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SAVINGS FROM CHECK 21

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Getting Rid of Paper: Savings from Check 21*

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Abstract

We estimate the cost savings to the U.S. payment system resulting from implementing Check 21. This legislation initially permitted a paper substitute digital image of a check, and later an electronic digital image of a check, to be processed and presented for payment on a same-day basis. Check 21 has effectively eliminated the processing and presentment of original paper checks over multiple days. By shifting to electronic collection and presentment, the Federal Reserve reduced its per item check processing costs by over 70%, reducing estimated overall payment system costs by $1.16 billion in 2010. In addition, payment collection times and associated float fell dramatically for collecting banks and payees with consequent additional savings in firm working capital costs of perhaps $1.37 billion and consumer benefits of $0.64 billion.

Key Words: Check 21, checks, electronic payment
JEL Classification Code: G28 G21

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1 Introduction

The issue of check float and the inefficiencies it creates for the U.S. payments system has a long history in regulation and law but very little in the way of economic analysis (McAndrews and Roberds, 1999) or even estimates of how it influences payment instrument use (Garcia-Swartz, Hahn, and Layne-Farrar, 2006). Recent legislation gave the same legal standing to the digital image of a check that paper checks have had for more than 100 years. This legislation reduced both the level of float in the payment system and the cost inefficiencies of check payments and we provide an estimate of the joint cost savings involved.

The Uniform Commercial Code has long required U.S. checks to be physically presented to the banks they are drawn on for payment. This allowed banks to inspect checks and verify signatures before payment, a necessity before electronic alternatives were invented. Although signature verification is only commonly done for high-value checks or for suspicious accounts, the required physical presentment generated expensive air and land courier transportation costs. It also led to delays in check collection of from 1 to 5 days, averaging 1 day for local or within-city checks and usually 2 to 3 days for non-local items such as checks going from one city to another across the country.

On September 11, 2001, planes were grounded and check float—the value of checks in the process of transportation and collection—rose to $47 billion (about eight times the normal daily level), while electronic payments were unaffected. Although the technology has been available for almost two decades to digitize check images and collect checks electronically on a same-day basis, the legal requirement of physical presentment inhibited its adoption. While a paying bank could agree to accept checks electronically, most large and small paying banks and their corporate customers, together with the courier networks, had an interest in maintaining the physical collection process and the check float it created.

The September 2001 disruption spurred the Federal Reserve to ask Congress to allow a paper representation of the digital image of the front and back of a check (called a substitute check) to be legally the same as the original physical item for purposes of collection and presentment. This legislation, adopted in 2003 and known as Check 21 (Check Clearing for the 21st Century Act), along with other initiatives, currently permits almost all of the 24.5 billion checks paid annually in the U.S. (worth $32 trillion) to be collected electronically on a same-day (or next-day) basis once they are deposited at a bank. The original check is imaged and transported electronically, and a substitute check is printed close to where the paying bank is located. The substitute check is then physically presented for payment. Since accepting billions of substitute checks is more costly than accepting and paying the electronic image itself, almost all paying banks now receive and pay the image.

Our purpose is to estimate the cost savings to the U.S. payment system resulting from the implementation of Check 21. This legislation took effect in 2004, gained traction in 2006, and today has effectively eliminated the processing and presentment of original paper checks over multiple days. Not only has

collection time and float been reduced for collecting banks and payees (with consequent savings in their working capital) but per item processing costs have fallen markedly. Overall, Check 21 is estimated to have directly reduced the cost of the U.S. payment system by $1.16 billion in 2010 with a further indirect benefit for business and consumer check depositors on the order of $1.37 billion for business and perhaps $0.64 billion for consumers.

An earlier study of Check 21 by the Government Accountability Office (GAO, 2008) did not find empirical evidence of reductions in aggregate or average costs of check clearing and settlement. The GAO concluded that the legislation "...has not yet resulted in overall gains in economic efficiency...but...officials expect efficiencies in the future [p.4]." Our analysis explains why the GAO found what it did and how outcomes have changed since the period of GAO's analysis. The GAO focused on the unit cost of paper checks and Check 21 items taken together (rather than separately) and this combined measure did not fall from its peak until after their study was completed (Bauer and Gerdes, 2009). In fact, this measure of overall average cost did not fall below its 2004 beginning value until late 2010. Our analysis, by looking at the average cost of Check 21 items and paper checks separately, shows that Check 21 costs had fallen below paper check costs by early 2005. In the years since 2005, the rapid replacement of paper checks by Check 21 items produced the considerable savings estimated in this paper.

In what follows, we explain how Check 21 works in Section 2 and illustrate the benefits for business and consumer payees. Section 3 illustrates the rapid growth of Check 21, notes some of the incentives used to speed up this growth, and outlines earlier efforts to shift checks to electronics. Accounting data and a cost function model are presented in Section 4 to illustrate the over 70% reduction in unit check costs and the estimated direct ($1.16 billion) and indirect ($1.37 billion plus $0.64 billion) cost benefits to the payment system from Check 21 in 2010. The effect of scale economies on this result is also noted. The future of the check is discussed in Section 5. Some possibilities are to continue to replace checks with debit cards and Automated Clearing House (ACH) payments, to lower Check 21 costs further by adopting image on demand, and to make the check electronic end to end (replacing the paper version entirely). Conclusions are presented in Section 6. For completeness, an appendix discusses and re-estimates the earlier GAO study of Check 21 costs and explains why that report reached a conclusion different from ours.

2 How Checks Are Collected: Paper Versus Electronic

Checks have played an increasingly important role in the U.S. payment system since 1865 when they started to replace cash for certain large-value business transactions. They have long been the most used non-cash payment instrument in the U.S. because, up until the 1950s when credit cards became estab-

lished, checks were the only significant non-cash instrument available. In 2009, 24.5 billion checks were paid out of 109 billion non-cash transactions totaling $72 trillion.[1] Only in the last three years has debit card use exceeded that of checks.[2] In contrast, Japan and many European countries hardly use checks at all. Japan relies on cash (some eight times the per person U.S. use of cash), while Europe relies on cash (about twice the per person U.S. use) and a Giro payment network, initially developed by national postal services (first using paper, now with electronics).

2.1 Paper Checks

Figure 1 illustrates how checks are received, processed, and collected. Checks written to pay bills via mail (point 1 in the figure) are received by the biller which, along with merchants who receives checks at the point of sale and consumers receiving checks (point 2), deposits them at its bank–commercial bank, savings bank, or credit union–for collection (point 3). The front of the check identifies the payee, the date, and the amount of the check and contains the MICR (magnetic ink character recognition) line. The MICR line identifies the bank the check is drawn on (bank number) and the customer account to debit (account number). After checks are deposited at a bank, or earlier, the amount of the check is read and encoded on the check using magnetic ink (point 4). The three items in magnetic ink–used so machines can quickly sort checks and route them to the bank that will pay the check–contain all the information needed to process and collect a check.

(insert Figure 1 here)

Once checks have been sorted to their different destinations (at point 4 or 5), clearing agents use motor and/or air couriers to transport them to the bank they are drawn on for payment (either directly or through a clearinghouse). Twenty-six percent of checks don't go very far since they are drawn on the same bank at which they were deposited ("on us" checks). The remaining "transit" items are either given directly to a bank's own contracted courier network for delivery if the check volume is large or re-deposited with a large intermediary correspondent bank or Federal Reserve office for collection using the intermediary's own courier networks.[3]

[1] These and many other payment volume and value figures that follow are from the Federal Reserve System (2011) study of non-cash payment instrument use.

[2] Debit card transactions were 38 billion, credit cards 22 billion, and ACH (Automated Clearing House) 19 billion.

[3] The process of going through an intermediary requires that each intermediary–and there can be more than one–takes legal responsibility for the checks deposited with it. The intermediary's name and time of check re-deposit is stamped as an endorsement on the back of the check and determines the route the check takes if it is returned unpaid. The final endorsement is by the paying bank (point 6) which has 2 days to determine if the account the check is drawn on has sufficient funds to pay the item. If not, or for another reason such as closed account or suspected fraud, the check is returned unpaid within the 2-day return item limit. Return items account for around 0.1% of all checks and, although small in number, are expensive to process.

If the check is to be paid, as around 99.9% are, funds are transferred from the paying bank to the collecting commercial bank or Federal Reserve office via wire transfer or book entry net settlement using the paying bank's Federal Reserve reserve account balance (point 7). The check writer's deposit account is then debited for the value of the check (point 8). Collecting banks pass back the credit to their reserve account directly to the deposit holder or to those banks that deposited checks with them, which, in turn, make good funds available to the original depositors (point 9). The delay in allowing depositors access to their funds is governed by funds availability schedules, which reflect the time it normally takes to process and collect checks and pass credit to the bank of first deposit. This completes the collection process.

Check Float. The collection sequence outlined here applies to paper checks and can generate mail float (points 1 to 2) of 1 to 3 days when checks are mailed to billers (rather than received by merchants at the point of sale). Once received, checks are processed by comparing the amount of the check with the value on the invoice (only needed for bill payments) and then the check amount is encoded on the check in magnetic ink with the processed checks delivered to a bank for collection. This creates processing float (points 2 to 4) of ranging from a few hours to 1 day. The collection process (points 4 to 9) can take 1 to 2 days (sometimes longer) and creates collection and availability float.[4]

Large corporate depositors and most consumers obtain use of the value of checks they deposit when the bank itself receives funds from the paying bank at the end of the collection process. In practice, the time involved for processing and availability float generally ranges from 1 to 2 days overall. As seen in Figure 1, mail float also exists, but many billers have eliminated this float expense by noting on their mailed invoice when a payment should be received in order not to incur a past due charge. Overall, paper check float today would range from 1 day (for on us and local items) to 2 days (for transit items going a longer distance).

2.2 Electronic Collection

The benefit of Check 21 is that once a check is deposited at a bank with the proper imaging equipment or at a Federal Reserve office, the original check is truncated and the image of the front and back of the check is sent to the paying bank. The result is that funds are received at the bank of first deposit on a same-day or next-day basis, reducing processing, collection, and availability float and saving 1 day or more in float opportunity cost.[5] Since businesses receive funds much faster, they need to hold less working capital and they save

[4] The exact time depends on how far the check has to travel to be collected, the time of day/night the checks were deposited at a bank, and how much sorting/amount encoding was done prior to depositing the items with a collecting bank. Consequently, individual checks within a group of items deposited at a bank can face quite different funds availability.

[5] Billers and/or merchants can image checks themselves (remote capture) and speed up the process of collection and returns. Imaging checks also permits banks to enclose the image, rather than the original check, in monthly statements mailed to customers or made available for download via the Internet. This yields additional cost savings.

the cost of borrowing these funds from a bank. Consumers also benefit since their need to hold extra balances to fund expenditures or tap a credit card line of credit is reduced.

Check float has been viewed as a zero-sum game since any benefit from reducing the value of float for collecting banks and their customers equals the loss of float received by paying banks and their customers. However, Check 21, by providing rapid electronic collection of check images, renders moot the incentive to incur the substantial costs of expedited collection and remote disbursement merely to redistribute float benefits. The reduction/elimination of expenses to redistribute float benefits reduces the social cost of the payment system (McAndrews and Roberds, 1999). In addition, inefficiencies are reduced and society benefits since the cost of processing (sorting) and collecting (delivery) an electronic image is much lower than for a paper check. Motor and air courier costs are eliminated and replaced with lower telecommunication expenses. Errors and adjustments are also markedly reduced, further lowering costs, and return items are returned faster, reducing the possibility of fraud.

3 Growth of Check 21

Processing of Check 21 items started in the fourth quarter of 2004. The share of Check 21 items in total checks processed at the Federal Reserve is shown in Figure 2a and reflects a standard S-curve (Gompertz curve) where growth initially increases at an increasing rate after 2005, reaches an inflection point in 2007, and increases at a decreasing rate thereafter, until effectively all paper checks are replaced by Check 21 in 2010. The full replacement took only 6 years, a remarkably short period for such a major technological change.[6]

(insert Figure 2a here)

The growth of Check 21 at commercial banks followed a similar pattern and Figure 2b shows the growth of Check 21 at the Federal Reserve and commercial banks together.[7] The expansion of total electronic images plus paper substitute checks is shown in the top line. Although there is significant monthly variation in total Check 21 volume, the S-curve pattern is clearly visible. The bottom line shows the initial rise and later fall in substitute checks as image volume (the vertical difference between the two lines) expanded. By the end of 2010, substitute checks were effectively zero. In terms of market share, the Federal Reserve processed 67% of all Check 21 items in 2006. By 2010, as commercial banks increasingly adopted Check 21, the shares were equal at 50% for both the Federal Reserve and commercial banks.

(insert Figure 2b here)

[6] S-curves are common in the adoption of new technologies and exist for the adoption of the telephone, the TV, the use of robots in the auto industry, and many other situations.

[7] The nationwide Electronic Check Clearing House Organization (ECCHO) provided these data. ECCHO sets rules and procedures for only those commercial banks wishing to clear Check 21 items. The National Automated Clearing House Association (NACHA) does the same for ACH but NACHA's rules apply to all commercial banks.

Check 21 grew rapidly because the benefits over paper checks–reduced float and lower unit processing prices–were large, stimulating a demand for this service even when significant up-front investment by banks was required to use it. A less obvious reason, however, concerns the early availability of equipment needed to use Check 21. Before any equipment can be manufactured and telecommunication facilities set up, a common format and other standards have to be developed and agreed upon. This was completed very early so the needed equipment was available with just a short lag. This is in contrast to other new electronic payment arrangements, such as Electronic Business Data Interchange (EBDI), where decisions regarding formats and other standards have encountered many delays.[8] Since with Check 21 geography no longer matters, all deposited checks must be made available within 2 business days under Regulation CC (which implements the 1987 Expedited Funds Availability Act). Previously, some transit items could have had a maximum delay of up to 5 days when collection was physically difficult.

3.1 Incentive Pricing and Service Level Changes

Additional incentives to adopt Check 21 were also implemented. In particular, the Federal Reserve adopted incentive pricing and service level changes that applied to checks deposited with them and to paying banks receiving Check 21 items to speed up the transition. And compared to paper checks, Check 21 prices were kept low since its costs fell initially due to strong scale economies. Favorable deposit deadlines were also offered. Allowing an hour later deposit deadline for Check 21 items versus paper checks, for example, permits a collecting bank to process more items prior to the deadline and thus collect a larger share of checks deposited with the bank each day. This reduced cash items in the process of collection (CIPC) and its associated float.

There were also disincentives to continue to use paper checks. As the volume of paper checks fell, the price of processing and collecting these checks rose. This reflected the higher unit cost experienced as the benefit of scale economies was reversed.[9] Finally, the physical transportation of paper checks using motor/air courier networks became less timely as the size of these networks was reduced due to the reduced volume of paper checks being collected. This raised float costs as availability schedules were lengthened. Instead of using costly dedicated air couriers, banks substituted less timely air freight on scheduled airlines on certain routes.

[8] EBDI can substantially reduce business payment/billing/receipt costs as payment and invoice information is exchanged electronically. However, developing common standards for transmitting invoice information has been slow due to differences in invoice information needed and used historically across different industries.

[9] Instead of spreading fixed costs over larger volumes and lowering paper check unit costs, lower volumes meant that each check had to cover a larger allocation of fixed cost raising unit costs and prices.

3.2 Earlier Efforts to Shift Checks to Electronics

There have been earlier efforts to shift payments to cheaper electronic methods. The most successful, although it took a long time, is the Automated Clearing House (ACH). Initiated during the 1970s by commercial banks that asked the Federal Reserve to become the ACH operator, there are now also many private-sector operators in different parts of the country. The ACH was envisioned to do what has been fully accomplished by Check 21. The idea was to take payment information on a check and transmit it electronically nationwide among check clearinghouses (where banks meet to exchange checks drawn on each other). This would speed up collection, reduce float, and markedly reduce processing and delivery costs.

Although ACH initially expanded slowly, many billers now receive payments via a preauthorized ACH debit to the payor's bank account (direct debit), and most employees, retirees, and Social Security recipients receive payroll and other payments via an ACH credit to their bank account (direct deposit). However, by value, the largest set of ACH transactions are among banks overnight for corporate cash management purposes. Banks collect daylight and end-of-day idle balances for their corporate customers from many dispersed individual banks and concentrate these balances at a cash concentration bank for sale into the market overnight or the next day or for other corporate uses such as funding other subsidiary operations. The funds sold would earn an interest return not otherwise available if left idle in a demand deposit account.[10]

Today, there are 19 billion ACH transactions annually. In terms of value, ACH accounts for 51% of non-cash transaction value, while checks paid accounts for 44%. Debit and credit cards together account for only 5%. The reason why ACH processes a larger value of transactions than checks, as opposed to check volume, which exceeds the number of ACH transactions, is due to business use of the ACH for cash management where the values being transferred are quite large.

The initially slow growth of ACH was due primarily to the difficulty in obtaining customer authorizations enabling companies, as both collectors and disbursers, to automatically debit/credit customer deposit accounts. ACH growth was also affected by the fact that the Uniform Commercial Code (UCC) permitted a paying bank to receive and inspect the physical check before paying it. While paying banks had long since stopped routinely inspecting the checks they receive for a stale date or to compare the signature on the check with one in a customer file, many still invoked their right under the UCC to receive the physical item and retain the associated float benefit, a benefit not available with ACH. Consequently, the key behind the success of Check 21 was legislation that made the image of a check (in the form of a substitute check) legally the same as the original physical item. Check 21 items can be presented for payment

[10] Until repealed in July 2011, Regulation Q precluded payment of interest on balances held in demand deposit accounts. When interest was paid on demand deposits prior to the Great Depression, banks competed for these funds, raising their interest costs. To cover the higher funding cost, banks (it was felt) invested in riskier assets.

under UCC rules, do not require a customer authorization to debit a deposit account, and are collected much faster than paper checks. Paying banks can still incur the expense of remotely disbursing checks to payees or require the physical delivery of a substitute check for inspection but they no longer enjoy the previous float benefit of doing so.

ACH debits for bill payments and credits for payroll and other recurring income transfers have over time replaced many checks previously written for these purposes. But ACH is also replacing checks after they are written. Some merchants who receive a check at the point of sale take the check, place it in a terminal that reads the MICR line, take the sale amount from their electronic cash register, and use this information to initiate an ACH electronic debit to the customer's deposit account. By using check conversion at the point of purchase (POP), the merchant receives the funds the next day at its bank–a process much faster than collecting the paper check itself. Similarly, billers receiving checks in the mail at their lockboxes–sited to minimize mail time and float–encode the check amount and read the MICR line to initiate an ACH accounts receivable conversion (ARC) debit to the payor's account. Finally, since 2007, merchants that accept checks at the point of sale can convert checks to ACH debits in their back office rather than at the cash register. back office conversion (BOC) avoids questions and confusion at the cash register that can arise with POP conversion. However, under National Automated Clearing House (NACHA) rules, ACH can handle only consumer checks, while Check 21 can handle both consumer and business checks.

Another effort to shift paper to electronic means was electronic check presentment (ECP) initiated by the Federal Reserve in the 1990s. Although the goal was the same as the ACH–to speed up check payments and lower unit costs–it faced the same problem: the paying bank had to voluntarily agree to accept and pay an electronic transmission of payment information rather than the paper check. The idea of ECP was the same as that later implemented on ACH via POP, ARC, and BOC, only instead of the MICR line and the encoded amount of the check becoming an ACH debit, it would be separately transmitted electronically to the paying bank and the paper check would be truncated at the sending bank or follow on to the paying bank a day or so later. Either way, float costs were reduced. All Federal Reserve Bank offices offered ECP, and by 2002, before Check 21 was passed by Congress in 2003, 25% of checks deposited at these offices were presented electronically via ECP.

4 Estimating the Cost Benefits from Check 21

Accounting data and a simple econometric model allow us to determine how the average cost of paper checks and Check 21 items have varied over 1998-2010, what the cost benefits of Check 21 have been, how paper check costs rose as volume fell, what was the cost impact of closing 46 paper check processing offices and to estimate the scale economies associated with processing paper as opposed to electronic images.

4.1 Cost Accounting Data and Benefits from Check 21

The average cost of paper checks and Check 21 activities used here was computed from the Federal Reserve's Programming and Control System cost accounting reports (PACS). Information on commercial bank check costs is not publicly available. Even so, it is believed that the relative costs of paper checks and Check 21 computed here for the Federal Reserve are also representative of commercial bank costs for these processes since the production functions and equipment used are the same.

Figure 3 illustrates how the average cost of paper check and Check 21 items has changed over time.[11] The ability to compute average cost for both check activities separately is only possible because cost accounting data exist in sufficient detail. If only the total cost of paper check and Check 21 activities were available, it would be possible to estimate scale economies but (for technical reasons noted below) the separate average costs of these two activities could not be determined.

(insert Figure 3 here)

Figure 3 shows that the cost of processing and clearing a paper check was 4.3 cents at the Federal Reserve in 1998. It rose to 7.4 cents by the end of 2003 when the Check 21 legislation was passed but before there was any Check 21 volume. Paper check costs rose strongly during and after 2006 as paper check volume started to fall with the growth of Check 21. Indeed, in late 2007 when Check 21 volume was 50% of all check volume, the average cost of a paper check was 17.5 cents, while it was less than a third of that, 4.8 cents, for Check 21 items. By the end of 2010, when paper check volume was effectively zero, the cost of a Check 21 item was only 2.2 cents.

A more accurate way to compare costs would be to examine the same mature volume level and use average annual unit costs (as costs vary by quarter). In 2006, annual paper check volume was 8.8 billion items with an annual average cost of 9.6 cents per item. Keeping the volume level roughly constant, this compares to an annual volume of 8.4 billion Check 21 items during 2010 with an annual average unit cost of 2.5 cents (a 74% reduction). It is clear that the implementation of Check 21 has led to a substantial reduction in check costs at the Federal Reserve and also at commercial banks.[12]

The reduction in average cost with expanding Check 21 volume is the result of a more efficient technology along with scale economies while the rise in average cost for paper checks is due to a reversal in scale economies as volume fell. Just as larger volumes can lead to lower costs, lower volumes reverse this

[11] The average costs shown in Figure 3 and all following figures have excluded the very highest values (associated with the lowest volumes) in order to make the cost comparisons clearer at normal levels of operation. All data in the figures and tables are based on PACS data provided by the Federal Reserve System and represent our own calculations. Estimates of unit cost are not the prices charged.

[12] These costs exclude the consumer cost of writing a check (and possibly mailing it) as well as the merchant/biller cost of receiving a check, which likely rose somewhat during this period due to inflation.

process.[13] This is not, strictly speaking, a transition cost as scale economies are embedded within the production function and so are not "one-time" costs but are directly related to volume. However, there have been "one-time" transition costs associated with the expense of closing down 46 paper check processing offices, laying off staff, and writing down certain capital assets no longer needed. Except for a few years, allocating these office closing expenses to the two check activities based on their relative volumes had little effect on unit costs. The thick line in Figure 3 includes these expensed costs, while the thin line excludes them.

4.2 Cost Savings

The difference between the Federal Reserve average cost of processing a paper check during 2006 (9.6 cents) and a Check 21 item during 2010 for approximately the same mature volume level (2.5 cents) times the 8.4 billion items processed in 2010 gives $0.60 billion as an estimate of the cost savings of Check 21 for the Federal Reserve for 2010 (Table 1). It is not unreasonable to assume that the same per item cost savings for similar processes have been realized for commercial banks that have also switched to electronic imaging for the paper checks they receive. The annual volume of Check 21 items processed at more than 3,000 commercial banks that are members of the Electronic Check Clearing House Organization (ECCHO) during 2010 was 7.9 billion and, times the difference in costs experienced by the Federal Reserve, suggests an additional cost savings of $0.56 billion.[14] The total production cost savings from Check 21 for the U.S. payments system during 2010 is thus estimated to have been $1.16 billion.[15]

[13] Bauer and Gerdes (2009) note that this reversal of paper check scale economies was the reason why the average cost of all Federal Reserve checks (paper and Check 21 items together) rose after Check 21 was implemented. As shown in the Appendix, it is also the reason why the earlier GAO (2008) study was unable to document the cost savings of Check 21.

[14] Although there is no public information on commercial bank check expenses, commercial banks have likely saved more from Check 21 than our estimated per item savings for the Federal Reserve. Specifically, they no longer have to physically transport checks to processing centers, and including an electronic image of a consumer's check in a monthly bank statement is cheaper than including the paper item.

[15] As the number of checks paid has fallen by 7.1% annually, due to (1) the shift to debit/credit cards instead of checks, (2) the increase in "on-us" checks as banking consolidation proceeds, and (3) a rise in collecting checks using ACH, these estimated cost savings will be reduced somewhat in the future. The number of checks written has been falling by 5.7% annually and reflects the shift to cards, so reason (1) above has had the greatest influence on the number of checks paid.

Table 1: Cost Savings and Benefits from Check 21 in 2010

Federal Reserve Cost Savings	$0.60 billion
Likely Commercial Bank Savings	$0.56 billion
Total Processing Cost Savings:	$1.16 billion
Business Payee Working Capital Savings	$1.37 billion

In addition, firms receiving checks can collect funds more rapidly due to Check 21 with a similar benefit for consumer payees. For business payees, who received 79% of all checks by value, this benefit is equivalent to the reduction in float due to Check 21 times the opportunity cost of funds, which is close to the average bank loan rate. Based on the 2010 Federal Reserve Payments Study (Federal Reserve System, 2011), the volume of consumer-to-business (C2B) and business-to-business (B2B) check remittances or bill payments received by business payees was 14.6 billion in 2009.[16] On-us items (26% of all checks) would not be collected more rapidly with Check 21. Similarly, checks written by consumers and converted to ACH items (a total of 3.3 billion apportioned across C2B and consumer-to-consumer or C2C checks) would not be collected much more rapidly with Check 21. Business payees are thus estimated to have received around 9.4 billion checks that would benefit from Check 21 collection in 2009. Multiplying this number by the estimated average values of C2B and B2B checks yields $14.3 billion for the total value of remittance checks received by business.[17] Multiplying again by 1/365 to reflect one-day-faster funds availability and applying the 2010 average bank loan rate of 3.5% (moderate risk, 31-365 days) suggests that business payees may have saved $1.37 billion in working capital costs by being able to collect checks a minimum of one day earlier because of Check 21.[18]

Consumer payees also benefit from Check 21, but for most of them, their opportunity cost of collecting funds one day earlier was likely close to zero in 2010 (e.g., in an interest-earning checking account) and so have not been included in Table 1. However, it is possible to approximate the benefit to indebted consumers from faster availability of deposited funds, specifically the

[16] C2B remittances were 8.6 billion while B2B remittances were 6.0 billion in 2009.

[17] The 9.4 B volume estimate is from 8.6 B C2B checks x (1 - .26) "on-us" adjustment x (1 - .224) for ACH check conversion plus 6.0 B B2B checks x (1 - .26) with no ACH conversion (Exhibit 6 in Federal Reserve System, 2011). The average value of C2B checks was $342 while for B2B items it was $2,839 (Exhibit 45 in the detailed version of Federal Reserve System, 2011).

[18] The gain by business payees is of course offset by the loss of float by check writers, just as the processing cost savings from Check 21 reduced the income of workers and firms engaged in physically collecting checks. In a similar vein, many have argued that float is a zero-sum game. However, real resources were expended by payors to delay collection and also expended by payees to expedite collection. Eliminating these real resource costs by speeding up collection via Check 21 represents a net social benefit (although we have no estimates of the real resources saved here). Another benefit is reduced fraud from faster return items but the cost effect of this benefit is difficult to estimate.

subset of consumers that revolves credit card debt. Business-to-consumer (B2C) plus consumer-to-consumer (C2C) checks totaled 7.6 B in 2009 but adjusting for "on-us" and ACH check conversion gives 5.2 B checks that could obtain funds one day sooner via Check 21.[19] Multiplying by the estimated average value of B2C and C2C checks gives $4,641 billion for the total value of checks received by consumers that could benefit from Check 21. Only 35% of households both have a checking account and maintain a revolving credit card balance, which has an average interest rate of 14.26%. Combining all of this information leads to a rough estimate that consumers may have saved $0.64 billion from Check 21.[20] This is in addition to the savings noted in Table 1.

4.3 Payment Scale Economies

As cost accounting data are rarely available for each payment activity separately, payment scale economies are typically estimated from a logarithmic multiproduct (translog) cost function where the total cost of paper checks and Check 21 items together (TC), for example, would be regressed on the volumes of paper checks (Q_{PC}) and Check 21 items (Q_{21}), the average prices of labor (P_L) and physical capital (P_K) used to process these outputs, along with other variables that can affect total cost if needed: $\ln TC = f(\ln Q_{PC}, \ln Q_{21}, \ln P_L, \ln P_K)$. In a translog specification, non-linearities are captured by specifying own and squared terms of all the variables in logs as well as interactions among these variables (e.g., Bolt and Humphrey, 2007). Once estimated, scale economies (SCE) are obtained from $SCE_i = \partial \ln TC / \partial \ln Q_i$ where values < 1.0 reflect economies since the percent change in total cost $\partial \ln TC$ is less than the percent change in one of the payment outputs $\partial \ln Q_i$ so that expanding volume lowers average cost. Values > 1.0 would indicate diseconomies where expanding volume raises average cost.[21]

(insert Figure 4 here)

In this application, a simple cost function is used to estimate the implied scale economies illustrated in Figure 3. Scale economies, however, relate the percent change in total cost to the percent change in check volume (rather than the change over time) and this is shown in Figure 4.[22] If changes in input prices and other non-volume-related influences on total costs are believed to be small or are driven by the change in check volume rather than being exogenous (as is

[19] The 5.2 B volume estimate is from 2.4 B C2C checks x (1 - .26) "on-us" adjustment x (1 - .224) for ACH check conversion plus 5.2 B B2C checks x (1 - .26).with no ACH conversion. The average value of B2C checks is $1,037 and $472 for C2C checks.

[20] The $0.64 B estimate is from $4,641 B x .35 x (1/365) x .1426. The 35% figure in the text is from a special tabulation of the publicly available *Survey of Consumer Preferences* by the Federal Reserve Bank of Boston.

[21] While a multiproduct cost function can allocate a portion of total cost to the two payment activities (Q_{PC} and Q_{21}) to estimate scale economies which deals with *changes* in cost as volume changes, the *level* of their separate average costs can not be determined without also knowing the mean effect on the level of TC from all of the other non-volume-related variables in the cost function (Baumol, Panzar, and Willig, 1982).

[22] Figure 4 is only different from Figure 3 because the former relates average cost to volume on the X-axis while the latter relates it to time.

the case here), then simply comparing the percent change in paper check total costs (35.5% over the first 48 quarters) to the percent change in volume (196%) gives a scale economy value (SCE) of 0.18 in Table 2. Here a doubling of paper check volume is associated with only an 18% rise in total cost, and average cost, as shown in Figure 4, falls dramatically. For Check 21 items from the end of 2004 to the end of 2010 (the period when Check 21 was in operation), total cost rose by 186% as volume expanded by 200%, giving an SCE = 0.93. Here the big reduction in average cost associated with the initial expansion in volume is effectively averaged with a slight rise in average cost (probably associated with some input price inflation) as volume continued to expand for Check 21 items in Figure 4. A cost function regression should give similar (but not identical) results.

Table 2: Check Processing Scale Economies

	Paper Checks	Check 21
Accounting Data	.18	.93
Full Model	.29*	1.14**
Quadratic Model	.03	.98**
Time Period	1998Q1 to 2009Q4	2004Q4 to 2010Q4

**(*) significantly different from zero at 5% (10%) level.
No test of significance for accounting data.

A standard translog-type cost function was estimated and for paper checks is shown in this footnote.[23] It turns out, however, that changes in check volume drove changes in other variables that could affect total cost. Specifically, check processing offices were closed directly as a result of and in step with the fall in paper check volume and rise in Check 21 volume. As well, the average price of employed labor for paper checks rose as volume fell since the mix of workers paid different wages also changed. As a result, in the full model shown in the footnote scale economies for paper checks was .29 (and significantly different from zero) while for Check 21 it was 1.14 (and significantly different from both zero and 1.0–or constant average costs). In effect, the full model suggests that scale economies were strong for paper checks but not as strong as when accounting data are used. Also, there are slight diseconomies to scale–average cost rises with increases in volume–for Check 21 (consistent with the accounting data for most of the time Check 21 was in operation).

[23] In logs, this function relates the total cost of paper checks (TC_{PC}) to the volume of paper checks (Q_{PC}), the input prices of labor and capital inputs (P_i), and contains squared and interaction terms. It is expressed as:
$\ln TC_{PC} = \alpha_0 + \alpha_1 \ln Q_{PC} + 1/2\alpha_2(\ln Q_{PC})^2 + \sum_{i=1}^{2} \phi_i \ln P_i + \sum_{i=1}^{2} 1/2\theta_i(\ln P_i)^2 + \sum_{i=1}^{2} \delta_{PC,i} \ln Q_{PC} \ln P_i$. Input price homogeneity of degree 1.0 was imposed in estimation. A similar equation was estimated for Check 21. The number of paper check offices (BR) is not included in either equation since this would change the scale estimate to reflect economies at the average office rather than for the overall check operation.

As volume changes drove the changes in average unit labor cost as well as the closure of processing offices, we also show a scale economy estimate based on the simple quadratic functions $\ln TC_{PC} = \alpha_0 + \alpha_1 \ln Q_{PC} + 1/2\alpha_2(\ln Q_{PC})^2$ and $\ln TC_{21} = \alpha_0 + \alpha_1 \ln Q_{21} + 1/2\alpha_2(\ln Q_{21})^2$ that comprise the first part of the full model shown in the footnote. As seen in Table 2, scale economies for paper checks are 0.03 (but not different from zero) while for Check 21 SCE = 0.98 (different from zero but not from 1.0).[24] These results summarize what Figures 3 and 4 illustrate visually. Namely, strong scale economies for paper checks led, when reversed, to the rise in average cost as volume fell while, after a big initial reduction in average cost for Check 21, additional volume growth either led to an approximate constant unit cost or a slight rise that was close to constant average costs. This rise, which can be see in Figure 4, was in part likely due to input price inflation but can not be separately estimated here since the change in output composition affected the change in average input prices so these prices are not exogenous from volume.

5 Possible Changes to Check 21

5.1 Lower Costs: Image on Demand

Currently, excluding on-us and local checks, almost 100% of transit checks deposited with the Federal Reserve or with commercial banks (following rules established by ECCHO) are collected electronically via Check 21. If the paying bank wishes to verify the signature on the check, the date (stale date), or the payee because the amount of the check is very large or because of concerns regarding the customer account, the bank has the image in its possession to do this. Check 21 costs could be further reduced, however, if instead of sending the entire image to the paying bank, only the MICR line (bank number and depositor account number) and the amount of the check were sent. Paying banks wishing more information before paying certain items could request the image (or a substitute check) to be sent before paying the item. That is, the image (or substitute check) would only be sent on demand.[25]

There are two precedents for such an arrangement. ACH debit transfers are collected from paying banks using the same three pieces of information (and nothing else).[26] As well, the Federal Reserve's Electronic Check Presentment (ECP) program noted above sent the same three pieces of check information to paying banks for payment. Since the original paper check followed the electronic presentment about one day later, it could be inspected if there were issues that needed to be resolved before paying the item. If image on demand were the rule, the cost of processing and collecting a Check 21 image could be somewhat reduced.

[24] The numerically different values shown in Table 2 are not unusual but most studies choose either to not estimate different models or to not report them.

[25] Even so, some facility would be needed to enable consumers to view images of their checks.

[26] NACHA rules govern ACH payments and these differ from the UCC, which governs checks.

5.2 Greater Convenience: Electronic End to End

Check 21 has made check processing and collection electronic but what about the front end? Would consumers and businesses write more checks in the future if the front end was also electronic? Jacob, et al., (2009) set forth a proposal to create a digital check, which they call an *electronic payment order* (EPO), that would make checks electronic end to end.

Just as consumers and businesses order paper checks from their banks or other suppliers that come with a printed MICR line and places to write the name of the payee, the date, the amount, and a place to sign the check, a computer program can provide a representation of the same check on a home computer screen or small device at the point of sale and this representation could be signed either digitally or physically. This would allow users to initiate a debit to their account for Internet bill payments or for point-of-sale purchases just like a standard check. For merchants and billers, this would be equivalent to accepting a credit card or signature debit card at the point of sale or a credit card over the phone or Internet–but without the interchange fee and likely with the same or better funds availability. The resulting EPO could be processed and collected using Check 21 or over the ACH network.

Allowing check users to initiate electronic checks would be an improvement over the current cumbersome process of arranging a pre-authorized debit for recurring bill payments. It would also be a lower cost and potentially more convenient way of making business-to-business payments (without the invoice) and making non-recurring bill payments as well as person-to-person transactions. A digital check would give users greater control over their accounts and, if made safe and secure, would improve on current arrangements for making Internet payments. However, these benefits would only occur if an electronically initiated check was deemed to be a check under UCC rules rather than being subject to Regulation E, which governs electronically initiated ACH transactions. If the EPO falls under Regulation E, it faces the same ACH requirement of obtaining authorization to debit an account–unless the act of initiating an EPO was deemed to give authorization itself. Then the issue becomes one of security: namely, is the initiator really the account holder?

6 The Future of the Check

The result of two decisions will determine the future of the check and Check 21. First, consumer payors have to decide to write a check or, instead, use a card at the point of sale or sign up for a pre-authorized ACH debit for a bill payment. Business payors make a similar decision, but their only alternative is to make bill payments and pay employees using ACH. Second payees must decide to clear a check using Check 21 or to convert it to an ACH debit. But NACHA rules limit ACH conversion to checks written by consumers (not businesses).[27]

[27] Paying banks and their business customers wanted to reduce the float cost of collecting consumer checks by using ACH check conversion but not let other banks take away the float

Table 3: Number of Checks Written by Type (in billions)

	Total	C2B			B2B			B2C	C2C
		Bills	POS	Either	Bills	POS	Either		
2006	33.1	10.7	4.4	1.9	5.4	1.1	1.8	5.6	2.2
2009	27.8	8.6	2.0	1.6	6.0	0.6	1.2	5.2	2.4
Change	-5.3	-2.1	-2.4	-0.3	+0.6	-0.5	-0.6	-0.4	+0.2

Source: Federal Reserve System (2011), Exhibit 49, detailed version of report.
Figures may not add due to rounding.

As shown in Table 3, the first decision resulted in 33.1 billion checks being written in 2006 but this number fell to 27.8 billion in 2009, a 5.3 billion reduction (16%) over three years. Of the 27.8 billion checks written in 2009, Table 4 indicates that only 24.5 billion were paid as checks in that year. The differences–3.3 billion checks (12%)–were converted to an ACH payment using POP, ARC, or BOC.[28] The net result of the payor's decision to write a check and the payee's decision on how to clear it has resulted in a 42% reduction in checks paid over the last 10 years.[29] Table 4 also shows that this reduction, plus the fact that the number of noncash payments has been rising over time, has also reduced the share of checks in noncash payments by 60% over the last decade. If the 5.3 billion reduction in checks written over the last three years is extrapolated forward, checks could disappear in 16 years (by 2026).[30] We now assess the likelihood that this declining trend in checks written may continue in the future. This is done by examining four categories of checks written and determining if they are likely to significantly alter their current downward trend.

Table 4: Checks Paid and Other Payment Volumes (in billions)

	Checks Paid	All Cards	ACH	Total Noncash	Check Share
2000	41.9	24.4	6.1	72.4	.58
2003	37.3	35.3	8.8	81.4	.46
2006	30.5	50.1	14.6	95.2	.32
2009	24.5	65.4	19.1	109.0	.23

Sources: Federal Reserve System (2011 and 2007) and Gerdes et al. (2005).

6.1 The Payor's Decision: To Write a Check or Not

Consumer-to-Business Checks (C2B). Consumer-to-business checks account for 45% of all checks written. Importantly, as seen in Table 3, C2B checks have fallen by 4.7 billion over the last three years and they accounted for 90% of the

benefits they received by being a paying bank for business checks. This is one explanation for the NACHA rule.

[28] The conversion of checks via POP and ARC did not become significant until after 2003.

[29] Checks are believed to have peaked around 1995. It is difficult to know for sure as regular surveys of check use were not made until 2000.

[30] Accurate annual data are not available to make an S-curve forecast for checks written, so a simple linear extrapolation is illustrated here instead.

5.3 billion reduction over 2006-2009. There were 8.6 billion C2B remittance or bill payments in 2009 and 2.0 billion point-of-sale payments.[31] With so many consumer remittance checks, there could be a big impact on future check use if consumers switched rapidly to preauthorized ACH debits (or the Internet) for bill payment. This large potential is unlikely to be quickly realized, however, as the growth of pre-authorized ACH debits has been slow in the past. These payments are cumbersome to set up and hard to stop, and the biller initiates the payment so consumers have little control. While businesses have been interested in getting consumers to adopt pre-authorized debits to obtain faster funds availability and a more predictable revenue flow, this interest will likely slacken since checks can now be collected more rapidly via Check 21. From this perspective, it is expected that the current trend in C2B bill payments will likely continue in the near future (e.g., falling by 2.1 billion over three years as it did over 2006-2009).[32]

The situation regarding C2B POS transactions is different. Over the 2006-2009 period, the decline in consumer checks written at the point-of-sale was 2.4 billion, or 45% of the total decline in checks written (see Table 3). While the expectation is that the shift from checks to cards (mostly debit) will continue in the future, this can only continue up to the point that the remaining 2.0 billion C2B checks written at the POS have switched to cards. Thereafter, any further reduction in checks written must come from other segments, and most of those have not been falling as rapidly.

Business-to-Business (B2B) and Business-to-Consumer Checks (B2C). Business -to-business checks make up 29% of all checks written. The largest category of B2B checks is for remittances, which actually rose by 0.6 billion. This was offset by business point-of-sale checks (only 0.6 billion in 2009), which fell by 0.5 billion. Even if one includes the "Either" category of checks–either for bill payment or POS–the overall effect on the declining trend in B2B checks written is small. Since Check 21 has eliminated the float benefit of businesses writing checks to other business, there is little reason to shift from B2B checks to initiating ACH credits unless this is tied to EBDI.[33] Unfortunately, EBDI growth has been slow even though the potential cost benefits are quite large. With EBDI there are no more paper invoices, no more postal expenses, no more lockbox costs, no more transferring electronic billing information to paper and back again as occurs when billers receive a check. One would think that the incentives here would be strong on the part of both business payors and payees to more rapidly expand EBDI and markedly reduce the 6.0 billion B2B checks. Unless this occurs, which based on historical experience appears doubtful, there is little reason to expect an important net reduction in B2B checks in the near future.

Business-to-consumer (B2C) checks account for 19% of all checks written,

[31] The "Either" category of checks shown in the table could not be classified as bill payments or POS transactions, but their large average value suggests they were remittance payments.

[32] This assumes that the growth in Internet and mobile payments for bill pay will continue to be slow as both still present security concerns from the perspective of consumers.

[33] Float and unit cost of Check 21 are similar to that for ACH.

but this category of checks has fallen by only 0.4 billion over the last three years. These checks are mostly used for employee payroll/retirement payments and their shift to ACH direct deposit is nearing saturation.[34] Even though there are 5.2 billion B2C checks written, little change in the trend in these payments is expected. Finally, the last category–consumer-to-consumer checks (C2C)–were 2.4 billion in 2009 and rose–not fell–by 0.2 billion over the period.

Overall, the only likely significant change resulting from future payor decisions to write a check or not concerns the shift from checks to cards. Once the 2.0 billion C2B POS checks shift to cards, the downward trend in checks written is expected to only be around 3 billion over three years rather than the 5.3 billion experienced over 2006-2009.

6.2 The Payee's Decision: How to Clear Checks Received

Checks written can be cleared or paid using Check 21 which currently accounts for 88% of checks written (24.5 billion items). Or a payee can collect a check using ACH POP, ARC, or BOC which accounts for the remaining 12% of checks written (3.3 billion items). While both ACH check conversion and Check 21 reduce float, Check 21 can provide slightly better funds availability at likely a similarly low cost. Over 2006-2009, 0.7 billion additional consumer checks were converted to ACH debits. Since there now is little difference in funds availability between ACH debits and Check 21, the 6.0 billion downward trend in checks paid over 2006-2009 may be 0.7 billion less than before since the incentive to clear checks via the ACH to obtain faster funds availability has been effectively eliminated.[35]

In sum, the likely effect of payor and payee decisions for the future of the check would be to slow the 5.3 billion decline in checks written to around 3 billion once the remaining 2.0 billion C2B POS checks shift to cards. This slowdown in checks written also reduces the 6.0 billion decline in checks paid by a similar amount. As well, the past reduction in checks paid will likely be 0.7 billion less in the future as the float incentive to clear checks through the ACH is eliminated. Combining these two effects suggests that the current 6.0 billion reduction in checks paid over the last three years could be half that going forward. This would still represent a significant reduction in future Check 21 volume over time, and a simple linear extrapolation of a 3 billion reduction in checks paid over future three-year intervals suggests that checks would effectively be phased out in 23 years (by 2033).[36] Even if this does not occur, at this point

[34] For example, in 2012 all new Social Security recipients will default to direct deposit or receive payment on a prepaid card. Nearly all existing recipients must forgo checks in 2013. These changes will also apply to a number of federal retirement benefit programs but at a later date. There is also a trend to disburse some payroll payments using prepaid cards for employees without bank accounts.

[35] This could change if NACHA rules are altered to allow same-day ACH debits.

[36] This simple linear "forecast" subtracts the 2.0 billion remaining C2B POS checks in Table 3 in 2009 from the 24.5 billion checks paid the same year in Table 4. The remaining 22.5 billion checks paid would approach zero in 2033 if the trend reduction in checks paid is 3.0 billion over successive three-year periods.

we see no opportunity for stabilization or reversal of the decline in the check share shown in Table 4.

7 Summary and Conclusions

The September 11, 2001, attacks disrupted the U.S. payment system. The grounding of airplanes, which were used to transport checks around the country, delayed their collection and raised check float to $47 billion while electronic payments were unaffected. Congress subsequently passed the Check Clearing for the 21st Century Act (Check 21), which allowed the digital image of a check (in printed and later in electronic form) to be processed and presented for payment on a same-day basis. By shifting from physical processing and delivery of paper checks to electronic collection and presentment, the Federal Reserve has reduced its per item check processing costs by over 70%. This is estimated to have reduced overall payment system costs at the Federal Reserve and commercial banks by $1.16 billion in 2010. As well, payment collection times and associated float fell for collecting banks and payees with consequent additional savings in firm working capital costs of perhaps $1.37 billion in 2010. Also, consumers that revolve credit card balances may have saved $0.64 billion. Today, almost all of the 24.5 billion checks paid annually in the U.S. (worth $32 trillion) are collected electronically on a same-day (or next-day) basis once they are deposited at a bank.

These cost savings are due to improved technology (electronics versus paper) combined with scale economies for electronic payments. The key, however, was legislation allowing a digital image of a check to have the same legal standing as the original paper check. Without this change, many paying banks could and did (under UCC rules) require the physical delivery of a check in order to gain the float benefits from the time it took to physically process and deliver checks for payment. Other inefficiencies were also eliminated, such as the practice of paying banks remotely disbursing checks to make them more time consuming to collect and having collecting banks try to offset this by spending real resources to expedite the collection process. All in all, the Check 21 legislation accomplished its goals.

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9 Appendix

9.1 The GAO Check 21 Study

The earlier GAO study of the effects of Check 21 was limited in two respects (U.S. Government Accountability Office, 2008): first in the data they chose to use over 1994-2007 and second in the restricted period of time Check 21 was then in operation. The GAO effectively focused on overall average cost in its statistical study while we determine average cost for paper checks and Check 21 items separately (rather than together). Regarding the second limitation, the GAO had 13 quarters of data during which Check 21 was in operation, while we have effectively doubled that to 25 quarters (by covering the additional 2008-2010 period). We can now determine how these two limitations could have contributed to GAO's conclusion that Check 21 did not reduce payment costs.

The GAO statistical model shown in Appendix II of its study is first re-run using the same variables to see if merely adding additional quarters of data would have resulted in a stronger conclusion concerning the benefits of Check 21. Using the variable definitions below, the GAO models were:

$$\begin{aligned} \ln TC &= \alpha_0 + \alpha_1 \ln Q_C + \alpha_2 \ln Q_R + \alpha_3 \ln BR \\ &\quad + \alpha_4 D_{21} + \sum_{m=5}^{7} \alpha_m \ln P_m \\ &\quad + \alpha_8 Q1 + \alpha_9 Q2 + \alpha_{10} Q3 + \alpha_{11} T + \alpha_{12} T^2 \end{aligned} \tag{A1}$$

where:

TC = total check processing operating expenses for paper check, Check 21, and return items composed of labor and physical capital costs (as well as other expenses not separately identified);

Q_C = total volume of processed checks, the sum of the number of standard paper checks (PC), the number of Check 21 substitute checks (SC), and the number of Check 21 electronic check images (EC);

Q_R = volume of all check return items (paper plus Check 21);

BR = number of paper check processing offices;

P_m $m = L, S, GDP$ for the prices of labor (L) and equipment and software (S) along with the value of GDP (GDP);

D_{21} = a dummy variable that takes the value of 1.0 when Check 21 was implemented in the 3rd quarter of 2004 and following periods, zero otherwise;

$Q1, Q2, Q3$ = three quarterly time dummy variables; and

T, T^2 = time (T) and time squared to represent a time trend in processing cost.

In the GAO's basic model, equation A1 is estimated as AR1 (first-order autocorrelation) with a single Check 21 dummy variable (D_{21}). In its structural break model, equation A2 is estimated as AR1 but 6 interaction terms are added to determine if the implementation of Check 21 over 2004-2007 affected the volume of total presentments, return items, the number of offices, the prices of labor or software or the effect that GDP had on total check operating cost (TC).

In estimating equation A1, the GAO was looking to see if the parameter on the Check 21 dummy α_4 was negative. This would indicate that Check 21 on average reduced overall check processing costs. This parameter was negative but not significantly different from zero. The GAO was also looking to see if the sum of α_1 and α_{1D} from equation A2–which was 0.84 + (-0.25)–was less than α_1 in A1–which was 1.34. While the sum was reduced, suggesting that Check 21 reduced check processing cost, neither of these two parameters in A2 were statistically significant. Even though there were important reductions in labor and transportation costs following the implementation of Check 21, the GAO concluded that Check 21 "...has not yet resulted in overall gains in economic efficiency...but...officials expect efficiencies in the future" [p.4].

The lack of statistical significance in the models the GAO estimated was attributed to having a relatively limited number of quarters in its sample when Check 21 was in operation. Another complicating factor concerns transition costs, such as the cost of closing the 46 paper check processing offices, that are incurred even if underlying processing costs may be falling with the implementation of Check 21.[37]

[37] Some methodological issues could in principle also have affected the GAO results. For example, it is typically unnecessary to correct for trends in the data by specifying a quadratic time trend in equations A1 and A2 and at the same time use AR1 (first differences) in estimation. In addition, quarterly changes in check volume should reflect quarterly changes in total cost so quarterly dummy variables should not be needed. Finally, AR1 estimation, since it involves changes in variables rather than their level, often reduces both R^2 values and parameter significance levels. As seen below, it turns out that these concerns, while valid, would not have materially altered the GAO's conclusions.

$$
\begin{aligned}
\ln TC \quad = \quad & \alpha_0 + \alpha_1 \ln Q_C + \alpha_2 \ln Q_R + \alpha_3 \ln BR \\
& + \alpha_{1D}(\ln Q_C) D_{21} + \alpha_{2D}(\ln Q_R) D_{21} + \alpha_{3D}(\ln BR) D_{21} \\
& + \alpha_4 D_{21} + \sum_{m=5}^{7} \alpha_m \ln P_m + \sum_{n=4D}^{6D} \alpha_n (\ln P_n) D_{21} \qquad \text{(A2)} \\
& + \alpha_8 Q1 + \alpha_9 Q2 + \alpha_{10} Q3 + \alpha_{11} T + \alpha_{12} T^2
\end{aligned}
$$

Using the same quarterly variables as in the GAO study, but now over 1998-2010 when at the end of 2010 over 99% of checks were processed via Check 21, equations A1 and A2 were reestimated in levels and with differencing using AR1. Although the R^2s were .96 or higher, the RHO (differencing) values were statistically significant and varied between .30 and .50. And while the degrees of freedom were in the low to high 30s (depending on the equation estimated), neither of the above GAO "tests" for significant cost reduction from Check 21 was met. This applied when the two equations were estimated in levels or with AR1(using either a Cochrane-Orcutt or maximum likelihood procedure). Thus having a limited number of quarters when Check 21 was in operation is not the reason why the GAO did not find that Check 21 led to a significant reduction in check costs. Instead, the reason lies in the approach used by the GAO to determine the cost effect of Check 21.

Simply put, the GAO was testing to see if the overall total cost of paper checks and Check 21 activities together, after accounting for changes in total check and return item volume, fell from the 3rd quarter of 2004 to the end of 2007. This is equivalent to seeing if the unit cost of paper checks and Check 21 items together–an overall measure of average cost–fell over the GAO's time period. In contrast, we have focused on determining the average cost of paper checks and Check 21 items separately (rather than together). The GAO used a dummy variable to see if there was a general reduction in payment costs as Check 21 items replaced paper checks.

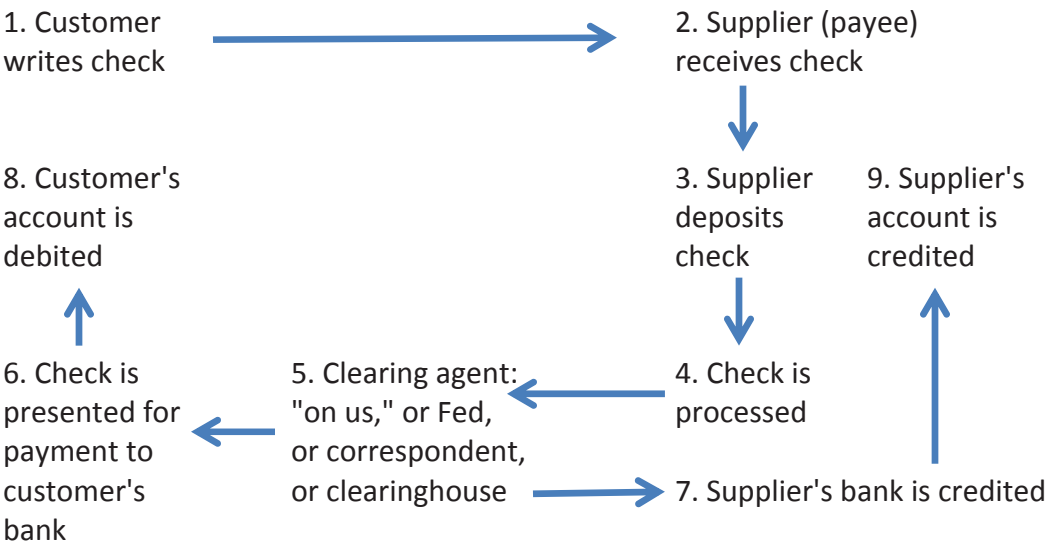
As seen in Figure 5, overall average costs (dashed line) rose from 4.3 cents per item in 1998 (reflecting only paper check costs) and reached a peak of 13.5 cents at the end of 2007 when the share of Check 21 items was 58% of total checks. As overall average cost rose and was almost always higher than it was initially, it is not surprising that the dummy variable approach did not identify a significant cost reduction. Our extension of the time period to the end of 2010 when the share of Check 21 items was 99.6% and overall average cost had by then fallen to 2.2 cents did not change this result. This was because for 22 out of the 25 quarters when the dummy variable was non-zero, overall average cost was higher than it was immediately before the dummy took a non-zero value.

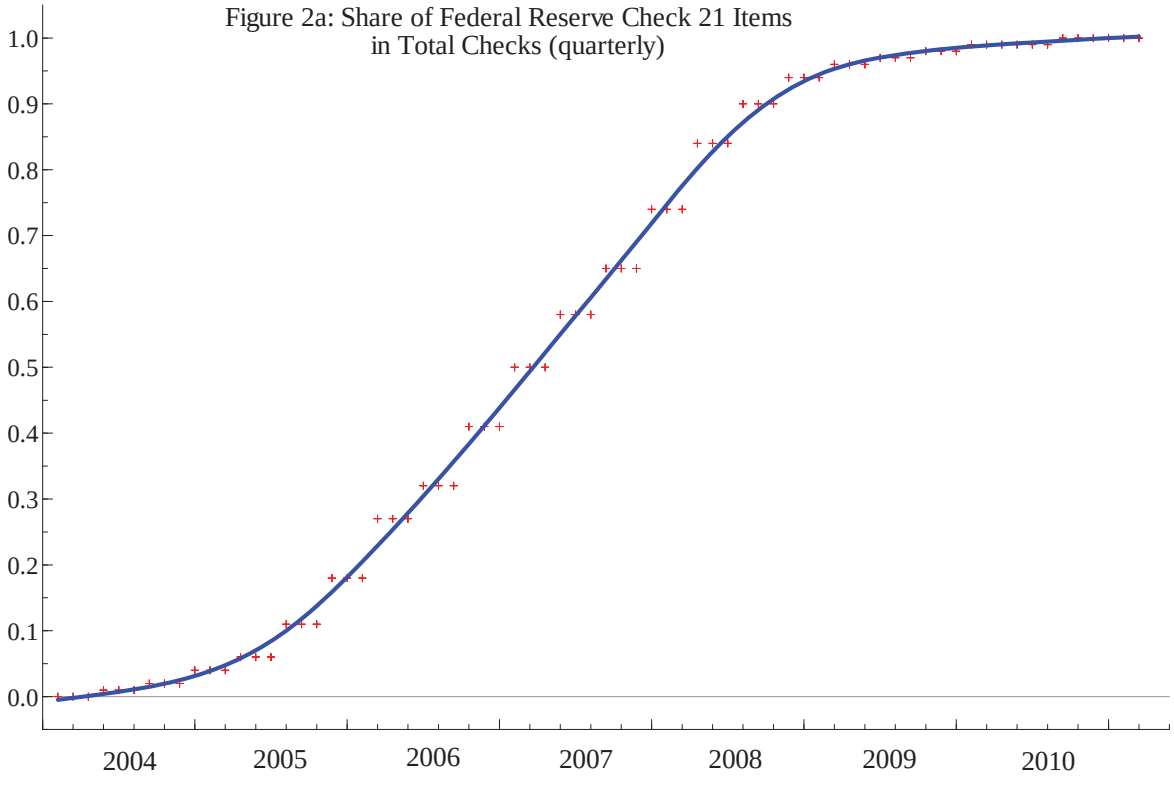
(insert Figure 5 here)

As explained earlier in this paper, Figure 3 shows that as paper check volume fell, its unit costs rose due to a reversal of pre-existing scale economies, while scale economies associated with expanding Check 21 volume led to initial reductions in their unit cost. As paper check costs were markedly higher than

Check 21 costs, the overall average cost of paper and Check 21 items together (dashed line) remained higher than it was before Check 21 was implemented. Only when paper checks were 1% of all items did the overall average cost fall below what it was prior to the 3rd quarter of 2004 (when the GAO dummy variable started to be non-zero). In focusing on an overall average cost measure, the GAO was not able to see that Check 21 unit costs were markedly lower than those for paper checks. This difference in unit cost clearly shows that Check 21 lowered check processing costs regardless of the effect of a declining volume on paper check costs due to a reversal of their scale economies. If paper check average costs had remained stable rather than increased, the GAO would have found that overall average costs had fallen over the time period it looked at. Neglecting to account for the influence of scale economies as paper check volume fell influenced the GAO's results.

Figure 1: The Check Clearing Process





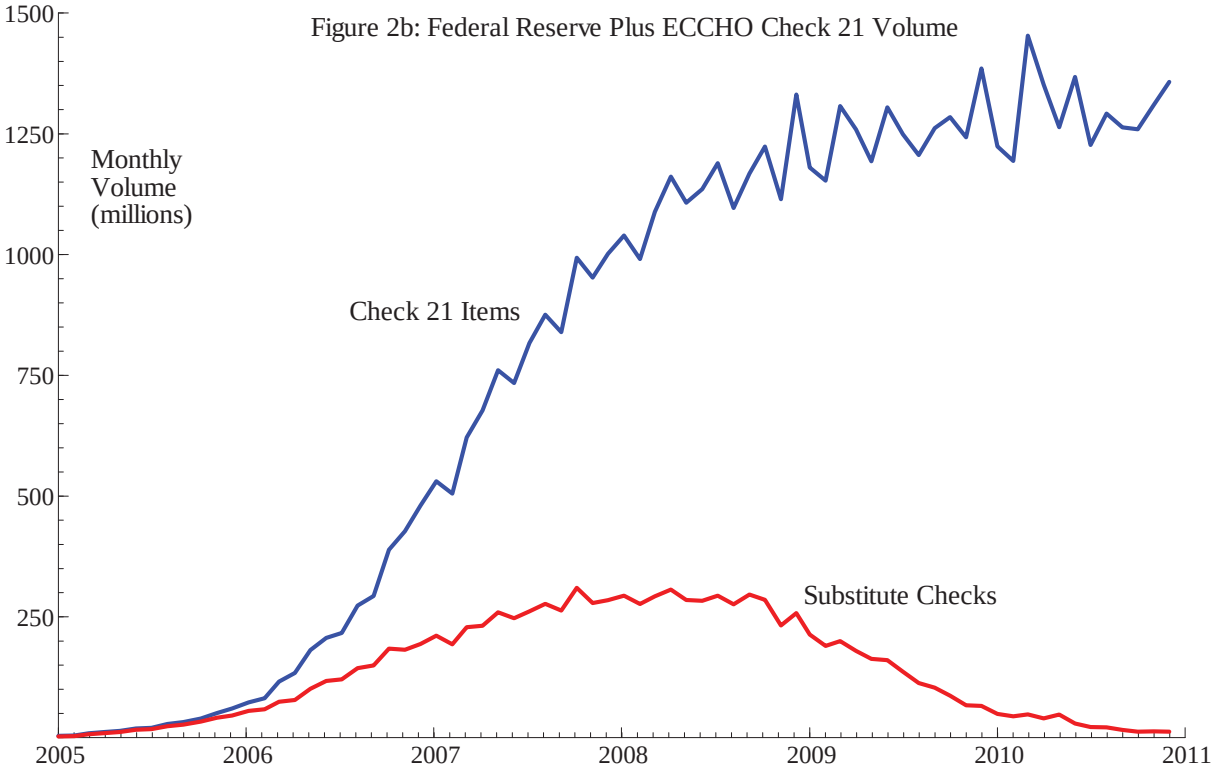


Figure 2b: Federal Reserve Plus ECCHO Check 21 Volume
Monthly
Volume
(millions)
Check 21 Items
Substitute Checks
1500
1250
1000
750
500
250
2005
2006
2007
2008
2009
2010
2011

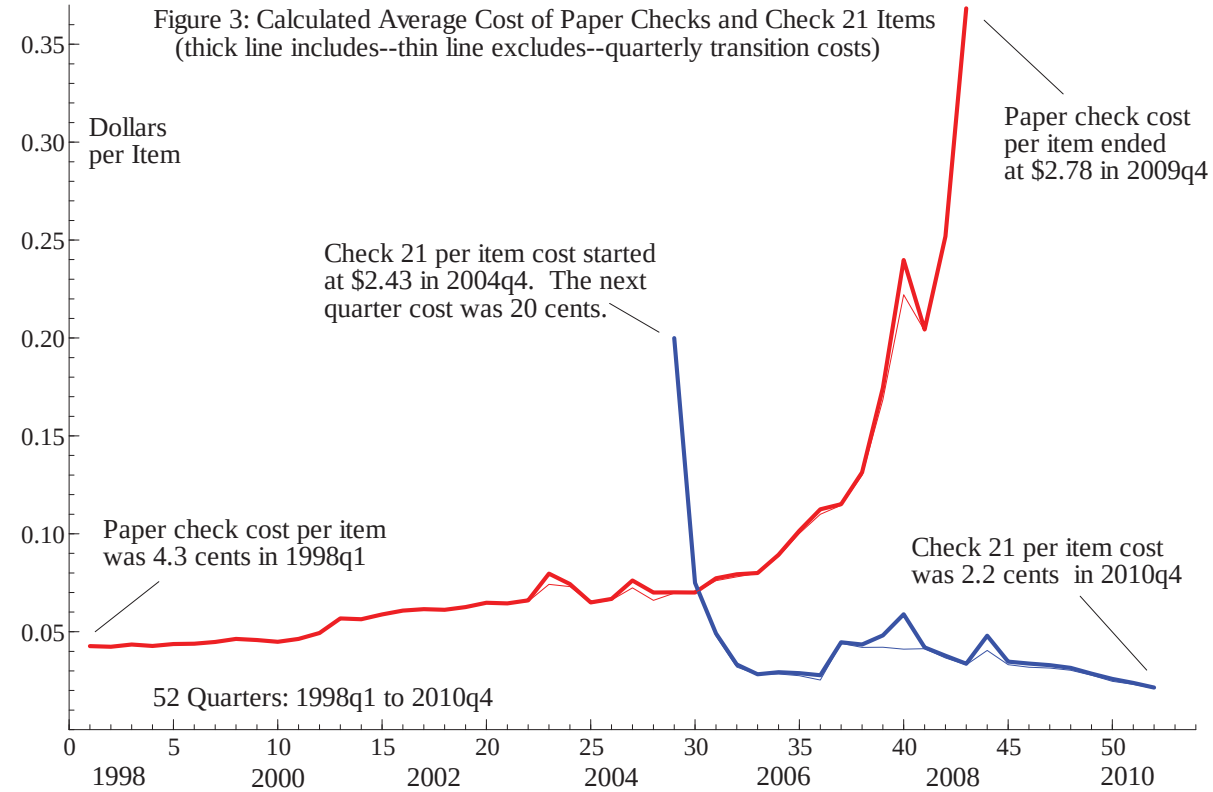


Figure 3: Calculated Average Cost of Paper Checks and Check 21 Items
(thick line includes--thin line excludes--quarterly transition costs)
Dollars
per Item
Paper check cost
per item ended
at $2.78 in 2009q4
Check 21 per item cost started
at $2.43 in 2004q4. The next
quarter cost was 20 cents.
Paper check cost per item
was 4.3 cents in 1998q1
Check 21 per item cost
was 2.2 cents in 2010q4
52 Quarters: 1998q1 to 2010q4
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
5
10
15
20
25
30
35
40
45
50
1998
2000
2002
2004
2006
2008
2010

Figure 4: Average Cost against Quarterly Check Volume
(Paper Checks and Check 21 Items, 1998-2010)

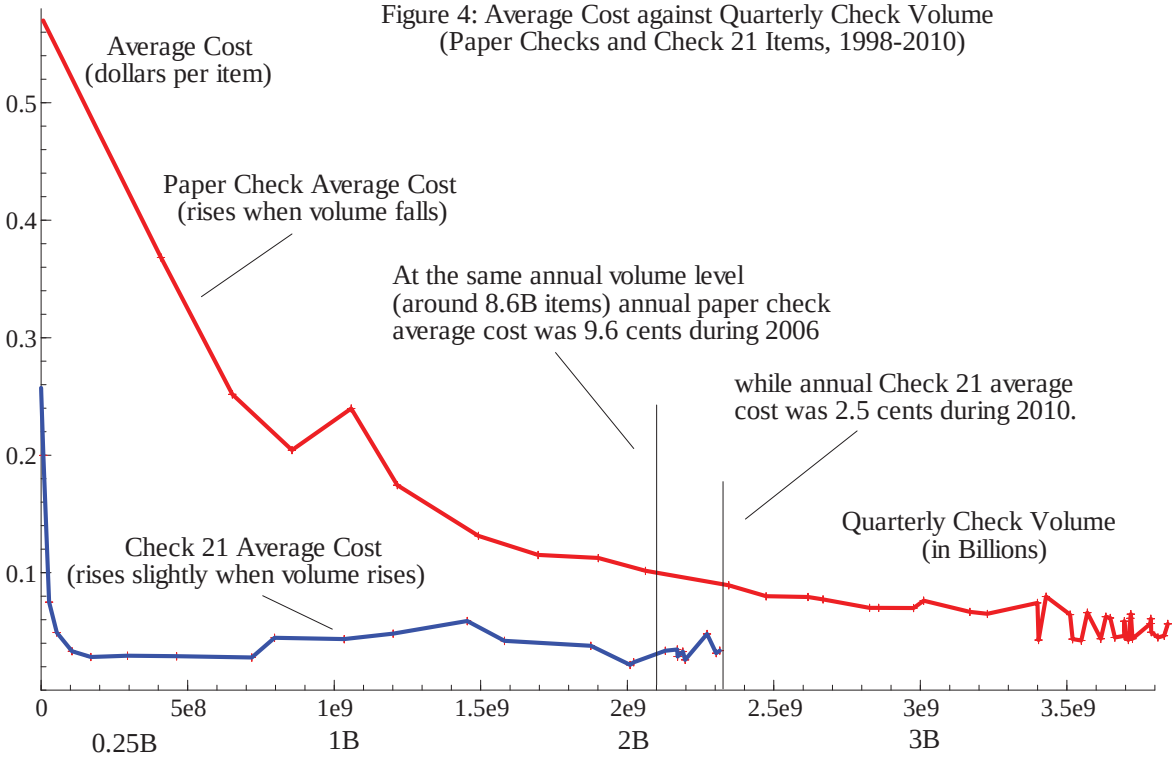


Figure 5 Average Cost against Time
(Paper Checks, Check 21, and Overall Average, 1998-2010)