C
Closed account	D
Unable to locate account	E
Frozen/blocked account	F
Stale dated	G
Possible Fraud	
Warranty breach (Includes Rules 8 & 9 claims)	3
Remotely created check (RCC) warranty breach (Rule 8)	4
Forged and counterfeit warranty breach (Rule 9)	5
Signature(s) irregular, suspected forgery	L
Altered/fictitious item/suspected counterfeit/counterfeit	N
Not authorized (includes drafts)	Q
Refer to maker	S
Duplicate presentment	Y
Forgery	Z
Other	
Does not conform to Industry's Universal Companion document	2
Retired/ineligible routing number	6
Post dated	H
Endorsement missing	I
Endorsement irregular	J
Signature missing	K
Noncash item (nonnegotiable)	M
Unable to process	O
Item exceeds stated max value	P
Branch/account sold (wrong bank)	R
Item cannot be re-presented	T
Unusable image	U
Cannot determine amount	W
Refer to Image	X

Sample

Checks where the classification for the payer, payee, or both was unknown were excluded from the estimates. Seven checks were removed as potential duplicates. An outlier return check in the amount of $35 million was removed because it was approximately 100 standard deviations from the mean of the return sample.[8] In all, approximately 0.15 percent of forward checks and 0.55 percent of return checks were eliminated from the final samples for these reasons.

Remotely created checks

Regulation (Reg) CC defines a remotely created check (RCC) as a "check that is not created by the paying bank and that does not bear a signature applied, or purported to be applied, by the person on whose account the check is drawn." Equally, Reg CC states that a "check that bears the signature applied, or purported to be applied, by the person on whose account the check is drawn is not a remotely created check." [9] To help financial institutions identify authorized RCCs, X9 standards were amended so that checks with a 6 in the external processing code (EPC) of the MICR line (position 44, to the left of the routing transit number) indicates an RCC.[10]

Remotely created checks included within the scope of Reg CC, based on the definition and comments by the Board of Governors of the Federal Reserve System, include checks created by a customer's bill payment service,[11] preauthorized drafts, ACH administrative returns, telephone payments, depository transfer checks, return item fee payments,[12] and payments created by a collection agency to collect on debt. In addition to checks with a 6 in the EPC, the 2021 CSS categorizes checks that have a signature authorization reference—such as "signature on file," "preauthorized payment," "authorized by drawer," "signature not required," "authorized signatory," and "authorized by depositor"—as remotely created. Checks categorized as RCC were reviewed manually to remove online bill pay checks from this category. [13]

Of the items examined for the 2021 CSS, 383 forward and 1,011 return checks contained one or more of these characteristics (table C-8 and findings in tables A-3 and 9).

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[8] The standard deviation of the return sample is $350,987.

[9] https://www.federalreserve.gov/boarddocs/press/bcreg/2005/20051121/attachment.pdf

[10] https://x9.org/wp-content/uploads/2017/01/X9-EPC-Training-2017.pdf. Although a check with a 6 in the EPC is considered a remotely created check, not all RCCs have a 6 in the EPC.

[11] https://www.federalreserve.gov/newsevents/pressreleases/files/bcreg20170531a1.pdf

[12] https://www.frbatlanta.org/-/media/documents/rprf/rprf_resources/rprfwp0510.pdf

[13] After an additional manual review, four checks with a 6 in the EPC were removed from RCC categorization as these checks did not meet the criteria for an RCC check.

Table B-8: Distribution of RCCs by identifying characteristics, 2021

Percentage shares of total

	Number	Value
Remotely created checks paid by identifying characteristics		
Checks with the number 6 in Position 44 of the MICR line	4.2%	6.2%
Checks with the number 6 and signature authorization reference	4.7%	2.6%
Checks with only a signature authorization reference	91.1%	91.2%
Remotely created checks returned by identifying characteristics		
Checks with the number 6 in Position 44 of the MICR line	1.1%	0.5%
Checks with the number 6 and signature authorization reference	4.1%	2.7%
Checks with only a signature authorization reference	94.9%	96.9%

Checks ineligible for ACH conversion

By agreement between the payer and payee, certain checks can be converted to ACH for clearing and settlement; other checks cannot be converted. The CSS aimed to identify the incidence of checks that were ineligible for conversion to ACH, according to NACHA rules,[14] based on the following conditions: payer's name and address indicated that the payer was a federal entity, mutual fund, or investment firm; check value exceeded $25,000; leftmost portion of the MICR line contained the optional number known as the auxiliary on-us field; check categorized as remotely created; cashier's check, money order, official check, or traveler's check.

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[14] NACHA—the National Automated Clearing House Association—manages the governance of the ACH network and has set the rules for what types of checks can or cannot be converted to ACH.