The following is a redacted version of the original report. See inside for details.

B2B

How the next payments frontier will unleash small business

Global business drives over $120 trillion of B2B commerce annually – but managing this trade is far from efficient. In the US, nearly 70% of B2B volume is still paid by paper checks, which cost up to $22 to process. Businesses incur over $2.7 trillion in B2B administrative costs – 80% of which is paid by small business. But a new generation of payment and software solutions is emerging which promises to cut costs by up to 75% and unleash $1.5 trillion in small business productivity.

James Schneider, Ph.D.
+1 917 343-3149
james.schneider@gs.com
Goldman Sachs & Co. LLC

Bill Schultz
+1 212 902-0044
bill.schultz@gs.com
Goldman Sachs & Co. LLC

Julia McCrimlisk
+1 917 343-2456
julia.mccrimlisk@gs.com
Goldman Sachs & Co. LLC

Jesse Hulsing
+1 415 249-7464
jesse.hulsing@gs.com
Goldman Sachs & Co. LLC

Ryan M. Nash, CFA
+1 212 902-8963
ryan.nash@gs.com
Goldman Sachs & Co. LLC

The Goldman Sachs Group, Inc.

Table of Contents

Executive summary	3
Setting the stage: The B2B market landscape	6
Today's B2B market: Significant direct and indirect cost burdens, borne by small business	8
How can payment and software solutions help?	15
Who can make money and how much?	25
Challenges in the adoption of B2B payment solutions	28
Disclosure Appendix	30

Note: The following is a redacted version of "Global Technology: B2B: How the next payments frontier will unleash small business" originally published September 16, 2018 [48pgs]. All company references in this note are for illustrative purposes only and should not be interpreted as investment recommendations.

Executive summary

B2B Payments: The biggest untapped market opportunity for the payments industry

We believe B2B payments currently account for $127tn in payment flows - and we expect this figure to reach nearly $200tn by 2028, over 5X the volume of the retail payments market. With the vast majority of invoices still processed manually and paid by paper check, we see significant opportunities for business to reduce costs - creating new revenue pools for payment and software companies entering the market with faster, lower-cost invoice processing and payment solutions. While large businesses and enterprises account for over half of B2B payment flows, we see the biggest revenue and cost savings opportunities for small business, where 80% of invoices are still manually processed and paid by check.

B2B solutions can unleash nearly $1.5 trillion in productivity for global small business

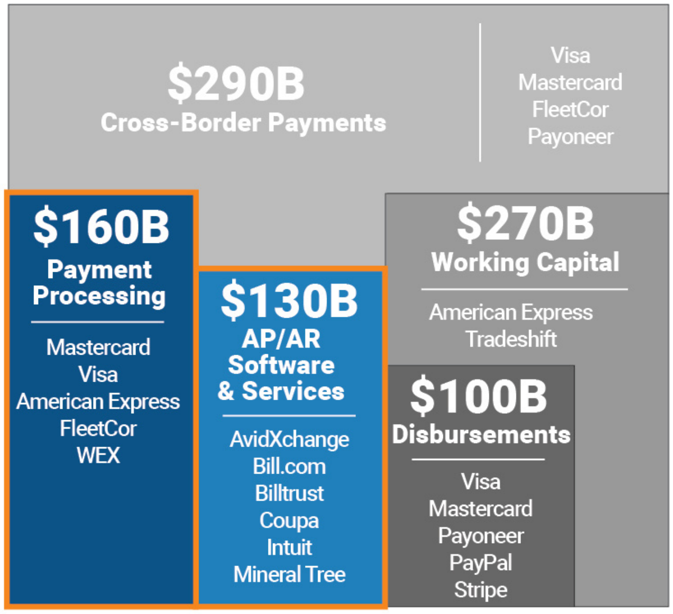
Today, the majority of global businesses still depend on manual, paper-based payment processes that command a steep price tag in terms of time, money, and operating friction. We estimate businesses in North America spend $187bn annually on accounts payable ("AP") processing - and this estimate captures only direct processing and labor costs. We believe these same businesses are spending closer to $510bn after taking indirect costs - such as short-term credit and additional fees for cross-border transactions - into account. North America represents only a fraction of the B2B market - and we believe the total global costs related to AP amount to over $2.7tn.

While thus far the digitization of B2B payment flows has been slow - especially among small business - we believe the market is finally poised to accelerate. We see several technological and market changes driving this acceleration, including the adoption by small business of software-based general ledger and accounting systems, the broader emergence of real-time payment infrastructure, and the introduction of novel business and financing services.

The opportunity: A fresh $1 trillion revenue opportunity in payments & software

We see a significant revenue opportunity for payments companies, software companies, and banks to capture meaningful market share over time, while simultaneously driving substantial cost savings for business. In total, we see a $950bn global revenue opportunity (with an estimated $186bn in North America) across invoice processing, AP payment processing, working capital management and factoring, and cross-border payment optimization. Our analysis assumes that B2B payment solutions can drive up to 75% savings in total costs (both direct and indirect) for business, with more savings accruing to small businesses than enterprises.

Exhibit 1: B2B market landscape with key public and private players



Source: Goldman Sachs Global Investment Research

The Future of B2B Payments in Numbers

B2B Payments Volumes

Today → **By 2028**

$127 trillion → **$200 trillion**

We estimate global B2B volumes will reach over 5 times the business-to-consumer market over the next decade.

Accounts Payable (AP) Costs Today

$2.7 trillion

What businesses are spending on manual, paper-based payment processing, which is a big burden in terms of time and money.

Small Business Bears the Brunt …

80%

SMBs account for this much of the total annual spending on labor and accounts payable processing.

Paper Checks Still Dominate

60% Our estimate for the total number of B2B payments still made by check.

Vs.

80% Our estimate for the number of small/medium-size business payments made by check.

But AP Automation Can Cut Costs Up to…

75%

The potential net savings for businesses who adopt AP automation solutions.

The Revenue Opportunity

$950bn

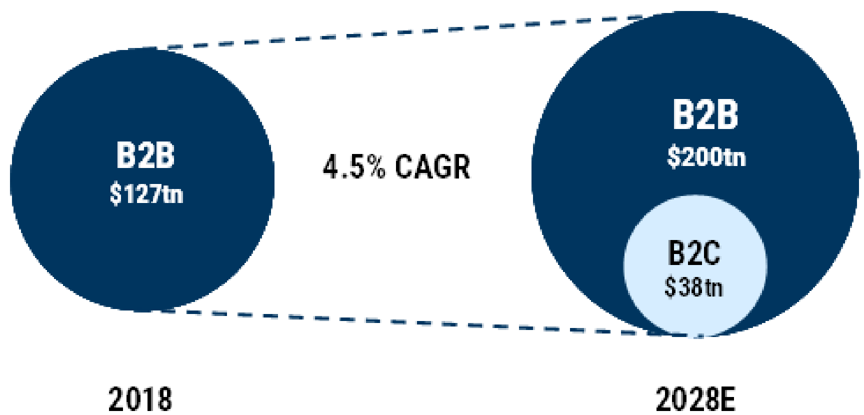
Across the B2B payments universe, we see the largest revenue opportunities in AP invoice processing, AP payment processing, working capital management and factoring, and cross-border payment optimization.

Setting the stage: The B2B market landscape

We estimate that B2B payments currently account for nearly $127tn in payment flows - and expect this figure to reach nearly $200tn by 2028, over 5X the volume of the retail payments market. With the majority of invoices still processed manually and paid by paper check, we see significant cost savings opportunities for businesses plus significant new revenue pools for payments and software companies entering the market with faster, lower-cost invoice processing and payment solutions. Although large businesses and enterprises account for over half of B2B payment flows, we see the biggest cost savings and industry revenue opportunities for small businesses, where 80% of invoices are still manually processed and paid by check.

We estimate that B2B payment volumes will reach $200tn by 2028 - five times the size of the B2C market. We believe global B2B payments account for $127tn in payment volume today and will reach $200tn in ten years. We believe North America currently accounts for 20% of the B2B market or $26tn in payment volume.

Exhibit 2: We estimate B2B volumes will reach $200tn in the next decade, 5X the size of B2C volumes
Global payment volume estimates, 2018 vs. 2028

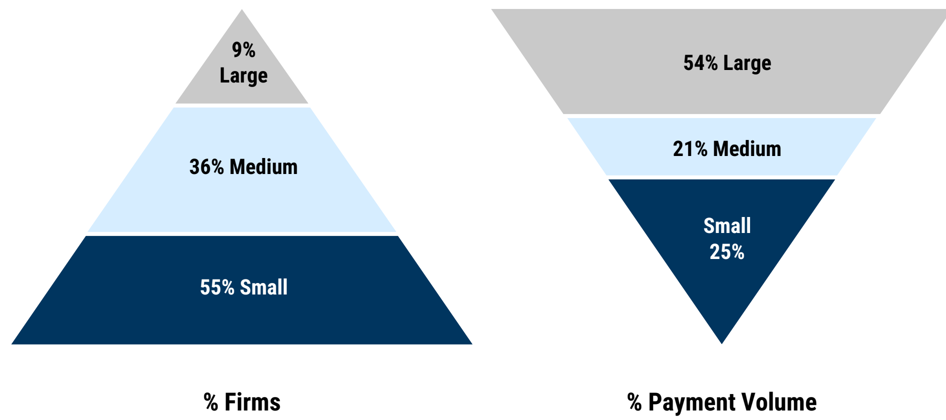


Source: Goldman Sachs Global Investment Research

Large businesses generate just over half of payment volumes...

In the United States, B2B payment flows are dominated by enterprises and large businesses (over $500mn in revenue), even though less than 10% of firms fall into this category. We estimate that small businesses (under $25mn revenue) account for only a quarter of B2B payment volumes even though over half of all US businesses fall into this category. We use US firm demographics as a proxy for North America (United States, Canada, and Mexico). Similar to the US and North America, we believe large businesses generate the majority of global B2B volumes - although we believe the international business mix is more heavily skewed towards small businesses.

Exhibit 3: SMBs represent over 50% of firms, but large businesses generate over 50% of payment volume
Distribution of US firms by size; distribution of US payment volume by firm size



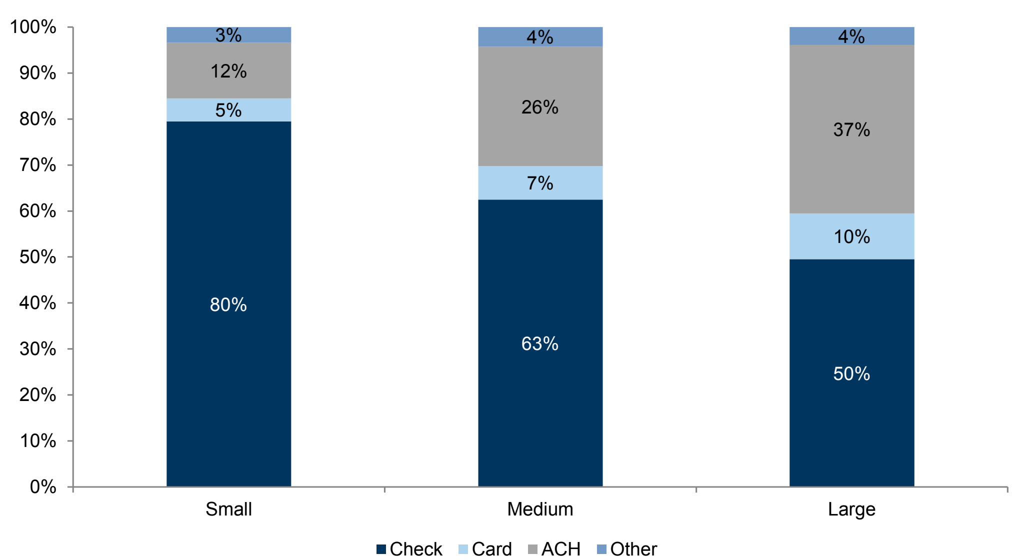
We define business by revenue size as follows: Small business under $25mn, medium business $25-$499mn, large business $500mn+.

Source: Visa, US Census Bureau, Goldman Sachs Global Investment Research

...and paper checks dominate the market today.

Overall, we estimate that nearly 60% of B2B payments in North America are still made with paper checks. While this varies by company size – we estimate checks account for up to 80% of small/medium-size business payments vs. roughly half of large business payments – paper checks remain the dominant form of payment across markets despite generating process inefficiencies and high overhead costs. Digital payment forms - including ACH and card - account for only 36% of B2B payments today.

Exhibit 4: We estimate checks still account for approximately 60% of B2B payments in North America
B2B payments mix by firm size, North America 2018



We define businesses by revenue as follows: Small businesses under $25mn, medium businesses $25-$499mn, large businesses $500mn+.

Source: Goldman Sachs Global Investment Research

Today's B2B market: Significant direct and indirect cost burdens, borne by small business

Today, the majority of businesses still depend on manual, paper-based payment processing, which represents a significant cost burden in terms of both time and money. We estimate businesses in North America are spending $187bn annually on accounts payable ("AP") processing - and this estimate only captures direct processing and labor costs. In reality, we believe businesses are shouldering up to $510bn in B2B payments costs when including indirect costs such as short-term credit for receivables financing and cross-border transaction fees. We believe the total direct and indirect B2B payments cost borne by global business is nearly $2.7tn.

Exhibit 5: We estimate businesses spend over $510bn in North America and $2.7tn globally on AP
Estimates for direct and indirect manual AP costs

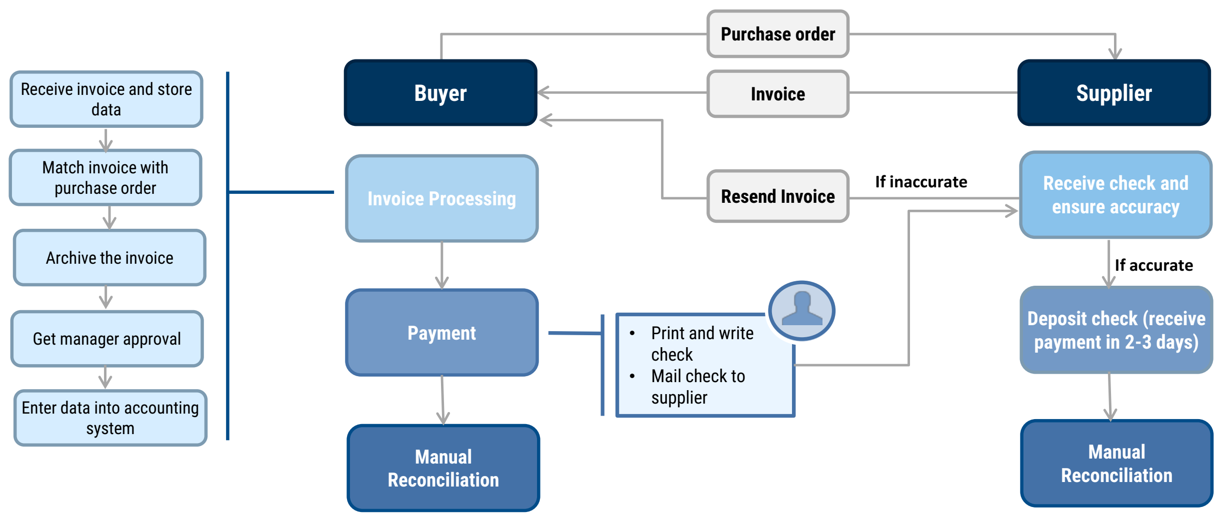
Cost per invoice using a manual AP management process		North America			World
	Small	Medium	Large	Total	Total
Payment volume ($bn)	**$6,500**	**$5,460**	**$14,040**	**$26,000**	**$127,320**
Average invoice ($)	$1,000	$3,000	$10,000		
Invoices (mn)	6,500	1,820	1,404		
Direct costs	**Small**	**Medium**	**Large**	**Total**	**Total**
Processing cost					
Average processing cost per invoice	$1.47	$1.31	$1.16		
Total processing cost ($bn)	**$10**	**$2**	**$2**	**$14**	**$66**
	0.1%	0.0%	0.0%	0.1%	0.1%
Headcount Costs					
Invoices processed per month	1,000	3,000	10,000		
Average headcount cost per invoice	$20.79	$14.69	$8.23		
Total headcount cost ($bn)	**$135**	**$27**	**$12**	**$173**	**$849**
	2.1%	0.5%	0.1%	0.7%	0.7%
Direct cost per invoice	**$22.26**	**$16.00**	**$9.39**		
Total direct cost ($bn)	**$145**	**$29**	**$13**	**$187**	**$916**
Total cost (%)	2.2%	0.5%	0.1%	0.7%	0.7%
Indirect costs	**Small**	**Medium**	**Large**	**Total**	**Total**
Cross-border cost					
Cross-border volume				$3,941	$23,099
Cost (% volume)				4.4%	4.4%
Total cross-border cost ($bn)				**$174**	**$1,020**
Cash management cost					
Inventory financing cost ($bn)				$125	$610
Late fees ($bn)				$25	$122
Total cash management cost ($bn)				**$150**	**$732**
Total indirect cost ($bn)				**$324**	**$1,752**
Total direct + indirect costs ($bn)				**$511**	**$2,668**

Source: Goldman Sachs Global Investment Research

Manual processing: The direct costs

Traditional payables processes are labor-intensive and inefficient, with manual intervention needed to receive and approve the invoice as well as to make the payment and reconcile accounts. In the exhibit below, we outline a typical manual accounts payable process. Opportunities to automate these processes can yield significant cost savings.

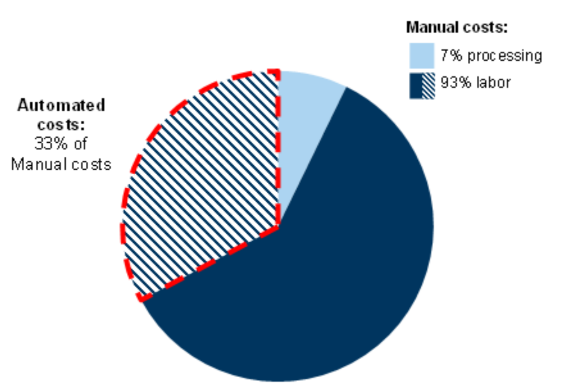
Exhibit 6: Labor accounts for over half the costs in a traditional, manual AP process
Manual accounts payable process



Source: Goldman Sachs Global Investment Research

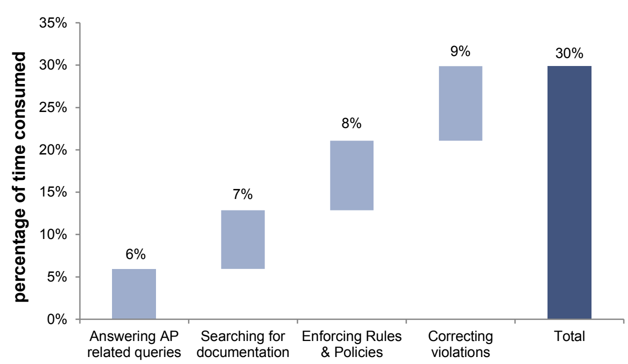
Labor is the most significant single driver of these costs - we estimate it accounts for over 90% of direct costs incurred. According to a survey by Hyland Software, AP employees spend an average of 30% of their time collecting data (e.g., purchase orders and invoices) and answering questions from employees, collectors, or vendors related to the AP process . Employees also spend a significant amount of time resolving issues that arise from input errors and tracking down managers for approval. These pain points significantly increase the cost of AP processing.

Exhibit 7: We estimate automated costs are only 33% of manual costs, mainly due to the elimination of significant labor costs
Comparison of manual costs (processing + labor) to automated costs



Source: Goldman Sachs Global Investment Research

Exhibit 8: Accounts payable personnel spend ~30% of their time on routine tasks
AP team work



Source: Hyland Software

Key pain points in manual AP processing include:

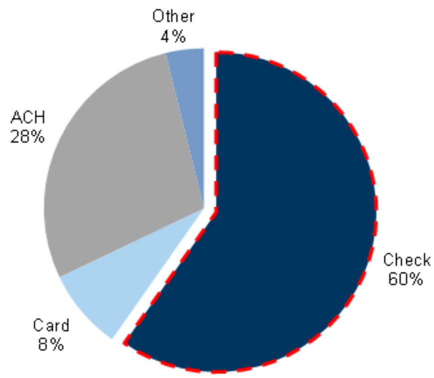
- **Invoice intake:** Invoices are not standardized across suppliers and instead are received in a huge variety of paper and electronic formats with non-standardized data fields. According to AvidXchange, 56% of invoices are received in a manual format (paper, PDF, email, or fax).
- **Data capture:** Given the abundance of non-standard invoice data, data often needs to be manually entered into a company's accounting and ERP systems. This process is costly - both in terms of labor and missed cost-savings opportunities - and prone to human error.
- **Matching:** Invoices must be matched against purchase orders and/or contracts. This process is highly manual, especially when purchase orders/contracts are housed in different systems or departments and prone to errors. Unmatched invoices need to be resolved, which often requires a lengthy dispute resolution process.
- **Approval:** Managers or department heads are frequently called upon to approve invoices for payment and resolve disputes, but tracking down the appropriate personnel can be slow and often results in missed discounts or late payments. This is particularly burdensome for small businesses, where executive officers average 5-10 times higher hourly rates than AP managers, as it substantially increases all-in labor costs.
- **Reporting:** Many companies have multiple back-office systems (purchasing systems, accounting software, ERP systems) that are not integrated with payment and invoicing data flows. This duplicates the data entry process and increases the likelihood of errors.

In 2015, Traxpay reported that 60% of B2B payments require some form of manual intervention that takes at least 15-20 minutes. Manual intervention - to resolve data entry errors, matching errors, duplicate payments - is a slow process that compounds labor costs and causes companies to miss rebates, pre-payment discounts, and even pay late fees.

Paper checks

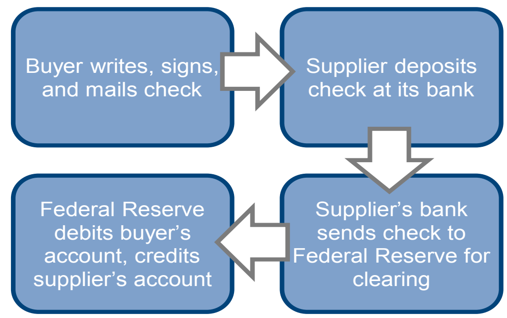
We believe 60% of B2B payments are still made by check, despite the fact checks create maximum inefficiencies for both buyers and suppliers. For the buyer, printing the check, obtaining the required signatures, and mailing the check is a manual, time-consuming process. We estimate the supplies alone (paper, postage) cost $1.55/check. For suppliers, checks can cost $7-$10 to process (Billtrust) and take 3-5 days to settle, increasing a supplier's days payables outstanding (DPO).

Exhibit 9: 60% of B2B volume still flows through checks
B2B payment mix



Source: Goldman Sachs Global Investment Research

Exhibit 10: Check processing



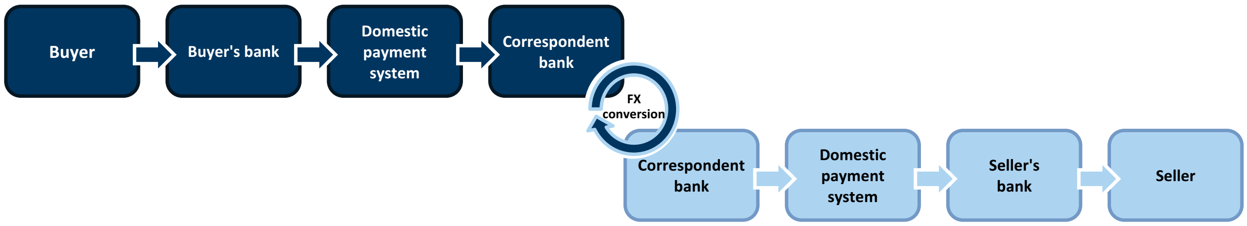
Source: Goldman Sachs Global Investment Research

Indirect costs more than double spending on accounts payable

Cross-border payments

Funds cannot be directly transferred between banks in different countries. Instead, funds must be routed through correspondent banks, which have relationships with both the sending and receiving banks. This process is slow, transactions can take 3-5 days to clear, and costly. We estimate the transaction and FX fees average 4.0% - 4.5% of volume.

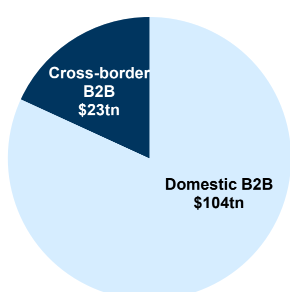
Exhibit 11: The majority of cross-border payments flow through correspondent banks, which charge hefty settlement and FX fees
Bank-to-bank cross-border payment flow



Source: Goldman Sachs Global Investment Research

Based on WTO estimates of global goods and services trade flows, we believe cross-border volumes account for nearly one-fifth of B2B payments. With non-bank cross-border payment rails just beginning to emerge, we believe over 95% of cross-border volume still flows through banks. Assuming an average transaction size of $5,600 (per our analysis of SWIFT transaction data), bank fees of $35-$50 per transaction (consistent with industry data), and a FX spread, we estimate bank transfers generate around $1tn of revenue.

Exhibit 12: Nearly one-fifth of B2B volume flows cross-border...
B2B volume, 2018



Source: World Trade Organization, Goldman Sachs Global Investment Research

Exhibit 13: ...yielding roughly $1tn in revenue
Estimated revenue from B2B cross-border bank transfers

Cross-border opportunity	Revenue	% revenue
Cross-border volume ($bn)	$23,099	
via banks	$21,944	95%
via alternate providers	$1,155	5%
Cost to send via Bank		
Number of transactions		
Daily transactions ('000s)	15,105	
Annual transactions ('000s)	3,927,201	
Average transaction value ($)	$5,588	
Cost per transaction	$45	0.81%
FX margin	$189	3.38%
Total cost to send ($bn)	**$917**	**4.18%**
Cost to receive via Bank		
Average cost to receive transaction	$23	
Annual transactions ('000s)	3,927,201	
Total cost to receive ($bn)	**$88**	**0.40%**
Total cost via bank ($bn)	**$1,006**	**4.58%**
Total cost via alt. provider ($bn)	**$14**	**1.25%**
Total cost - Current ($bn)	**$1,020**	**4.42%**

Source: World Trade Organization, SWIFT, McKinsey, Goldman Sachs Global Investment Research

Cash flow/working capital management

Manual AP processing is time consuming, often causing buyers to miss pre-payment discounts, rebates, or pay late fees. We estimate that each year late fees cost businesses an average of $25bn in North America and $122bn globally. Our estimates assume 5% of all invoices are 30 days past due.

Suppliers often do not receive payments until 30-60 days after sending an invoice or providing a service. This makes it difficult for small businesses, which often run with minimal working capital buffers, to manage cash and maintain minimum liquidity thresholds needed to operate. Many small businesses have to either rely on (1) a credit line – which can carry substantial interest costs, or (2) invoice factoring services – which purchase receivables at a steep discount.

- Small businesses draw on both commercial and personal credit lines. APRs for small business loans and credit cards typically run in the mid- to high-teens, depending on credit score, while APRs for personal credit cards can run in excess of 20%. With US payment terms averaging 30 days, interest costs add up quickly – we estimate small businesses could spend anywhere from $600 to over $850 just to cover a one-month $50,000 shortfall.
- Invoice factoring services offer an alternative to credit lines – allowing businesses to sell outstanding invoices at a discount in exchange for cash. The process is fairly straightforward: factoring companies advance a certain percentage of the invoice (typically 70-90%) in cash and pay back the remainder of the invoice – less the factoring fees – after the customer pays. The factoring fee can be a flat fee, a tiered fee based on the length of time the invoice is outstanding, or a "prime plus" fee where interest is accrued each day the invoice is outstanding. Below, we provide an illustrative example of the potential loss if a business sells a $50,000 invoice to a factoring company under each of these three models.

Exhibit 14: Cost to carry $50,000 credit for 30/60/90 days

	APR	Cost to carry		
	Average	30 days	60 days	90 days
Business Loan	14.99%	$616	$1,232	$1,848
Commercial credit card	17.99%	$739	$1,479	$2,218
Personal Loan	14.99%	$616	$1,232	$1,848
Personal credit card	21.12%	$868	$1,735	$2,603

Source: American Express, JP Morgan, Goldman Sachs Global Investment Research

Exhibit 15: Cost to sell $50,000 invoice to a factoring company

Assumptions

Invoice value	$50,000
Prime rate	5.0%

Factoring model

	Fee	30 days	60 days	90 days
Flat fee	5.0%	$2,500	$2,500	$2,500
Fee		*5.0%*	*5.0%*	*5.0%*
Tiered fee	2.0% per month	$1,000	$2,000	$3,000
Fee		*2.0%*	*4.0%*	*6.0%*
Prime plus	prime + 5.0%	$417	$833	$1,250
Fee		*0.8%*	*1.7%*	*2.5%*

Source: Goldman Sachs Global Investment Research

Ultimately, we believe businesses spend over $125bn in North America on supply chain financing and over $610bn worldwide. Our estimates assume SMBs turn to short-term financing solutions (30 days at a 9% average APR) to finance around a third of their invoices each quarter, while large businesses do not use supply chain financing solutions.

Exhibit 16: We believe businesses in North America spend over $125bn on supply chain financing...
North America financing costs ($bn)

Mths/yr need financing	% invoices financed: 10%	20%	30%	40%	50%
2	$44	$64	$83	$103	$122
3	$55	$79	$104	$128	$153
4	$66	$95	$125	$154	$183
5	$77	$111	$145	$179	$214
6	$88	$127	$166	$205	$244

We assume businesses pay a 1-2% annual fee to access 30-day financing at a 9.00% APR.

Source: Goldman Sachs Global Investment Research

Exhibit 17: ...and global businesses are collectively spending over $610bn
Global financing costs ($bn)

Mths/yr need financing	% invoices financed: 10%	20%	30%	40%	50%
2	$216	$311	$407	$502	$598
3	$270	$389	$508	$628	$747
4	$324	$467	$610	$753	$897
5	$378	$545	$712	$879	$1,046
6	$432	$623	$814	$1,005	$1,196

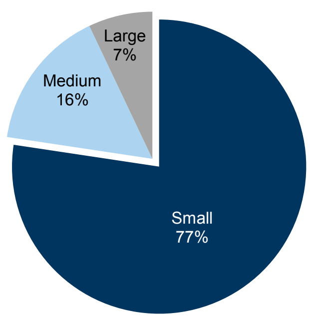
We assume businesses pay a 1-2% annual fee to access 30-day financing at a 9.00% APR.

Source: Goldman Sachs Global Investment Research

Small businesses bear the brunt of AP costs

Accounts payable processing benefits significantly from economies of scale. As such, we believe small businesses account for nearly 80% of spending on labor and accounts payable processing. Consequently, they stand to benefit the most from AP automation.

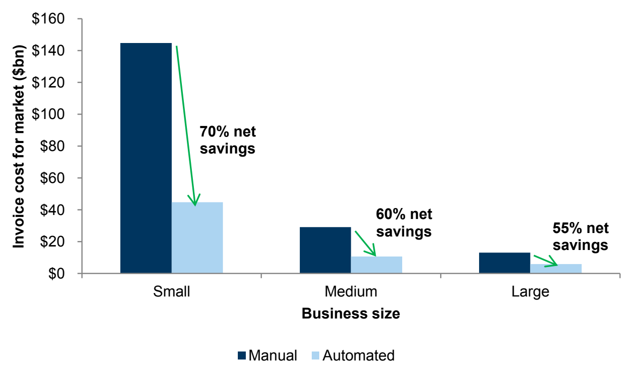
Exhibit 18: Small businesses spend the most on AP...
Total spend on AP by company size



We define businesses by revenue as follows: small businesses <$25mn, medium businesses $25-499mn, large businesses $500mn+.

Source: Goldman Sachs Global Investment Research

Exhibit 19: ...positioning them to be the biggest beneficiaries of AP automation
Estimated net savings by business size



Source: Goldman Sachs Global Investment Research

How can payment and software solutions help?

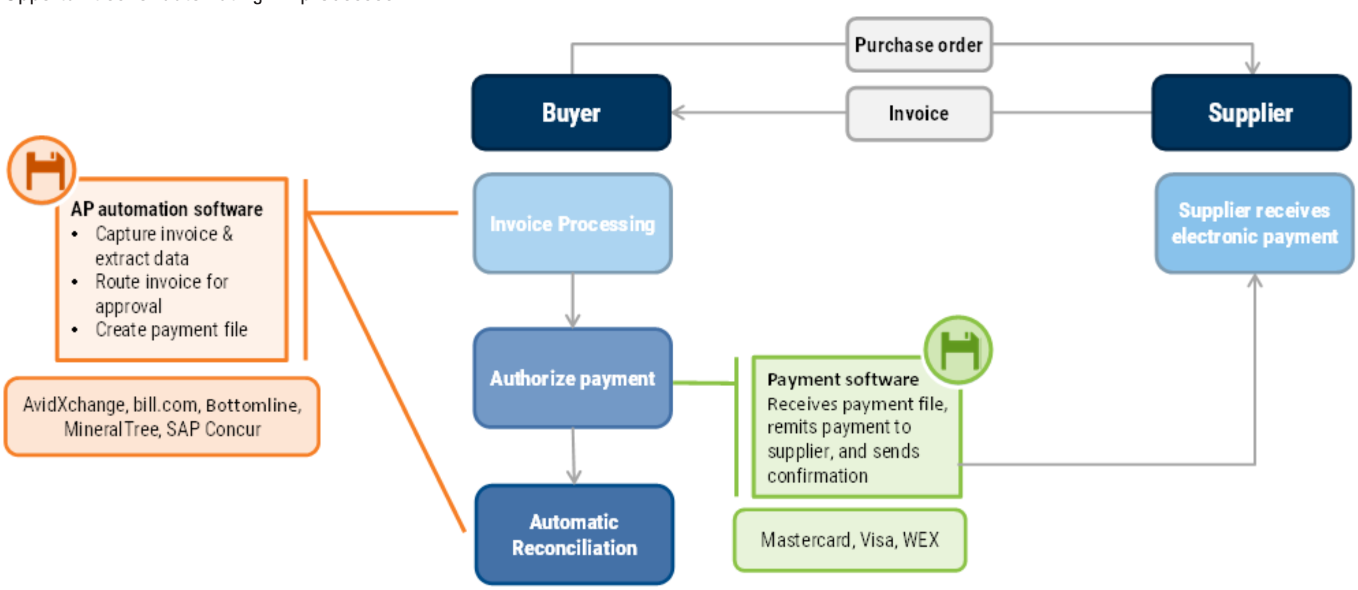
Today, organizations are focused on automating accounts payable processes to generate G&A savings. We see this as the biggest near-term opportunity in B2B payments, but over the longer term see significant opportunities for specialist providers to supply working capital and cash management solutions.

Payables automation

Managing the AP process is a significant hurdle and cost center for many businesses. Numerous solutions have emerged to address different pain points in the payables process:

- **Pre-payment solutions** are improving the procurement process, aggregating bills, automating invoice processing, and streamlining approval workflows.
- **Payment solutions** are replacing manual check payments with electronic alternatives including ACH, card, virtual card, and push payments.
- **Post-payment solutions** are helping companies with account reconciliation and cash management.

Exhibit 20: Numerous solutions have emerged to streamline pre-/post-payment workflows and facilitate payments
Opportunities for automating AP processes

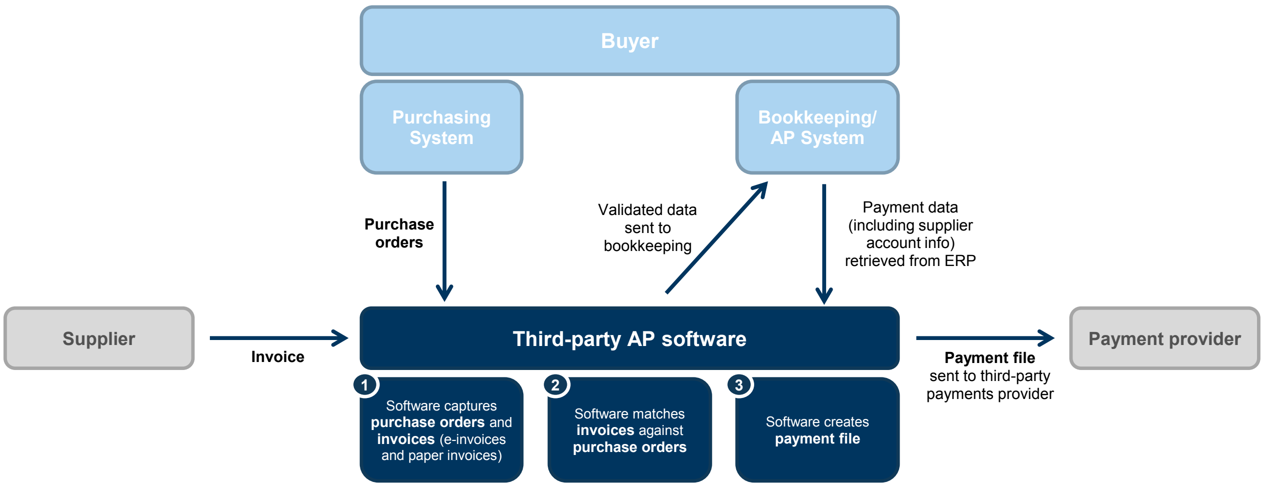


See "Who can make money and how much?" for a detailed breakdown of different vendors' AP processing and reconciliation solutions

Source: Goldman Sachs Global Investment Research

These pre- and post-payment solutions often integrate directly with a company's existing back office software.

Exhibit 21: These solutions integrate directly with a company's back office software
Typical ERP integration



Source: Basware, Goldman Sachs Global Investment Research

Payment Solutions: Cutting the cost burden of paper checks

To reduce the pain points associated with paper checks, providers are pushing a variety of electronic payment alternatives including ACH/EFT, cards, virtual cards/single-use accounts, and push payments. We summarize these four alternatives below:

- **ACH:** In ACH transactions, funds are transferred between bank accounts over the Automated Clearing House (ACH) network – an electronic payment network. Typically, the buyer sends payment instructions to its bank. The buyer's bank bundles all of the ACH requests it has received and sends them to the ACH operator. The ACH operator then distributes these requests to the appropriate receiving banks.

  ACH has been gradually taking share from paper checks and, based on a survey by the CRF and NACHA, is expected to exceed check volume by 2020. However, ACH remains slow due to wide technology gaps between the 12,000+ banks in the United States. Transfers typically take one to two days to process and clear, and ACH records provide limited detail on the nature of the transaction (sender, recipient, amount). The lack of underlying transaction details (such as the specific item being invoiced) makes it difficult to reconcile payments.

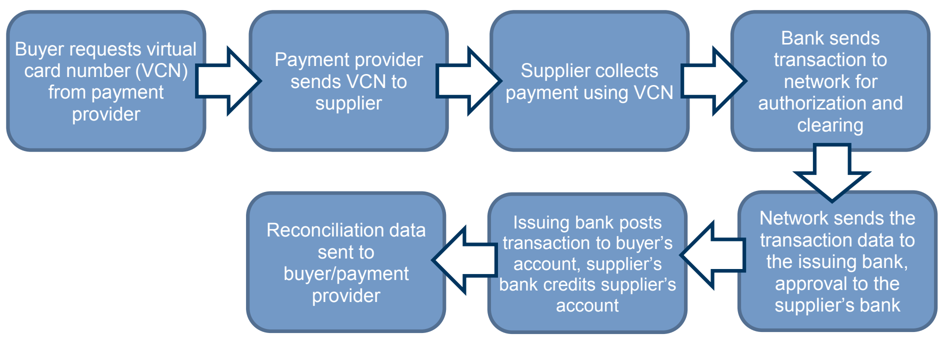
- **Cards:** B2B card payments (travel and entertainment, fleet, P-cards, etc.) operate the same way as B2C card payments. The supplier charges the card, and the supplier's gateway/acquirer captures the request and sends it to the acquiring bank. The acquiring bank sends a request to the issuing bank over the card network, and the issuing bank decides whether or not to authorize the transaction. Authorization is then sent back over the card network to the acquiring bank and through the acquirer to the merchant.

Although corporate credit cards first emerged in the 1970s, their usage continues to grow at a rapid clip - with US commercial card volume outpacing US consumer card volume growth by about 110bps in 2017.

- **Virtual cards/single-use accounts:** A virtual card is a single-use account number that processes against a predetermined credit limit equal to the amount to be paid. The virtual card is created by an application that can be hosted by a payment provider, bank issuer, or the card network. The virtual card application provides a secure, convenient way for users to sign in, request a card, and specify how it will be used (including things like amount, timeframe, supplier name, number of transactions). Virtual card payments can either be made in real-time or in batches.

  Virtual card transactions include rich remittance data that makes it easier for suppliers to reconcile accounts compared to ACH transfers, which only provide the sender's name and the amount transferred. Using virtual cards for international payments could also help to minimize cross-border fees and other surcharges since transactions do not need to be routed through a correspondent bank. While virtual card solutions have been in existence for 10-15 years, growth is inflecting given a heightened focus on cash management, product maturity, and regulation-driven demand in verticals like healthcare, construction, and online travel.

Exhibit 22: Virtual card payments

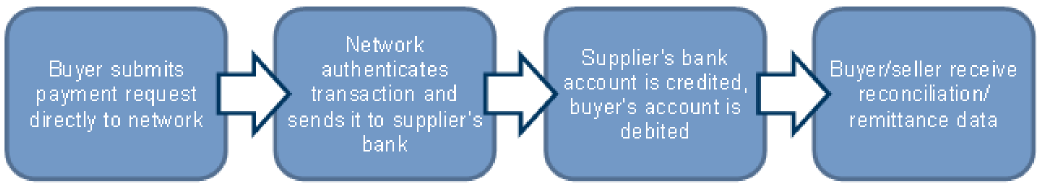


Source: Goldman Sachs Global Investment Research

- **Push payments:** Push payments reverse the traditional payment process as buyers initiate the transaction and proactively "push" funds into the supplier's account.

  Push payments offer clear time and cost savings: transactions are settled in real time, giving companies better visibility on cash flows, and run on the networks' debit rails - so we would expect pricing to begin to approximate current debit card spreads over time. Push payment transactions also provide rich data records with details about the underlying transactions, making it easier for businesses to track payments and reconcile accounts, and security, since transactions only require a debit card number (versus the recipient's bank account information, which is needed for ACH).

Exhibit 23: Push payments



*Also referred to as direct debit, buyer-initiated payments (BIP), and straight-through processing (STP)

Source: Goldman Sachs Global Investment Research

Quantifying the savings

Reducing direct costs - paper, postage, payment processing and labor

We see automating the pre-payment process as the largest immediate revenue opportunity for the industry. We see automating pre-payment workflows - from receiving the invoice through authorizing the payment - as the biggest near-term opportunity. A number of solutions have already emerged targeting small and mid-sized businesses, which currently shoulder nearly 80% of manual processing costs worldwide.

Where are the inefficiencies and where are the savings? AP automation speeds up invoice processing and cuts labor costs. This combination not only drives down costs and allows companies to reallocate headcount to higher-value work, but enables growing companies to scale their AP operations without increasing headcount. Speeding up AP processing also positions companies to capture rebates and pre-payment discounts.

Exhibit 24: Time savings is the biggest benefit of using AP automation solutions
Various steps involved in AP management (pre-payment)

Pre-payment process	Process description	Inefficiencies in the process	How AP automation can help?	Nature of savings
Capturing data from invoices	Manually enter data from each invoice into the company's ERP	- Invoices received in numerous formats (paper, email, or fax) - Time spent on manual data entry - Data inaccuracies from manual entry	Automatically reads and captures data from the invoices (using OCR, other technologies)	Time savings
Matching invoices against POs/contracts	Match each invoice against a PO or contract to ensure the invoice is valid	- Time spent manually matching each invoice - POs are typically spread across different departments - Difficult to ensure accuracy - Time spent addressing unmatched invoices	Automatically matches invoices to POs through integrations with the company's other systems and accounting software	Time savings
Approvals	Get the necessary approvals to process the payment	- Time delays when payments require multiple approvals - Time spent by AP personnel answering approver's questions since no centralized system exists for the approver to independently check the accuracy - Time spent by approver	Automatically notifies the Approver once the invoice is matched with the PO and approver can send approval through the App/solution itself	Time savings
Writing and sending checks	Writing and sending checks	- Time from receiving the approval to the payment being processed could take 7-10 days - Time spent writing checks - Inaccuracies in checks - Postage costs - Lost/misplaced checks	Once the invoice is approved, the solution can process payments in real-time or one business day if buyers pay via ACH, virtual card, or a push payment.	Time savings, postage/paper cost savings

Source: Goldman Sachs Global Investment Research

Based on our conversations with users and providers of AP automation solutions, we estimate that SMBs pay an average of $16-$22 to manually process an invoice, but that this can be reduced to $6-$7 (60%-70% net savings) after adopting AP automation. Our key assumptions driving the analysis are as follows:

- **Payment mix**
  - We believe checks currently account for 65%-80% of B2B payments for SMBs.
  - After shifting to AP automation solutions, we think ACH will account for 40-50% of payments, virtual cards will account for approximately 30% of payments, and checks will only account for 15-25% of payments.
- **Headcount**
  - We assume a SMB's typical AP team includes clerks, analysts, supervisors, and a manager. Our headcount assumptions reflect an estimate of the industry average, but actual headcounts vary substantially depending on the industry, scale of the business, and existing processes.
  - We think AP automation can drive 70-80% time savings for AP staff. In our analysis, time savings are represented in USD, but in reality companies do not recognize hard dollar savings through headcount reduction since excess staff will typically be reallocated to higher-value work.
- **Software solution pricing:** AP automation solutions typically charge a fixed fee per invoice, plus a nominal monthly subscription fee for the solution. Based on our interactions with various solution providers, we assume pricing of $1.25-$1.50 per invoice.

For larger companies, we estimate invoices cost roughly $9 each to process, which can be reduced to roughly $4 (55% net savings) with AP automation. Large companies usually rely on ERP accounting software, which often provides account reconciliation and invoice matching, but rarely provides integrated payments. As a result, we believe roughly 50% of invoices are still paid with paper checks. AP automation should not only increase electronic payment adoption across large companies, but reduce the time spent by the AP staff managing the AP process by 65%-70%.

Exhibit 25: We see potential for net savings of ~70% for SMBs and ~55% for large companies who adopt AP automation

Key assumptions, costs, and savings for SMBs from using an AP automation solution

	Cost per invoice using a manual AP management process				
	Processing costs (paper, postage, processing)				
	Split of Payment Process used to pay major suppliers				
			Small	**Medium**	**Large**
	Payment Method	**Cost**			
	Checks	$1.55	80%	63%	50%
	ACH	$0.30	12%	26%	37%
	Virtual Cards	$1.25	5%	7%	10%
	Others	$4.00	3%	4%	4%
A	**Average processing cost per invoice**		**$1.47**	**$1.31**	**$1.16**
	Headcount Costs				
			Small	**Medium**	**Large**
	Invoices processed per month		**1,000**	**3,000**	**10,000**
		Salary ($/hour)		**Headcount**	
	AP Clerk	19	3	6	10
	AP Analyst	24	1	3	5
	AP Supervisor	29	0	1	3
	AP Manager	38	1	1	2
	Total Headcount		**5**	**11**	**20**
				Headcount cost per Invoice	
	AP Clerk		9.98	6.65	3.33
	AP Analyst		4.16	4.16	2.08
	AP Supervisor		0.00	1.66	1.50
	AP Manager		6.65	2.22	1.33
B	**Total headcount cost per invoice**		**$20.79**	**$14.69**	**$8.23**
			Small	**Medium**	**Large**
A+B	**Total cost per invoice**		**$22.26**	**$16.00**	**$9.39**

	Cost per invoice using an AP management software/service				
	Processing costs (paper, postage, processing)				
	Savings in processing costs				
			Small	**Medium**	**Large**
	Payment Method	**Cost**			
	Checks	$1.65	25%	15%	10%
	ACH	$0.30	42%	50%	55%
	Virtual Cards	$0.80	30%	32%	35%
	Others	$4.00	3%	3%	0%
C	**Average processing cost per invoice**		**$0.90**	**$0.77**	**$0.61**
	Headcount Costs				
			Small	**Medium**	**Large**
	Invoices processed per month		**1,000**	**3,000**	**10,000**
				Reduction in working hours on AP	
	AP Clerk		80%	75%	70%
	AP Analyst		80%	75%	70%
	AP Supervisor		75%	70%	65%
	AP Manager		75%	70%	65%
	Total Headcount		**2**	**3**	**7**
				Headcount cost per Invoice	
	AP Clerk		2.00	1.66	1.00
	AP Analyst		0.83	1.04	0.62
	AP Supervisor		0.00	0.50	0.52
	AP Manager		1.66	0.67	0.47
D	**Total headcount cost per invoice**		**$4.49**	**$3.87**	**$2.61**
			Small	**Medium**	**Large**
C+D	**Total cost per invoice**		**$5.39**	**$4.64**	**$3.22**
E	**Software/service charge**		**$1.50**	**$1.25**	**$1.00**
C+D+E	**Total Cost per invoice**		**$6.89**	**$5.89**	**$4.22**
	Absolute savings		**76%**	**71%**	**66%**
	Net savings		**69%**	**63%**	**55%**

Savings based on our 10-year forecasts for AP automation adoption and payment method mix. Absolute savings reflects processing and labor savings; net savings includes software/service charges.

Source: Primary research, Goldman Sachs Global Investment Research

Beyond AP automation...

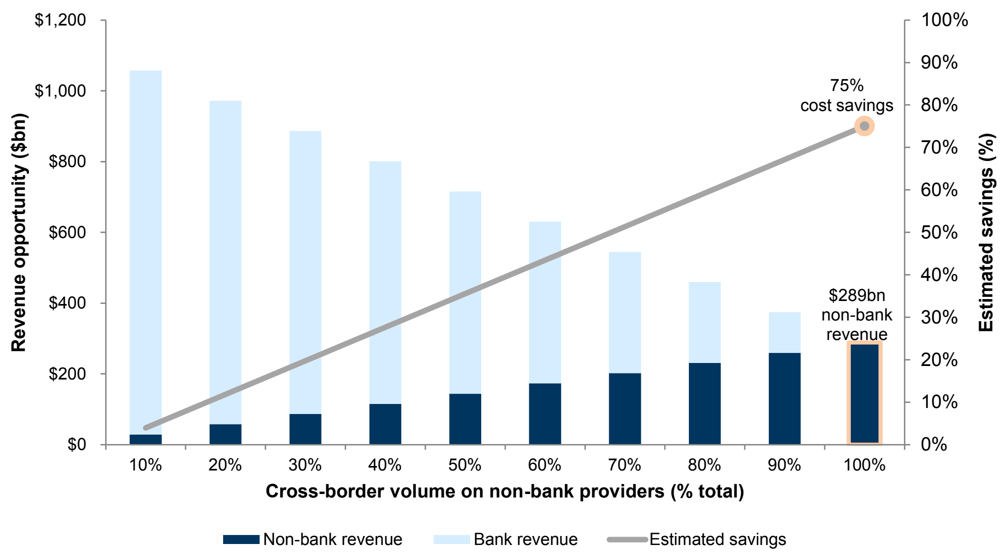
In addition to general AP automation solutions, more targeted solutions have emerged for cross-border payments, disbursements, short-term financing, and specific industry verticals.

Cross-border payments

We see a significant opportunity for cross-border providers that can undercut bank pricing by eliminating correspondent bank fees and locking in FX rates. Below, we show the incremental revenue opportunity for non-bank providers and corresponding savings for companies as volumes shift from banks to non-bank providers. Our analysis only captures savings on transaction and FX fees, and does not factor in the value of faster settlement times. However, with cross-border bank transactions taking up to 3-5 days, we see faster settlement times as a catalyst for faster adoption of non-bank solutions.

Exhibit 26: Ultimately, we believe companies can cut costs 75%, a ~$290bn opportunity for non-bank providers

Cross-border transfers: Estimated cost savings (%) and revenue opportunity ($bn)



Currently ~95% cross-border volume goes through banks.

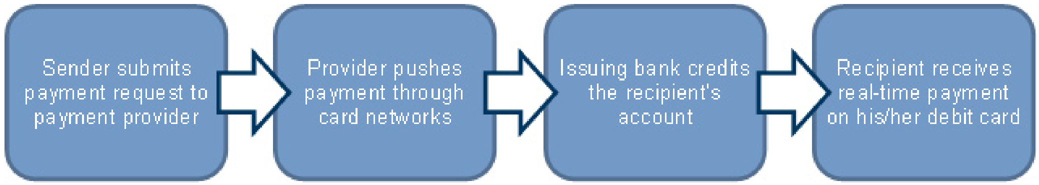
Source: Goldman Sachs Global Investment Research

The players: Beyond banks and credit card networks, solution providers include established niche players (Cambridge FX), traditional remittance providers (Western Union), and start-ups such as Payoneer, GoCardless, and TransferMate. These providers offer faster settlement times (e.g., Payoneer offers instant transfers between Payoneer accounts), low fees (GoCardless charges 1% per transaction and TransferMate charges a flat $5 fee on transfers under $5,000), and the opportunity to lock in real-time FX rates.

Disbursements

Disbursements are push payments - funds are "pushed" from the buyer's account into the supplier's account. There are two primary use cases for disbursements in B2B: (1) payments to suppliers and (2) direct payroll for contractors, freelancers, and 1099 workers. We expect disbursement solutions to see the fastest adoption in the gig economy, where companies need to pay contractors, resellers, and suppliers. This includes both freelancers and contractors in the Sharing Economy - including Uber and Lyft drivers, Airbnb hosts, and food delivery couriers.

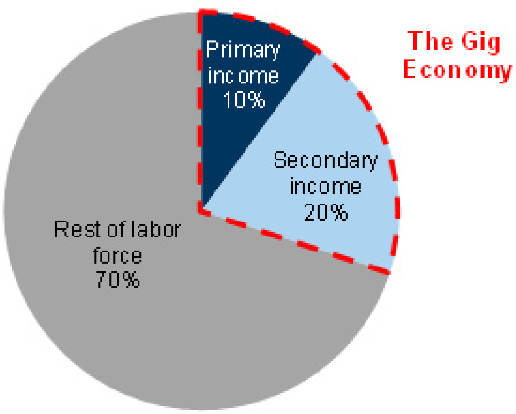
Exhibit 27: Disbursements (direct debit/push payments)



Source: Goldman Sachs Global Investment Research

The "Gig Economy" opportunity: We estimate that 30% of US workers participate in the gig economy on either a full-time basis or as a supplemental source of income and collectively earn over $1.3tn in 2018.

Exhibit 28: Contract workers represent ~30% of the US labor force...
US labor force



Source: US Bureau of Labor Statistics, Federal Reserve, Cornell ILR, Goldman Sachs Global Investment Research

Exhibit 29: ...and will collectively earn about $1.3tn in 2018
Estimate of US gig economy

US population ('000s)		% employed
Population (adults)	328,055	
Population (16+)	214,843	
US labor force ('000s)		**% employed**
Labor force	162,245	
Employed	155,965	
Gig economy	**no. workers**	**% employed**
All workers	46,790	30.0%
Primary source of income	15,752	10.1%
Secondary source of income	31,037	19.9%
Earnings ($mn)	**Weekly**	**Annual**
Primary source of income	826	41,297
Secondary source of income	781	39,030
Market size ($mn)		**1,310,835**

Source: US Bureau of Labor Statistics, Federal Reserve, Cornell ILR, Goldman Sachs Global Investment Research

Shifting check payments to digital disbursements eliminates the inefficiencies tied to paper checks and gives contractors faster access to funds. Assuming 1.5% pricing, we see a $20bn revenue opportunity in the United States and - assuming the same mix of gig workers in the global economy - a $96bn global revenue opportunity.

While our revenue opportunity is limited to "gig workers," we see a larger opportunities as the rest of the labor force pushes for faster access to their paychecks. Based on the size of the US labor force and average hourly earnings, we believe there is an opportunity to process over $6.8tn in Direct Payroll. Assuming the same 1.5% pricing, this would equate to over a $100bn revenue opportunity just within the US.

The players: Card networks are the chief infrastructure providers for direct debit payments, but there are a number of providers who offer disbursement solutions that run over the networks' rails or operate their own closed-loop supplier payment networks.

Working capital and financing solutions

Automating AP processing allows businesses to pay and get paid faster. For buyers, this means avoiding late fees and capturing pre-payment discounts and rebates. For suppliers, this means better working capital and cash flow management.

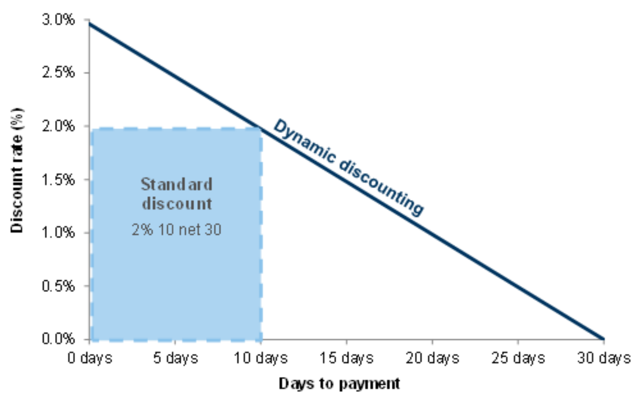
While we expect invoice and payment processing solutions (domestic + cross-border) to experience the fastest adoption, we also see tremendous opportunities for working capital management and cash management (i.e., dynamic discounting) solutions. Dynamic discounting takes standard prepayment discounts, such as 2% 10 net 30 (i.e., a 2% discount if the buyer pays within 10 days following invoice issuance), to the next level. With dynamic discounting, a buyer can set an APR and the supplier can decide how early it wants to be paid based on that APR. Working capital and cash management solutions are only beginning to emerge, but we expect competition to intensify and to see more solutions that offer direct interfaces between the supplier and buyer, allowing them to negotiate discounts, and offer real-time payments.

Exhibit 30: With dynamic discounting, the buyer sets an APR and the seller can choose when it wants to be paid based on the APR
Discount rate (%)

		Days to payment			
APR (%)	0.0%	0	10	20	30
	6%	0.5%	0.3%	0.2%	0.0%
	9%	0.7%	0.5%	0.2%	0.0%
	12%	1.0%	0.7%	0.3%	0.0%
	15%	1.2%	0.8%	0.4%	0.0%
	18%	1.5%	1.0%	0.5%	0.0%
	21%	1.7%	1.2%	0.6%	0.0%
	24%	2.0%	1.3%	0.7%	0.0%

Source: Goldman Sachs Global Investment Research

Exhibit 31: This provides more flexibility than traditional "all or nothing" discounts
Illustrative example of dynamic discounting



Source: Goldman Sachs Global Investment Research

Beyond specific financing solutions, a complete "procure-to-pay" working capital solution would enable an organization to manage its business more efficiently by raising purchase orders based on current inventory levels and FX movements, automatically approving invoices after the procurement process is complete, processing payments, reconciling accounts, and using analytics to forecast net cash and make decisions around raising short-term debt or paying down debt. We see a significant opportunity for these solutions to gain traction with larger organizations that have complex, global supply chains.

Who can make money and how much?

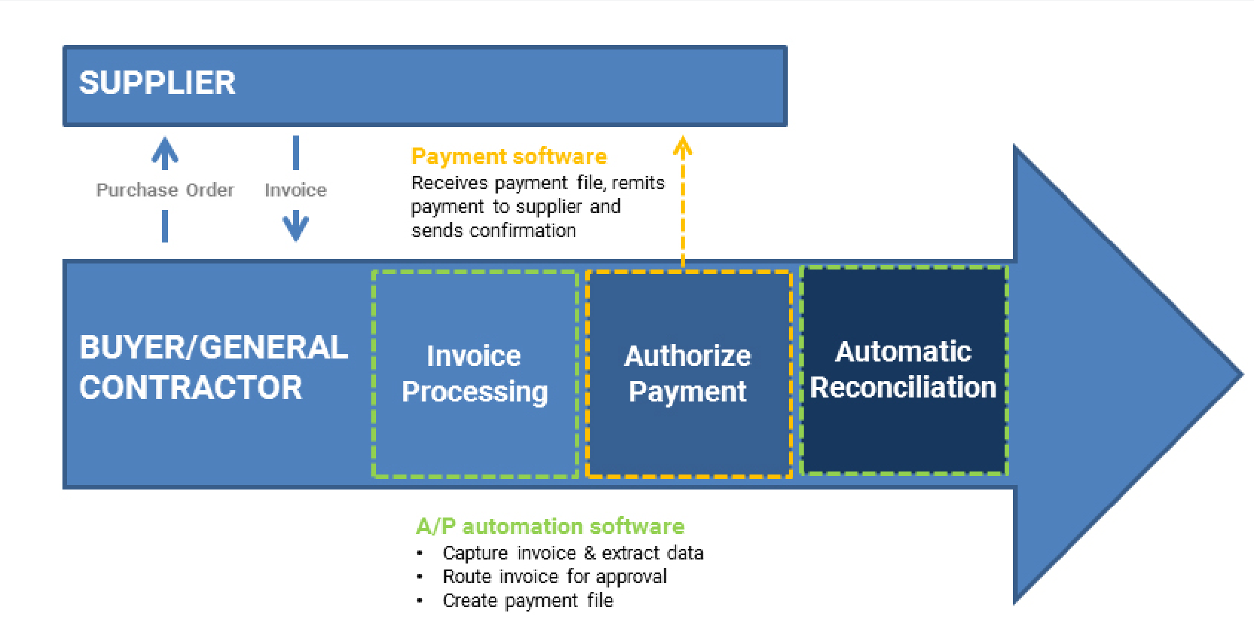
Payment processors, software companies, banks, and services providers are vying to help businesses take control of manual, paper-based payables processes - but in many cases, competition is not the only force at work. Partnerships are becoming vitally important for vendors across the B2B market looking to distribute complete solutions to SMBs. We see meaningful revenue opportunities for all these groups:

- **Payments companies:** Payment companies - including card networks, merchant acquirers, and virtual card providers - are responsible for transferring funds between the buyer and the supplier to settle an invoice. Payment processing is often integrated with ancillary software and services provided by other vendors. In many cases, payment companies serve as the aggregator of software and services solutions because of their position at the heart of the B2B ecosystem.
- **Software and services companies:** Software and services companies provide workflow solutions and ancillary software that integrates with traditional ERP and accounting software to help ease pain points for businesses. In the core accounts payable market, a range of vendors offers software to automate AP processing - receiving and matching invoices and purchase orders, streamlining the approval process, and reconciling payments in the company's general ledger. A number of vendors also provide specialized solutions for cross-border payments, disbursement payments, and solutions to help companies bridge cash shortfalls and finance working capital.
- **Banks and financial institutions:** Payment companies and software/services providers often work with banks to distribute their solutions to market, given that in many cases banks retain the core client relationship. Payment processors and software/services providers will often "white label" their solutions to banks or partner with other companies offering payments services, such as accounting firms. This enables the providers to reach a significant number of companies while minimizing sales and marketing costs.

A Small Business Case Study

Consider the example of an independent general contractor who wishes to automate his supplier payments. The home contractor might bank at a regional bank (such as Fifth Third) and hear about Fifth Third's Expert AP offering, which is white label solution provided by AvidXchange. The contractor can use Fifth Third Expert AP to automate the entire accounts payable process from receiving the invoice to making payments. If the contractor pays by virtual card or Fast ACH, the payment will be powered by Mastercard. In this case, the economics would be split between Fifth Third (the distributor), AvidXchange (the software/services provider), and Mastercard (the payment processor).

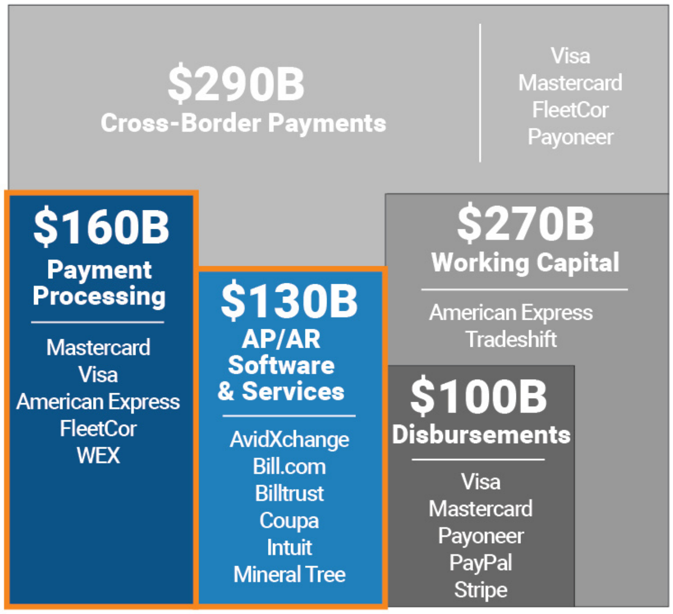
Exhibit 32: How the B2B payments process works for small business.



Source: Goldman Sachs Global Investment Research

Overall, we see a $300bn revenue opportunity in core payment processing and AP software/services - and a $950bn revenue opportunity when taking into account specialized B2B solutions for cross-border payments, disbursements, and working capital financing. We see this broader B2B revenue opportunity reaching $1.5tn by 2028.

Exhibit 33: B2B market landscape with key public and private companies



Source: Goldman Sachs Global Investment Research

Card networks: B2B payments represents the next frontier

Apart from niche corporate payments such as travel and entertainment (T&E), card networks have historically focused on consumer payments. However, they have now started to concentrate significant attention and resources on the B2B payment opportunity - and we believe even modest penetration in the B2B market can drive meaningful revenue upside for the card networks over time.

We believe 5%-10% of B2B payments can be automated by 2023, which represents a revenue opportunity of around $12bn for the card networks, depending on pricing and the split between the network, software provider, and bank.

Exhibit 34: We believe 5%-10% of AP payment volumes could be automated by 2023...

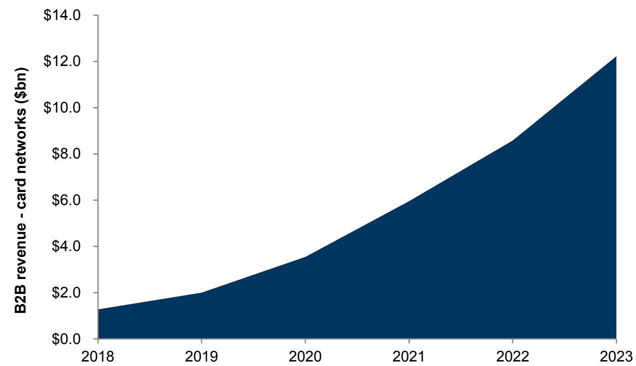
Card network revenue opportunity ($mn), 2023

2023 Market penetration	Card network pricing (%)					
	0.05%	0.06%	0.07%	0.08%	0.09%	0.10%
5%	4,074	4,888	5,703	6,518	7,332	8,147
6%	4,888	5,866	6,844	7,821	8,799	9,777
7%	5,703	6,844	7,984	9,125	10,265	11,406
8%	6,518	7,821	9,125	10,428	11,732	13,035
9%	7,332	8,799	10,265	11,732	13,198	14,665
10%	8,147	9,777	11,406	13,035	14,665	16,294

Source: Goldman Sachs Global Investment Research

Exhibit 35: ...roughly a $12bn opportunity for the card networks

Card network revenue opportunity ($mn), 2018-23



GS base case assumes 7.5% market penetration by 2023, 10bp pricing for card networks.

Source: Goldman Sachs Global Investment Research

Challenges in the adoption of B2B payment solutions

B2B payments remains a huge market opportunity, but it does face some structural challenges which could potentially hinder the adoption of tech-enabled solutions - making it difficult to identify winners early in the market's development.

- **The market is likely to remain fragmented for longer:** In contrast to the retail (B2C) and P2P payments markets where simple process flows and network effects have led to a consolidated group of winners in a short period of time, we think the B2B payments market is likely to remain fragmented for longer. Accounting solutions, internal processes, and ERP solutions differ from company to company, and the enterprise sales cycle is much longer – making it difficult for AP automation providers to expand exponentially and rapidly consolidate market share. We believe players which are able to build robust technology platforms, form key partnerships, customize offerings for clients, and integrate seamlessly with various accounting and payment systems are likely to survive in the medium term and emerge as winners in the long run.
- **Different systems used by buyers and suppliers generate friction**: A B2B payment follows a complex process and requires accounting reconciliation on both the buyer and supplier sides to close the loop. If the buyer wants to use AP automation solutions and e-payments, but its suppliers still rely on manual accounting, the supplier may still be paid by check. Since a part of the cost savings from AP automation come from electronic payments and automatic reconciliation, adopting AP automation will not be as financially lucrative for the buyer unless the supplier follows suit and accepts electronic payments. AP automation providers will need to ensure that their solutions do not hinder the reconciliation processes of a diverse set of suppliers.
- **Replacement costs can be high:** Smaller businesses, especially those using paper-based accounting systems, still prefer checks as they provide an easily

verifiable trail for reconciliation, audits, and handling exceptions. On the other hand, larger businesses have already invested heavily in automated ERP and payables systems. Using a new AP automation solution requires businesses to completely shift their existing processes and reassign their AP headcount, which can be met by internal resistance as the internal "sunk costs" are high. Solutions that provide end-to-end services including accounting, pre-payment process management and payments, on a SaaS model will help businesses adopt AP automation without incurring high replacement costs.

Disclosure Appendix

Reg AC

We, James Schneider, Ph.D., Julia McCrimlisk, Bill Schultz, Jesse Hulsing, Ryan M. Nash, CFA, Richard Ramsden, Mohammed Moawalla and Heath P. Terry, CFA, hereby certify that all of the views expressed in this report accurately reflect our personal views about the subject company or companies and its or their securities. We also certify that no part of our compensation was, is or will be, directly or indirectly, related to the specific recommendations or views expressed in this report.

Unless otherwise stated, the individuals listed on the cover page of this report are analysts in Goldman Sachs' Global Investment Research division.

GS Factor Profile

The Goldman Sachs Factor Profile provides investment context for a stock by comparing key attributes to the market (i.e. our coverage universe) and its sector peers. The four key attributes depicted are: Growth, Financial Returns, Multiple (e.g. valuation) and Integrated (a composite of Growth, Financial Returns and Multiple). Growth, Financial Returns and Multiple are calculated by using normalized ranks for specific metrics for each stock. The normalized ranks for the metrics are then averaged and converted into percentiles for the relevant attribute. The precise calculation of each metric may vary depending on the fiscal year, industry and region, but the standard approach is as follows:

Growth is based on a stock's forward-looking sales growth, EBITDA growth and EPS growth (for financial stocks, only EPS and sales growth), with a higher percentile indicating a higher growth company. **Financial Returns** is based on a stock's forward-looking ROE, ROCE and CROCI (for financial stocks, only ROE), with a higher percentile indicating a company with higher financial returns. **Multiple** is based on a stock's forward-looking P/E, P/B, price/dividend (P/D), EV/EBITDA, EV/FCF and EV/Debt Adjusted Cash Flow (DACF) (for financial stocks, only P/E, P/B and P/D), with a higher percentile indicating a stock trading at a higher multiple. The **Integrated** percentile is calculated as the average of the Growth percentile, Financial Returns percentile and (100% - Multiple percentile).

Financial Returns and Multiple use the Goldman Sachs analyst forecasts at the fiscal year-end at least three quarters in the future. Growth uses inputs for the fiscal year at least seven quarters in the future compared with the year at least three quarters in the future (on a per-share basis for all metrics).

For a more detailed description of how we calculate the GS Factor Profile, please contact your GS representative.

M&A Rank

Across our global coverage, we examine stocks using an M&A framework, considering both qualitative factors and quantitative factors (which may vary across sectors and regions) to incorporate the potential that certain companies could be acquired. We then assign a M&A rank as a means of scoring companies under our rated coverage from 1 to 3, with 1 representing high (30%-50%) probability of the company becoming an acquisition target, 2 representing medium (15%-30%) probability and 3 representing low (0%-15%) probability. For companies ranked 1 or 2, in line with our standard departmental guidelines we incorporate an M&A component into our target price. M&A rank of 3 is considered immaterial and therefore does not factor into our price target, and may or may not be discussed in research.

Quantum

Quantum is Goldman Sachs' proprietary database providing access to detailed financial statement histories, forecasts and ratios. It can be used for in-depth analysis of a single company, or to make comparisons between companies in different sectors and markets.

GS SUSTAIN

GS SUSTAIN is a global investment strategy focused on the generation of long-term alpha through identifying high quality industry leaders. The GS SUSTAIN 50 list includes leaders we believe to be well positioned to deliver long-term outperformance through superior returns on capital, sustainable competitive advantage and effective management of ESG risks vs. global industry peers. Candidates are selected largely on a combination of quantifiable analysis of these three aspects of corporate performance.

Disclosures

Coverage group(s) of stocks by primary analyst(s)

James Schneider, Ph.D.: America-IT Consulting and Outsourcing, America-Transaction Processors. Jesse Hulsing: America-Emerging Software. Ryan M. Nash, CFA: America-Consumer Finance, America-Regional Banks. Richard Ramsden: America-Large Banks. Mohammed Moawalla: Europe-IT Services, Europe-Software. Heath P. Terry, CFA: America-Internet.

America-Consumer Finance: Alliance Data Systems Corp., Ally Financial Inc., American Express Co., Capital One Financial Corp., Discover Financial Services, Santander Consumer USA Holdings, Synchrony Financial.

America-Emerging Software: Alteryx Inc., Appian Corp., Apptio Inc., Avalara Inc., Benefitfocus Inc., Blackline Inc., Ceridian HCM Holdings, Cornerstone OnDemand Inc., Coupa Software Inc., Guidewire Software Inc., Hortonworks Inc., HubSpot Inc., Intuit Inc., New Relic Inc., ServiceNow Inc., Shopify Inc., Splunk Inc., Tableau Software, Talend SA, Teradata Corp., Ultimate Software Group, Veeva Systems Inc., Zendesk Inc., Zuora Inc..

America-IT Consulting and Outsourcing: Accenture Plc, Black Knight Inc., CGI Group, CGI Group, Cognizant Technology Solutions, DXC Technology Co., Fidelity National Information Services, Fiserv Inc., International Business Machines, Sabre Corp..

America-Internet: Amazon.com Inc., Blue Apron Holdings, Booking Holdings Inc., CarGurus Inc., Criteo SA, eBay Inc., Etsy Inc., Expedia Group, GrubHub Inc., LendingClub Corp., Netflix Inc., Pandora Media Inc., PayPal Holdings, Redfin Corp., Snap Inc., Spotify Technology S.A., TripAdvisor Inc., Trivago N.V., Twitter Inc., Zillow Group.

America-Large Banks: Bank of America Corp., Citigroup Inc., J.P. Morgan Chase & Co., Morgan Stanley & Co., PNC Financial Services, U.S. Bancorp, Wells Fargo & Co..

America-Regional Banks: Bank of N.T. Butterfield & Son Ltd., BankUnited Inc., BB&T Corp., Cadence Bancorporation, Citizens Financial Group, Comerica Inc., Fifth Third Bancorp, First Hawaiian Inc., First Horizon National Corp., First Republic Bank, Huntington Bancshares Inc., KeyCorp, M&T Bank Corp., Regions Financial Corp., Signature Bank, SunTrust Banks Inc., Synovus Financial Corp., Zions Bancorporation.

America-Transaction Processors: Automatic Data Processing Inc., Euronet Worldwide Inc., Evertec Inc., EVO Payments Inc., First Data Corp., FleetCor Technologies Inc., Global Payments Inc., GreenSky Inc., MasterCard Inc., MoneyGram International Inc., Paychex Inc., Square Inc., Total System Services Inc., Visa Inc., Western Union Co., WEX Inc., Worldpay Inc., Worldpay Inc..

Europe-IT Services: Atos, Capgemini, Evry AS, Indra, Wirecard, Worldline.

Europe-Software: Aveva, Dassault Systemes, Hexagon AB, Micro Focus, Sage Group, SAP, SAP, Simcorp A/S, Software AG, Temenos.

Company-specific regulatory disclosures

Compendium report: please see disclosures at http://www.gs.com/research/hedge.html. Disclosures applicable to the companies included in this compendium can be found in the latest relevant published research

Distribution of ratings/investment banking relationships

Goldman Sachs Investment Research global Equity coverage universe

	Rating Distribution			Investment Banking Relationships		
	Buy	Hold	Sell	Buy	Hold	Sell
Global	35%	53%	12%	63%	56%	51%

As of July 1, 2018, Goldman Sachs Global Investment Research had investment ratings on 2,851 equity securities. Goldman Sachs assigns stocks as Buys and Sells on various regional Investment Lists; stocks not so assigned are deemed Neutral. Such assignments equate to Buy, Hold and Sell for the purposes of the above disclosure required by the FINRA Rules. See 'Ratings, Coverage groups and views and related definitions' below. The Investment Banking Relationships chart reflects the percentage of subject companies within each rating category for whom Goldman Sachs has provided investment banking services within the previous twelve months.

Price target and rating history chart(s)

Compendium report: please see disclosures at http://www.gs.com/research/hedge.html. Disclosures applicable to the companies included in this compendium can be found in the latest relevant published research

Regulatory disclosures

Disclosures required by United States laws and regulations

See company-specific regulatory disclosures above for any of the following disclosures required as to companies referred to in this report: manager or co-manager in a pending transaction; 1% or other ownership; compensation for certain services; types of client relationships; managed/co-managed public offerings in prior periods; directorships; for equity securities, market making and/or specialist role. Goldman Sachs trades or may trade as a principal in debt securities (or in related derivatives) of issuers discussed in this report.

The following are additional required disclosures: **Ownership and material conflicts of interest:** Goldman Sachs policy prohibits its analysts, professionals reporting to analysts and members of their households from owning securities of any company in the analyst's area of coverage. **Analyst compensation:** Analysts are paid in part based on the profitability of Goldman Sachs, which includes investment banking revenues. **Analyst as officer or director:** Goldman Sachs policy generally prohibits its analysts, persons reporting to analysts or members of their households from serving as an officer, director or advisor of any company in the analyst's area of coverage. **Non-U.S. Analysts:** Non-U.S. analysts may not be associated persons of Goldman Sachs & Co. LLC and therefore may not be subject to FINRA Rule 2241 or FINRA Rule 2242 restrictions on communications with subject company, public appearances and trading securities held by the analysts.

Distribution of ratings: See the distribution of ratings disclosure above. **Price chart:** See the price chart, with changes of ratings and price targets in prior periods, above, or, if electronic format or if with respect to multiple companies which are the subject of this report, on the Goldman Sachs website at http://www.gs.com/research/hedge.html.

Additional disclosures required under the laws and regulations of jurisdictions other than the United States

The following disclosures are those required by the jurisdiction indicated, except to the extent already made above pursuant to United States laws and regulations. **Australia:** Goldman Sachs Australia Pty Ltd and its affiliates are not authorised deposit-taking institutions (as that term is defined in the Banking Act 1959 (Cth)) in Australia and do not provide banking services, nor carry on a banking business, in Australia. This research, and any access to it, is intended only for "wholesale clients" within the meaning of the Australian Corporations Act, unless otherwise agreed by Goldman Sachs. In producing research reports, members of the Global Investment Research Division of Goldman Sachs Australia may attend site visits and other meetings hosted by the companies and other entities which are the subject of its research reports. In some instances the costs of such site visits or meetings may be met in part or in whole by the issuers concerned if Goldman Sachs Australia considers it is appropriate and reasonable in the specific circumstances relating to the site visit or meeting. To the extent that the contents of this document contains any financial product advice, it is general advice only and has been prepared by Goldman Sachs without taking into account a client's objectives, financial situation or needs. A client should, before acting on any such advice, consider the appropriateness of the advice having regard to the client's own objectives, financial situation and needs. **Brazil:** Disclosure information in relation to CVM Instruction 483 is available at http://www.gs.com/worldwide/brazil/area/gir/index.html. Where applicable, the Brazil-registered analyst primarily responsible for the content of this research report, as defined in Article 16 of CVM Instruction 483, is the first author named at the beginning of this report, unless indicated otherwise at the end of the text. **Canada:** Goldman Sachs Canada Inc. is an affiliate of The Goldman Sachs Group Inc. and therefore is included in the company specific disclosures relating to Goldman Sachs (as defined above). Goldman Sachs Canada Inc. has approved of, and agreed to take responsibility for, this research report in Canada if and to the extent that Goldman Sachs Canada Inc. disseminates this research report to its clients. **Hong Kong:** Further information on the securities of covered companies referred to in this research may be obtained on request from Goldman Sachs (Asia) L.L.C. **India:** Further information on the subject company or companies referred to in this research may be obtained from Goldman Sachs (India) Securities Private Limited, Research Analyst - SEBI Registration Number INH000001493, 951-A, Rational House, Appasaheb Marathe Marg, Prabhadevi, Mumbai 400 025, India, Corporate Identity Number U74140MH2006FTC160634, Phone +91 22 6616 9000, Fax +91 22 6616 9001. Goldman Sachs may beneficially own 1% or more of the securities (as such term is defined in clause 2 (h) the Indian Securities Contracts (Regulation) Act, 1956) of the subject company or companies referred to in this research report. **Japan:** See below. **Korea:** Further information on the subject company or companies referred to in this research may be obtained from Goldman Sachs (Asia) L.L.C., Seoul Branch. **New Zealand:** Goldman Sachs New Zealand Limited and its affiliates are neither "registered banks" nor "deposit takers" (as defined in the Reserve Bank of New Zealand Act 1989) in New Zealand. This research, and any access to it, is intended for "wholesale clients" (as defined in the Financial Advisers Act 2008) unless otherwise agreed by Goldman Sachs. **Russia:** Research reports distributed in the Russian Federation are not advertising as defined in the Russian legislation, but are information and analysis not having product promotion as their main purpose and do not provide appraisal within the meaning of the Russian legislation on appraisal activity. **Singapore:** Further information on the covered companies referred to in this research may be obtained from Goldman Sachs (Singapore) Pte. (Company Number: 198602165W). **Taiwan:** This material is for reference only and must not be reprinted without permission. Investors should carefully consider their own investment risk. Investment results are the responsibility of the individual investor. **United Kingdom:** Persons who would be categorized as retail clients in the United Kingdom, as such term is defined in the rules of the Financial Conduct Authority, should read this research in conjunction with prior Goldman Sachs research on the covered companies referred to herein and should refer to the risk warnings that have been sent to them by Goldman Sachs

International. A copy of these risks warnings, and a glossary of certain financial terms used in this report, are available from Goldman Sachs International on request.

European Union: Disclosure information in relation to Article 4 (1) (d) and Article 6 (2) of the European Commission Directive 2003/125/EC is available at http://www.gs.com/disclosures/europeanpolicy.html which states the European Policy for Managing Conflicts of Interest in Connection with Investment Research.

Japan: Goldman Sachs Japan Co., Ltd. is a Financial Instrument Dealer registered with the Kanto Financial Bureau under registration number Kinsho 69, and a member of Japan Securities Dealers Association, Financial Futures Association of Japan and Type II Financial Instruments Firms Association. Sales and purchase of equities are subject to commission pre-determined with clients plus consumption tax. See company-specific disclosures as to any applicable disclosures required by Japanese stock exchanges, the Japanese Securities Dealers Association or the Japanese Securities Finance Company.

Ratings, coverage groups and views and related definitions

Buy (B), Neutral (N), Sell (S) -Analysts recommend stocks as Buys or Sells for inclusion on various regional Investment Lists. Being assigned a Buy or Sell on an Investment List is determined by a stock's total return potential relative to its coverage. Any stock not assigned as a Buy or a Sell on an Investment List with an active rating (i.e., a stock that is not Rating Suspended, Not Rated, Coverage Suspended or Not Covered), is deemed Neutral. Each regional Investment Review Committee manages various regional Investment Lists to a global guideline of 25%-35% of stocks as Buy and 10%-15% of stocks as Sell; however, the distribution of Buys and Sells in any particular analyst's coverage group may vary as determined by the regional Investment Review Committee. Additionally, each Investment Review Committee manages Regional Conviction lists, which represent investment recommendations focused on the size of the total return potential and/or the likelihood of the realization of the return across their respective areas of coverage. The addition or removal of stocks from such Conviction lists do not represent a change in the analysts' investment rating for such stocks.

Total return potential represents the upside or downside differential between the current share price and the price target, including all paid or anticipated dividends, expected during the time horizon associated with the price target. Price targets are required for all covered stocks. The total return potential, price target and associated time horizon are stated in each report adding or reiterating an Investment List membership.

Coverage groups and views: A list of all stocks in each coverage group is available by primary analyst, stock and coverage group at http://www.gs.com/research/hedge.html. The analyst assigns one of the following coverage views which represents the analyst's investment outlook on the coverage group relative to the group's historical fundamentals and/or valuation. **Attractive (A).** The investment outlook over the following 12 months is favorable relative to the coverage group's historical fundamentals and/or valuation. **Neutral (N).** The investment outlook over the following 12 months is neutral relative to the coverage group's historical fundamentals and/or valuation. **Cautious (C).** The investment outlook over the following 12 months is unfavorable relative to the coverage group's historical fundamentals and/or valuation.

Not Rated (NR). The investment rating and target price have been removed pursuant to Goldman Sachs policy when Goldman Sachs is acting in an advisory capacity in a merger or strategic transaction involving this company and in certain other circumstances. **Rating Suspended (RS).** Goldman Sachs Research has suspended the investment rating and price target for this stock, because there is not a sufficient fundamental basis for determining, or there are legal, regulatory or policy constraints around publishing, an investment rating or target. The previous investment rating and price target, if any, are no longer in effect for this stock and should not be relied upon. **Coverage Suspended (CS).** Goldman Sachs has suspended coverage of this company. **Not Covered (NC).** Goldman Sachs does not cover this company. **Not Available or Not Applicable (NA).** The information is not available for display or is not applicable. **Not Meaningful (NM).** The information is not meaningful and is therefore excluded.

Global product; distributing entities

The Global Investment Research Division of Goldman Sachs produces and distributes research products for clients of Goldman Sachs on a global basis. Analysts based in Goldman Sachs offices around the world produce equity research on industries and companies, and research on macroeconomics, currencies, commodities and portfolio strategy. This research is disseminated in Australia by Goldman Sachs Australia Pty Ltd (ABN 21 006 797 897); in Brazil by Goldman Sachs do Brasil Corretora de Títulos e Valores Mobiliários S.A.; Ombudsman Goldman Sachs Brazil: 0800 727 5764 and / or ouvidoriagoldmansachs@gs.com. Available Weekdays (except holidays), from 9am to 6pm. Ouvidoria Goldman Sachs Brasil: 0800 727 5764 e/ou ouvidoriagoldmansachs@gs.com. Horário de funcionamento: segunda-feira à sexta-feira (exceto feriados), das 9h às 18h; in Canada by either Goldman Sachs Canada Inc. or Goldman Sachs & Co. LLC; in Hong Kong by Goldman Sachs (Asia) L.L.C.; in India by Goldman Sachs (India) Securities Private Ltd.; in Japan by Goldman Sachs Japan Co., Ltd.; in the Republic of Korea by Goldman Sachs (Asia) L.L.C., Seoul Branch; in New Zealand by Goldman Sachs New Zealand Limited; in Russia by OOO Goldman Sachs; in Singapore by Goldman Sachs (Singapore) Pte. (Company Number: 198602165W); and in the United States of America by Goldman Sachs & Co. LLC. Goldman Sachs International has approved this research in connection with its distribution in the United Kingdom and European Union.

European Union: Goldman Sachs International authorised by the Prudential Regulation Authority and regulated by the Financial Conduct Authority and the Prudential Regulation Authority, has approved this research in connection with its distribution in the European Union and United Kingdom; Goldman Sachs AG and Goldman Sachs International Zweigniederlassung Frankfurt, regulated by the Bundesanstalt für Finanzdienstleistungsaufsicht, may also distribute research in Germany.

General disclosures

This research is for our clients only. Other than disclosures relating to Goldman Sachs, this research is based on current public information that we consider reliable, but we do not represent it is accurate or complete, and it should not be relied on as such. The information, opinions, estimates and forecasts contained herein are as of the date hereof and are subject to change without prior notification. We seek to update our research as appropriate, but various regulations may prevent us from doing so. Other than certain industry reports published on a periodic basis, the large majority of reports are published at irregular intervals as appropriate in the analyst's judgment.

Goldman Sachs conducts a global full-service, integrated investment banking, investment management, and brokerage business. We have investment banking and other business relationships with a substantial percentage of the companies covered by our Global Investment Research Division. Goldman Sachs & Co. LLC, the United States broker dealer, is a member of SIPC (http://www.sipc.org).

Our salespeople, traders, and other professionals may provide oral or written market commentary or trading strategies to our clients and principal trading desks that reflect opinions that are contrary to the opinions expressed in this research. Our asset management area, principal trading desks and investing businesses may make investment decisions that are inconsistent with the recommendations or views expressed in this research.

The analysts named in this report may have from time to time discussed with our clients, including Goldman Sachs salespersons and traders, or may discuss in this report, trading strategies that reference catalysts or events that may have a near-term impact on the market price of the equity securities discussed in this report, which impact may be directionally counter to the analyst's published price target expectations for such stocks. Any such trading strategies are distinct from and do not affect the analyst's fundamental equity rating for such stocks, which rating reflects a stock's return potential relative to its coverage group as described herein.

We and our affiliates, officers, directors, and employees, excluding equity and credit analysts, will from time to time have long or short positions in, act as principal in, and buy or sell, the securities or derivatives, if any, referred to in this research.

The views attributed to third party presenters at Goldman Sachs arranged conferences, including individuals from other parts of Goldman Sachs, do not necessarily reflect those of Global Investment Research and are not an official view of Goldman Sachs.

Any third party referenced herein, including any salespeople, traders and other professionals or members of their household, may have positions in the products mentioned that are inconsistent with the views expressed by analysts named in this report.

This research is not an offer to sell or the solicitation of an offer to buy any security in any jurisdiction where such an offer or solicitation would be illegal. It does not constitute a personal recommendation or take into account the particular investment objectives, financial situations, or needs of individual clients. Clients should consider whether any advice or recommendation in this research is suitable for their particular circumstances and, if appropriate, seek professional advice, including tax advice. The price and value of investments referred to in this research and the income from them may fluctuate. Past performance is not a guide to future performance, future returns are not guaranteed, and a loss of original capital may occur. Fluctuations in exchange rates could have adverse effects on the value or price of, or income derived from, certain investments.

Certain transactions, including those involving futures, options, and other derivatives, give rise to substantial risk and are not suitable for all investors. Investors should review current options disclosure documents which are available from Goldman Sachs sales representatives or at http://www.theocc.com/about/publications/character-risks.jsp. Transaction costs may be significant in option strategies calling for multiple purchase and sales of options such as spreads. Supporting documentation will be supplied upon request.

Differing Levels of Service provided by Global Investment Research: The level and types of services provided to you by the Global Investment Research division of GS may vary as compared to that provided to internal and other external clients of GS, depending on various factors including your individual preferences as to the frequency and manner of receiving communication, your risk profile and investment focus and perspective (e.g., marketwide, sector specific, long term, short term), the size and scope of your overall client relationship with GS, and legal and regulatory constraints. As an example, certain clients may request to receive notifications when research on specific securities is published, and certain clients may request that specific data underlying analysts' fundamental analysis available on our internal client websites be delivered to them electronically through data feeds or otherwise. No change to an analyst's fundamental research views (e.g., ratings, price targets, or material changes to earnings estimates for equity securities), will be communicated to any client prior to inclusion of such information in a research report broadly disseminated through electronic publication to our internal client websites or through other means, as necessary, to all clients who are entitled to receive such reports.

All research reports are disseminated and available to all clients simultaneously through electronic publication to our internal client websites. Not all research content is redistributed to our clients or available to third-party aggregators, nor is Goldman Sachs responsible for the redistribution of our research by third party aggregators. For research, models or other data related to one or more securities, markets or asset classes (including related services) that may be available to you, please contact your GS representative or go to http://360.gs.com.

Disclosure information is also available at http://www.gs.com/research/hedge.html or from Research Compliance, 200 West Street, New York, NY 10282.