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MEASURING SHIFTS IN THE SUPPLY CHAIN

NOVEMBER 21, 2022

Automation, regulation, nearshoring, infrastructure, consumer habits, and geopolitical pressures will shape the future of the supply chain.

COVID has accelerated tech-enablement in supply chain management from port, warehouse, and truck automation.

The case for Mexico has been re-ignited, driven by proximity, labor, geopolitical de-risking, ESG, and a potentially expanding NA rail network.

Stock recommendations: ABB, ATSG, CAT, CGNX, CMI, COST, CP, GATX, GBX, GXO, HD, NKE, NVDA, SLAB, SYM, TFII, TGT, TJX, TRN, WAB, and WMT.

Jason H. Seidl
646 562 1404
jason.seidl@cowen.com

Chris Krueger
202 868 5307
chris.krueger@cowen.com

Cowen Research
646 562 1010
cowen.research@cowen.com

COLLABORATIVE INSIGHTS

November 21, 2022

Multi-Sector

COWEN RESEARCH

EQUITY RESEARCH

Jason H. Seidl
646 562 1404
jason.seidl@cowen.com

Helane Becker
646 562 1399
helane.becker@cowen.com

John Blackledge
646 562 1359
john.blackledge@cowen.com

Oliver Chen, CFA
646 562 1424
oliver.chen@cowen.com

Matt Elkott
646 562 1409
matthew.elkott@cowen.com

Joseph Giordano, CFA
646 562 1405
joseph.giordano@cowen.com

John Kernan, CFA
646 562 1324
john.kernan@cowen.com

Max Rakhlenko, CFA
646 562 1423
max.rakhlenko@cowen.com

Matthew D. Ramsay
415 646 7373
matt.ramsay@cowen.com

COWEN WASHINGTON RESEARCH GROUP

MACRO POLICY

Chris Krueger
202 868 5307
chris.krueger@cowen.com

MULTI-SECTOR

MEASURING SHIFTS IN THE SUPPLY CHAIN - AHEAD OF THE CURVE

THE COWEN INSIGHT

A COVID-induced supply chain spiral led to a logistical conundrum that forced shippers and executive teams to adapt to an ever-changing global environment. As the dust begins to settle, we take a closer look at the more long-lasting changes across the supply chain and consumer. A multi-sector angle provides insight into the long-term impact for supply chains and beneficiaries of these shifts.

Our Thesis (Jason Seidl)

A cyclical slowdown has eased some headline supply chain pressures, but despite the macro slowdown, shippers' actions have resulted in structural shifts that will likely lead to long-term changes up and down the supply chain. Automation, regulation, nearshoring, infrastructure, consumer habits, and geo-political pressures will likely shape the future of the supply chain.

Based on our proprietary survey data, we estimate that ~10% of freight shift may stay on the East Coast, potentially benefiting Eastern transports (CSX, NSC). Multiple regulatory headwinds (CARB, AB5) will force change in the California market in 2023, with the potential to set a regulatory precedent. We discuss four motives that highlight the opportunity for reshoring in Mexico and the beneficiaries associated with potential shifts; the cost of transportation, among others, offers enticing opportunities for shippers on the heels of the KCS/CP merger. The pandemic has accelerated tech-enablement in supply chain management with measures ranging from port, warehouse, and truck automation.

What Is Proprietary? (Jason Seidl)

We conducted a proprietary survey to measure how shipper habits and sentiment have changed in a post-COVID supply chain environment. We collaborated with Cowen Analysts across retail, consumer, internet, OEMs, semiconductors, and airlines on the broader implications across the supply chain and consumer. This report offers a wide perspective on how shifts in the supply chain ripple through the economy.

Financial & Industry Model Implications (Jason Seidl)

While a majority of shippers will likely move their freight back to the West Coast, we believe there may be a ~10% permanent shift of freight to the East Coast, which has absorbed volumes from Western counterparts, creating long-term opportunities for Eastern transportation companies. Cost/benefit analysis tilts in favor of nearshoring supply chains (Mexico), as friendly neighbors reduce political risk while offering affordable labor, manufacturing (industry specific), and seamless port/rail opportunities and tailwinds. Despite 2022 rail congestion and labor negotiations that should ultimately affect rail service into 2023, we believe intermodal operations will be a long-term growth driver for transports due to cost efficiencies and ESG initiatives.

What To Watch (Jason Seidl)

Catalysts and what to watch include: 1) retail inventories, 2) e-commerce trends, 3) greenfield investment in North America, 4) US port volume data, 5) import/export data from Asia and North America, 6) rail and intermodal volumes, 7) industrial production, and 8) energy pricing.

Stock Conclusions (Cowen Research)

Stock recommendations: ABB, ATSG, CAT, CGNX, CMI, COST, CP, GATX, GBX, GXO, HD, NKE, NVDA, SLAB, SYM, TFII, TGT, TJX, TRN, WAB, WMT.

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Executive Summary (Cowen Research)

Frothy freight markets and congested supply chains of 2021 seem like a distant memory in 4Q22 with normalization occurring at rapid pace (investors may recall that in our November 2021 AOTC we called for a normalization of the supply chain in the back half of 2022). Shipping container rates which had reached as high as 15-16x 2019 rates have come down to pre-pandemic levels. TL spot rates are down 37% y/y and contract rates are beginning to come under pressure. Anchored vessels at the Port of LA/LB are in the low single digits from ~100 in January '22. Pent up demand for automobiles is now being served as chip shortages ease. Yet, the pandemic has left an indelible mark on every facet of the supply chain ranging from just-in-case inventory management strategies to labor challenges. This report investigates the permanent and long-lasting impacts of the pandemic on the supply chain as well as the likely implications for companies and consumers.

A lot has changed over the nearly 30 years that we have been involved with the supply chain. Decades ago, most CEOs (and other corporate officers) viewed their supply chains as a cost center and were barely aware of the complexities and far-reaching implications that they possessed. The last 24 months has changed that corporate dynamic drastically. Supply chains are now getting the focus they very much deserve not only in North America but all over the globe.

Despite clear signs of a macroeconomic slowdown, shippers remain wary of supply chain uncertainty that the pandemic spotlighted and continue to favor just-in-case inventory management. **Our proprietary survey indicates that ~50% of railroad shippers have shifted permanently to a strategy involving higher inventories, similar to results that we reported in our last AoTC edition**. In our view, this shift in inventory management has contributed to the pulling forward of peak season that we witnessed in 2022. We will be watching how inventories are re-built when we come out of the anticipated downturn.

Lingering fears of service and labor disruptions also have long-lasting implications for the U.S. ports. Shippers are increasingly motivated to organize their supply chains using multiple points of entry to reduce reliance on the Port of LA/LB. Per our proprietary survey, 32% of railroad shippers had diverted freight away from LA/LB with Savannah, NY/NJ and Houston being the largest beneficiaries. **In our view, while the West Coast enjoys natural advantages that offer it a predominant position among ports, we estimate that ~10% of freight moved during COVID will stay on the East Coast**. Per industry contacts and recent reports, the Gulf Coast ports are well positioned to gain share permanently as well.

Supply chain delays continue to cause shippers to shift to air from ocean. We are seeing non-traditional operators, such as shipping companies Mediterranean Shipping Co., Maersk and CMA CGM form air divisions with leased in aircraft. **This shift away from ocean to air enables their growth in logistics, but benefits aircraft leasing companies such as Atlas Air and Air Transport Services Group. ATSG is rated Outperform.**

The pandemic-induced congestion also brought technological enhancement to the forefront of the supply chain conversation across industries. At the ports, automation efforts at the Port of LA/LB are underway, though we expect pressure from unions to prevent adoption at scale (currently only 3 terminals at the port are automated and most of the world's fully automated ports were designed to be so at the outset). On the trucking side, our proprietary carriers' survey suggests that willingness to test autonomous trucks is at a survey high with 31% of respondents indicating in the affirmative. **Our TL names KNX, WERN and SNDR have made significant forays in**

autonomous investments. Autonomous uptake in the LTL space is less pronounced due to the complexities of urban transportation. Lastly, automation is also emerging as a source of differentiation in the warehousing and logistics business. Our discussions with major integrators suggest that globally only ~10% of warehouses are fully automated, 30-40% have some automation (mainly infrastructure like conveyors), while the remaining 50-60% are completely manual. **Our pure-play logistics name, GXO, is a leader in the space with ~60% of new business wins involving highly automated solutions.** In the retail space **WMT has been particularly acquisitive in the robotics and automation space to improve the speed and efficiency of fulfillment centers to cope with pandemic-induced e-commerce-like demand.**

Concurrent to tech enablement spurred by the pandemic, ESG considerations are also gaining traction in the transportation space. Industry contacts suggest that ESG is already a key decision-making factor among large shippers with smaller shippers expected to follow gradually. **Intermodal will likely benefit in the long-run as we estimate that these routes are ~3.3x more fuel efficient when compared with an over-the-road alternative as shippers incorporate carbon reduction initiatives into contracts** (in addition to being cheaper). Drayage carriers will likely face negative impact from CARB (California Air Resources Board) rules as trucks and busses that were made before 2011 will not be allowed on the road. Similar rules pertaining to ocean carriers can reportedly reduce capacity by 5-15% according to shipping giants Hapag-Lloyd and Maersk. On the warehousing side, greater e-commerce activity supported by the pandemic lifestyle shifts has generated the need for effective reverse logistics solutions (reverse logistics consists primarily of customer returns) that have a notable ESG component to them. **Reverse logistics enhances ESG credentials by enabling greater recycling, improving manufacturing efficiency and reducing wastage. In fashion e-commerce for example, GXO sends less than 1% of returned items to landfills compared to the industry average of 25%.**

Zero-COVID policies in China have highlighted nearshoring and manufacturing shifts. Delivery proximity was the most widely discussed bull case for Mexico during Cowen's Transportation and Sustainable Mobility conference in September. Companies are already working on the fringes of certain countries to inch closer to the end consumer. **In May, CP debuted their first rail service between Lazaro Cardenas to Chicago, a 7-day journey that if/when formally approved by the Surface Transportation Board, could be a gamechanger in terms of intermodal service in North America, in our view.** Considering the move via rail/truck after it arrives at the port (plus drayage), there are measurable cost savings seen from nearshoring a supply chain, all else being equal. **In semiconductor manufacturing, we estimate that there are $110B of fabs, primarily in the U.S., that will start construction (or already started this year) in 2022 and 2023 with production starting 2024.**

As firms continue to invest in their supply chains, the Cowen semis team believes that companies enabling those changes have the opportunity to grow into larger TAMs than they have served in the past and drive above-market growth. **In our view, these opportunities align with four main themes: 1) AI Training & Optimization; 2) AI Inference, Sensing, & Processing; 3) Autonomous Logistics; and 4) Connectivity.** Each company will vary with its thematic exposure, and, given the relatively fragmented nature of these markets it is likely not material for even some of the leading company's stocks (yet). Supply chain modernization as a case study is yet another example of how increasing semiconductor content across the economy is likely to drive durable, above GDP growth for the broad semis ecosystem for the foreseeable future.

The pandemic clearly left a permanent mark on supply chains, despite mean reversions in the more commoditized aspects of the industry (spot rates etc.) that hog the

headlines. Beneath the hood, paradigm shifts in inventory management, consumption patterns, technological innovation, ESG outlook and globalization strategies promise to have far reaching impacts on companies across industries.

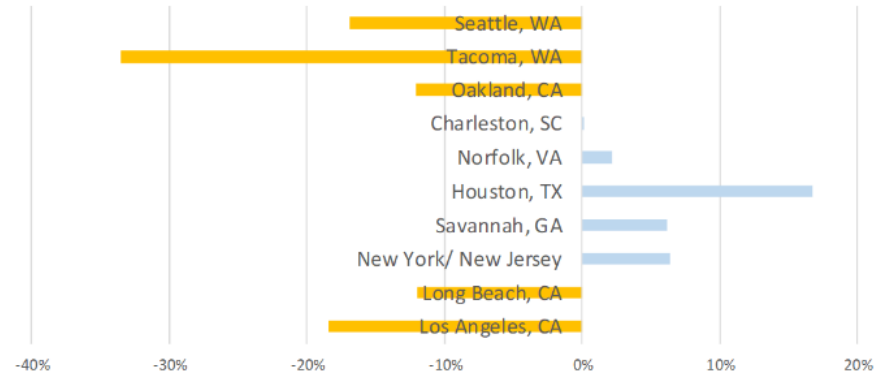
The truck OEMs' ability to produce to demand remains constrained by supply chain issues. While we expect this to continue into 1H23, we see it moderating as the year progresses as disruptions ease slowly and because we expect order activity to slow. On the machinery and truck equipment side of our coverage, we favor CMI, CAT, and WAB, while we are cautious on PCAR and DE. We expect freight car availability to be tight through at least 1Q23, contributing to supply chain challenges. We favor TRN, GATX, and GBX in the railcar subsector of our coverage.

Stock recommendations: ABB, ATSG, CAT, CGNX, CMI, COST, CP, GATX, GBX, GXO, HD, NKE, NVDA, SLAB, SYM, TFII, TGT, TJX, TRN, WAB, WMT

Rebound at the Ports? (Jason Seidl)

The consumer frenzy induced by the pandemic lockdowns and monetary stimulus is now a thing of the past. Demand conditions are being suppressed by inflationary pressures and the associated squeeze of monetary tightening, prompting a much more cautious consumer. At the same time, capacity building efforts continue across the supply chain. Congestion remained considerably stubborn through much of 2022 with anchored vessels waiting off North American ports reaching peaks in January and then again in July. However, on aggregate, congestion has eased materially, and we expect this trend to continue as we move further into the down cycle. This easing of congestion is not uniform across the board, however, as substantial freight has been diverted from LA/LB to the East Coast in recent months on fears of a labor dispute causing a work stoppage at the port.

Figure 1 : Top 10 Ports Volume Shift May – Sep '21 vs Jun-Oct '22

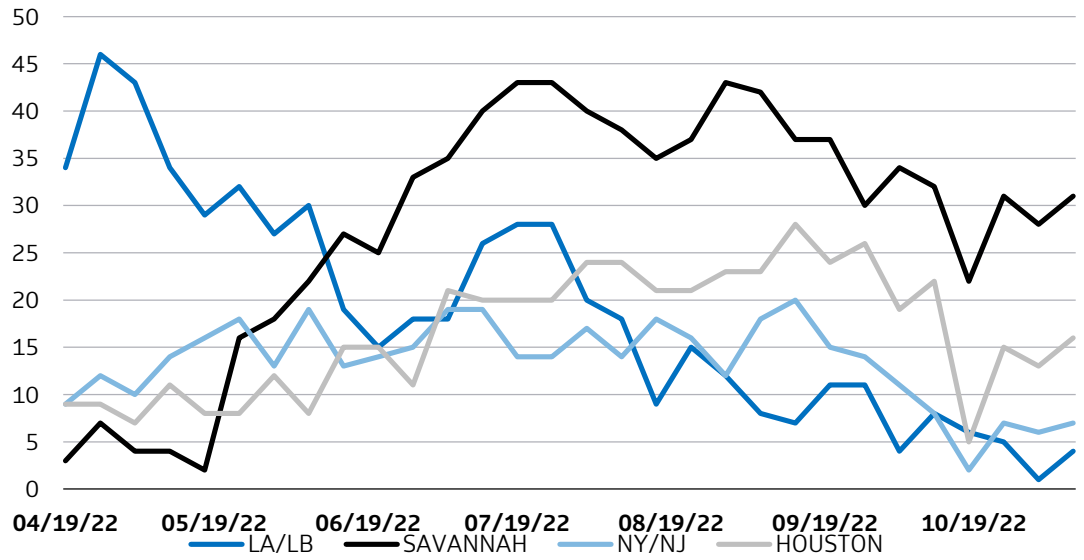


Source: Descartes

The Port of LA/LB (typically accounting for ~40% of US imports) saw 109 vessels anchored offshore in January '22 at the peak of congestion; this figure has come down to only 1 vessel as of November 2022. Meanwhile, vessels have piled up off the shores at the Port of Savannah, Port of NY/NJ and Port of Houston. Canadian ports also witnessed an uptick in activity (a fact consistently pointed out by CP and CNI as a tailwind to 2H rail volumes).

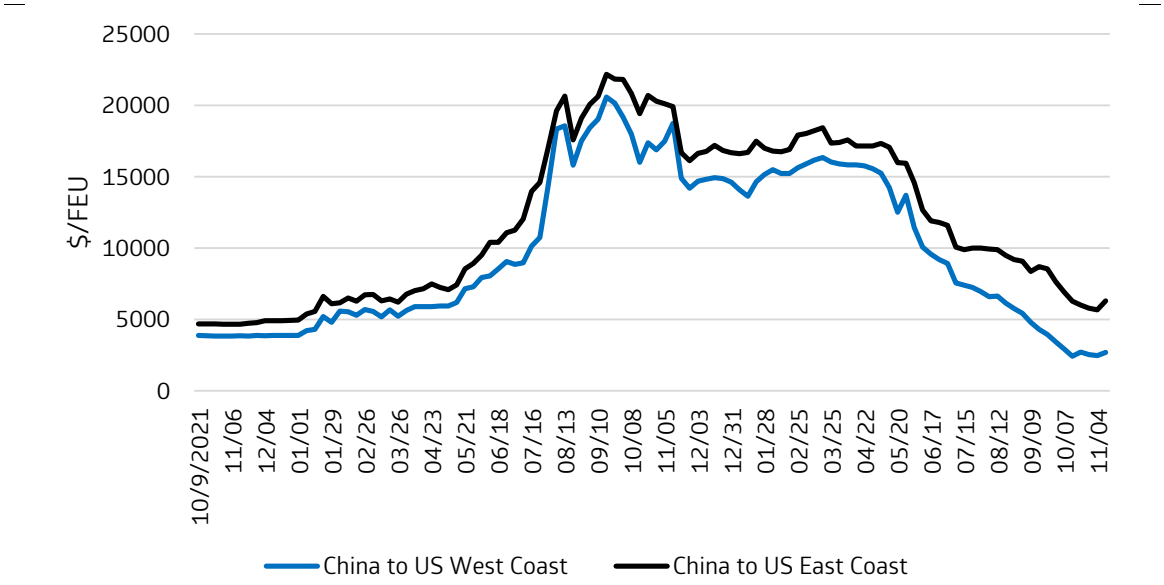
As a result of these dynamics, while there is no more congestion at the West Coast, improvements at the East Coast are expected to lag behind. We also note that anchored vessels are only part of the story – chassis availability remains a constraint at all ports. Panelists at our annual transportation conference pointed out that inland issues continue to hobble fluidity at the ports. At NY/NJ, drivers are facing ~4-hour delays moving in and out of the port as multiple containers sit atop chassis preventing swift loading. The problem persists at LA/LB as well. As we highlighted in our previous AoTC, the Southern California chassis pool was built on 3.5 days per turn and had reached 9.3 days in November 2021. Street dwell at LA/LB has improved only marginally since, dropping to 7.5 days in November 2022. Importantly, however, the crux of the problem is not on the port itself. Participants in our ports call claimed that high inventories are behind the congestion; industrial availability of warehouse space reached as low as 4% in September and continues to be pressured. A panelist emphasized that a shift in inventory management strategies from just-in-time to just-in-case is responsible for greater inland congestion. This means that softening demand and the subsequent freeing up of inventory space should ease congestion as well.

Figure 2 : Anchored Vessels By Week



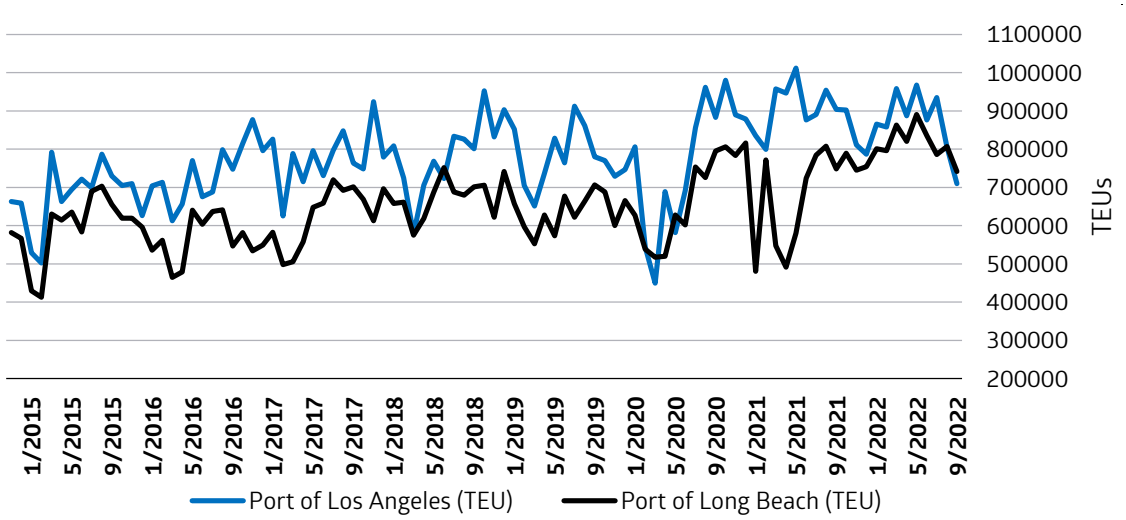
Source: Flexport, Cowen and Company

Figure 3 : Container Rates, China to U.S. West Coast and East Coast (USD per FEU)



Source: Bloomberg, Cowen and Company

Figure 4 : Container Volumes at the Port of LA/LB



Source: Bloomberg, Cowen and Company

This softening of demand is well underway. US container import are down 13% y/y and ~flat sequentially per recent October data. As seen in the table below, container volumes coming in from China, which accounts for 34.9% of total US container imports, declined 5.5% from September to October, driving the slowdown at LA/LB. Concurrently, container rates have continued to normalize, coming down sharply from previous peaks as seen in the chart below. Container spot rates from China to the US

West Coast have now fallen back to pre-pandemic levels. We note that container spot rates could face further downward pressure from a deluge of shipping capacity coming online in 2023 and beyond. The container ship orderbook-to-fleet ratio reportedly reached an all-time high of 30% in mid-2022 and much of that supply could come online at a time when demand is weak. At the same time, however, carriers are already blanking sailings (which are said to sap 20-30% of capacity) in response to slipping spots and could continue to do so, placing a floor on rates.

We consider it unlikely that congestion will return to the ports as we move through 4Q. According to Port of LA officials, typical August peak season freight activity was witnessed in the summer months itself as retailers adopted just-in-case inventory strategies. Some of our companies that reported in 3Q pointed to a peak season that has been pulled forward in the year. Combined with weak demand, we do not anticipate a peak on a y/y basis but rather a normalization towards 2019 levels.

Figure 5 : September to October Comparison of U.S. Import Volumes from Top 10 Countries of Origin

Country	TEU Change	% Change
China	-45,071	-5.5%
Vietnam	-3,636	-2.0%
India	-13,770	-13.3%
South Korea	4,315	5.2%
Thailand	11,691	16.4%
Taiwan	8,917	15.5%
Hong Kong	-2,722	-4.9%
Japan	2,613	5.2%
Germany	72	0.1%
Italy	14,717	32.8%

Source: Descartes

The East Coast Will Permanently Gain Share but not Supplant West Coast Hub

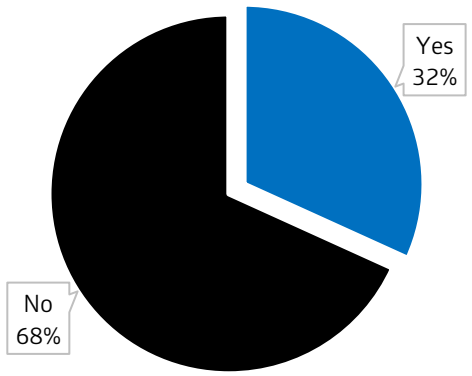
Even as container volumes plummeted at LA/LB, the East Coast ports recorded robust volume growth despite clearly deteriorating macro conditions. In September, container volumes at the ports of NY/NJ, Houston and Mobile were up 34.8%, 36.0% and 17.5% respectively. NY/NJ actually passed LA/LB as the number one container port in the US this year, a historic moment for the east coast. Volumes at Savannah were up 9.6% in 3Q (though down in September due to impact from Hurricane Ian). The Canadian rail giants CP and CNI have moved to capitalize on the diversion of freight from the West coast by striking partnerships with the Port of St. John and Port of Halifax respectively. These partnerships have reaped clear dividends in 3Q22; CP reported international intermodal volume up 30% y/y and CNI reported container volumes handled at Halifax were up 20% y/y.

Equipment availability is also more constrained on the East Coast according to CP. The question of whether these shifts among the ports is a long-term one is of critical importance to supply chains. Our belief is that, in the near-term, a majority of the displaced freight will ultimately move back to LA/LB with the East Coast ports capturing

some share permanently on the margins. In total, this is a slight negative for western railroad UNP and a slight positive for CSX and NSC.

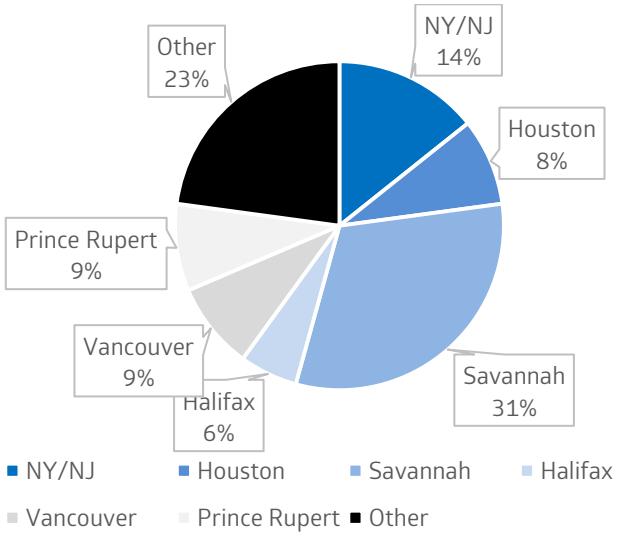
We asked shippers in our proprietary survey whether they had moved freight from LA/LB to other entry points since the start of the pandemic. Only 32% of respondents reported having shifted freight. Of those that had switched entry points, most moved to Savannah, NY/NJ and Houston as can be seen in the chart below.

Figure 6 : Have you moved freight from the Port of LA/LB to other entry points in the past 2 years?



Source: Cowen 3Q22 Rail Shipper Survey, SurveyPlanet.com

Figure 7 : If you have moved freight away from LA/LB in the past 2 years, where have you moved it to?

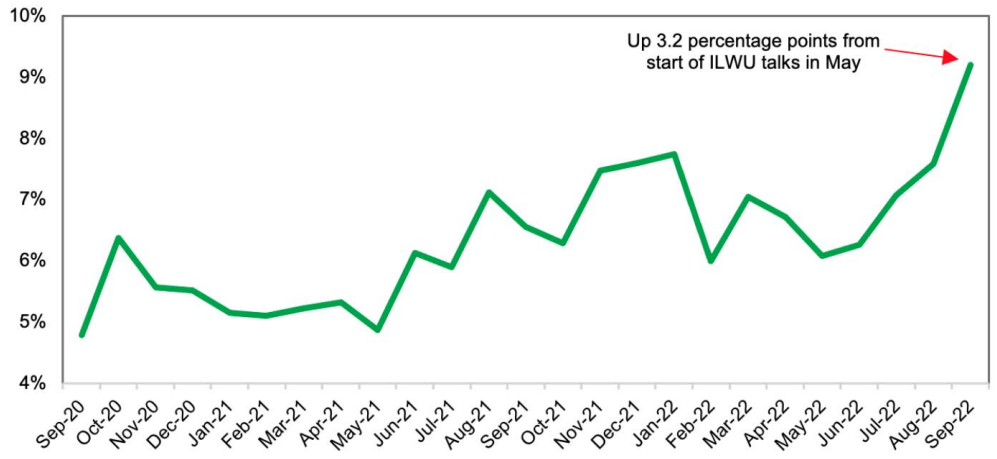


Source: Cowen 3Q22 Rail Shipper Survey, SurveyPlanet.com

At our annual transportation conference in September, an industry contact in the drayage space said that the Port of Houston in particular was positioned to gain some share permanently with a large uptick in capacity on the horizon. More recently, officials

at the Gulf Coast ports have also suggested that this is the case, attributing the shift to the emergence of new manufacturing facilities in the region. The Gulf Coast ports see an opportunity to gain volumes destined for the Midwest which have previously been handled almost entirely by the West Coast ports. UNP and BNSF tested an intermodal service from the Port of Houston to Dallas and Fort Worth in 2019 and 2022 respectively but both discontinued the run. The Port of Mobile in Alabama expects a similar opportunity to capture share of volume moving to the Midwest and is expanding port capacity. CNI and CSX are the main intermodal partners of the Port of Mobile. We anticipate Class I interest in Gulf Coast facilities will return in the coming years as demand trends stabilize and infrastructure in the region comes online.

Figure 8 : Gulf Coast Ports Asia Import Share

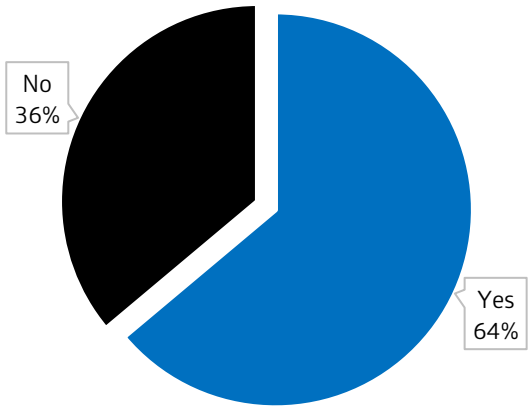


Source: JOC, IHS Markit

Nevertheless, the Port of LA/LB enjoys natural advantages that provide it a solid competitive foundation. Distance to Asia is a big one. Even though ports on the East rank higher in terms of efficiency, it costs $6,293 to move freight from China to the East as compared to $2,702 to ship to LA/LB. The trip from Shanghai to the East Coast is also roughly two weeks longer than to the West. Furthermore, the Jones Act gives international shippers only one berthing choice in the US as foreign vessels are not allowed to drop freight at one US port and sail to another for a second drop.

We believe that most of the current shift of freight away from the West is a symptom of work stoppage fears and inland congestion arising from backed up retail inventories as opposed to a structural loss of competitiveness, i.e., a more temporary hiccup. Panelists on our recent ports call indicated that negotiations between the ILWU and ocean carriers will likely conclude without major impediment as the unions wield considerable leverage. Collective bargaining is underway as of November '22 and has dragged out longer than expected. The Chief Executive at the Port of LA stated recently that it is uncertain whether a deal will be reached by the end of the year. While we acknowledge the possibility that the labor dispute at the port could go the way of the rails with a contracted dispute and risk of strike, over the long-term we believe the bulk of the diverted freight will move back when conditions eventually stabilize. As demand conditions soften and shippers are driven to aggressively manage their margins due to persistent inflation, the LA/LB cost advantage will likely attract freight back. Indeed, 64% of respondents that had switched entry points stated that they would consider moving their freight back to LA/LB upon improvement of labor conditions and inland congestion.

Figure 9 : Will you consider moving freight back to LA/LB if/when labor issues and inland congestion improve?



Source: Cowen 3Q22 Rail Shipper Survey, SurveyPlanet.com

The U.S. Ports are Changing in Long-lasting Ways

1. **ESG pressure**: Environmental considerations will likely thrust the ports into a phase of transition that will impact levels of service and freight rates in the medium to long term. Ocean shipping contributes 3% of global carbon emissions and the industry is widely regarded as lagging in its emissions reduction ambitions relative to autos and oil & gas, among others. In recognition of this, the International Maritime Organization (IMO), a shipping regulator, is requiring shipowners to report carbon intensity as well as develop plans to gradually reduce intensity and make these plans available by January 2023. The NT solution to secure compliance is likely to be a 10% drop in ship cruising speeds; these reportedly cut fuel usage by ~30%. The new rules could reduce capacity by 5-15% according to shipping giants Hapag-Lloyd and Maersk. Moreover, in the long-term, shipowners will need to find ways to make fleets more fuel-efficient, incurring greater R&D and capex, costs that will likely exert upward pressure on rates in the long run.

On the drayage side in California, clean truck rules coming into effect early next year that prohibit the use of models older than 2011 (with some exceptions) could shrink fleet capacity by more than 20% per the California Trucking Association. In our last AOTC edition, we had emphasized that drayage driver shortages lay at the heart of port congestion. While the correction in TL rates has reportedly directed some drivers back into drayage since then, we believe ESG pressures on drayage can shift the baseline of inland congestion at the ports in the medium term, particularly before emission-reducing equipment becomes widely available.

2. **Creeping automation**: Long ship queues and bottlenecks at LA/LB put a spotlight on port productivity and will arguably provide impetus to automation initiatives. The Pacific Maritime Association (PMA), a body representing 70 shipping companies, has called for expanded automated cargo-handling at LA/LB. The two automated terminals at LA/LB reportedly process TEUs twice as fast as conventional terminals and container throughput is 44% higher on average. In August this year, the DOT awarded the Port of LA $3MM to implement cloud-based AI applications to streamline scheduling with the aim of alleviating congestion. Even so, complete and widespread terminal automation

akin to the ports in China is unlikely to occur any time soon as union objection tends to slow port automation substantially. Indeed, automated infrastructure is excluded from grant eligibility per the provisions of the recently passed Inflation Reduction Act. The International Longshore and Warehouse Union (ILWU) has responded to the PMA with a report drawing attention to eliminated manhours and cites an OECD report that finds 7%-15% lower productivity in automated ports compared to non-automated ports. Automation is also deterred by provisions in current labor contracts stipulating that 40 hours of weekly income be payable to any ILWU member that is unable to find work due to automation. As with previous bouts of automation at the ports, we expect staggered, incremental progress in the coming years that will likely continue to lag long term demand growth.

3. **Policy and Legislation**: At the height of this year's supply chain congestion, detention and demurrage (D&D) charges had doubled to reach almost $300/day as shipper's were reportedly kept in the dark about the causes of delays. In response to this pain, lawmakers passed the Ocean Shipping Reform Act (OSRA) which directs ocean carriers and equipment holders to assess D&D charges "reasonably." The Federal Maritime Commission is seeking public comment on what constitutes "reasonable" D&D. It is clear however, that the burden of proof in a dispute has been shifted from the shipper onto the carriers. Perhaps even more importantly for supply chains, the law mandates additional data sharing protocol between shippers and carriers, particularly in periods of congestion. It is yet to be determined what data supply chain players will be required to exchange and how much of an impact the new rules might have in mitigating bottlenecks in the future.

Other policies considered include 24/7 operations (which, without other changes has its challenges) and a container dwell fee. While operating on a 24/7 basis would improve port productivity, reports suggest that only one terminal at LA/LB participated in the experiment in late 2021 and followed the schedule for only 4 days a week. Implementing such a policy would also require the cooperation of drayage truckers, warehouse staff and other port labor. With union labor standing in the way of 24/7 operations and congestion beginning to ease we remain cautious on the uptake of this policy. Similarly, the $100 per day container dwell fee proposed in LA/LB was never fully implemented and is not likely to be required in the NT. Even so, if congestion returns on the other end of the current slowdown, the ports will likely be better positioned to have some of these policies snap back.

4. **Infrastructure Coming Online**: The historic levels of congestion witnessed during much of 21' and 22' has spurred significant capacity building efforts at the major ports. Ports and inland waterways are expected to receive $17 bn in federal funding over five years by way of the Bipartisan Infrastructure Law. Naturally, LA/LB has been the focus of much in the recent efforts. The Port of Savannah is also seeing a swift uptick in capacity building considering recent cargo volumes. The table below lists some of the major projects in the pipeline at LA/LB and Savannah. Several projects are also underway and planned at the Ports of Houston and NY/NJ.

Figure 10 – Major Port Infrastructure Projects Currently in Development

Location	Project Details	Capex Estimated
LA/LB	Four-lane rail-roadway grade separation. Estimated to reduce delays by 2500 truck hours/day.	$20 MM
	Goods Movement Training Campus at San Pedro	$110 MM
	Zero-emission equipment and infrastructure including trucks and other equipment	$760 MM
	Mojave Inland Port with capacity of 3MM TEUs/year to be fully operational in 2024	$75MM
	Commercial Driver's Licenses capacity enhancement to allow more truckers to operate at the port	$40MM
	Barstow International Gateway Facility including intermodal facility, rail yard and warehousing being built by BNSF	$1.5bn
Savannah	Expansion of Garden City Terminal West adding 1MM TEUs in capacity during 2023 and 2024	$200MM +
	Construction of ship berth at Garden City Terminal adding 1.4MM TEUs in capacity in July 2023	ND
	Raising/replacing Talmadge Memorial Bridge to enable handling of post-panamax vessels	TBD
Houston	Project 11 - Widening and deepening channel to accommodate post-Panamax ships	$1bn
	Expansion of Bayport Wharf 6 including building of 1000 ft long wharf; completion expected in 2023	$86MM
	Rehabilitation of Container Yard 3N at Barbours Cut Terminal; increase footprint by a third	$14MM
Mobile	Phase IV expansion program bringing annual throughput capacity to 1MM TEUs; completion by early 2025	$104MM
	Dredging Mobile Harbor to 50 ft draft allowing neo-Panamax vessels up to 14,000 TEUs; completion by early 2025	$366MM

Source: Port of LA/LB, JOC, Cowen and Company

Inflation and Labor Relations at Ports Across the Globe

With inflation reaching a fever pitch not seen in decades this year, port workers across the globe were driven to ignite labor disputes with port management. In the UK, dockworkers at the Port of Felixstowe went on an eight-day strike that resulted in a 7% increase in salaries and a one-time 500 GBP bonus. The Port of Liverpool followed suit in September and then once again in October. Workers at both ports claim the proposed wage increases do not cover inflation which was 12.3% in October and have threatened repeated strikes until demands are met. Unionized port workers in Germany also threatened to strike in August this year securing a 9.4% wage increase and backpay with further wage increases scheduled for 2023. Importantly, port workers and operators may restart negotiations if the rate of inflation remains elevated and erodes purchasing power. A common thread running through each of these strike stories is workers' accounts of the hardship faced during COVID lockdowns as essential employees. In our view, the pandemic-induced spotlight on essential labor has granted port workers across the globe significant leverage that will be deployed more frequently in the coming years, especially if inflationary pressures remain elevated for longer than expected. The threat of recurring port strikes should reinforce "just-in-case" inventory strategies among shippers and retailers. Indeed, supply chain disruptions from the strike at Felixstowe were reportedly mitigated by retailers stocking up on inventory earlier in the year.

We also believe congestion is unlikely to return to exit points in China despite the ongoing zero COVID policy. Our discussions with experts indicate that port capacity is abundant on the Chinese east coast – when Shanghai was crippled by lockdowns, the neighboring ports at Ningbo and Tianjin picked up the slack. As a result, congestion was short-lived – average waiting times for container ships dropped from a high of 69 hours in early April back to the historically appropriate level of 28 hours as early as June. This is a far cry from the chronic congestion the US ports have faced over the past year.

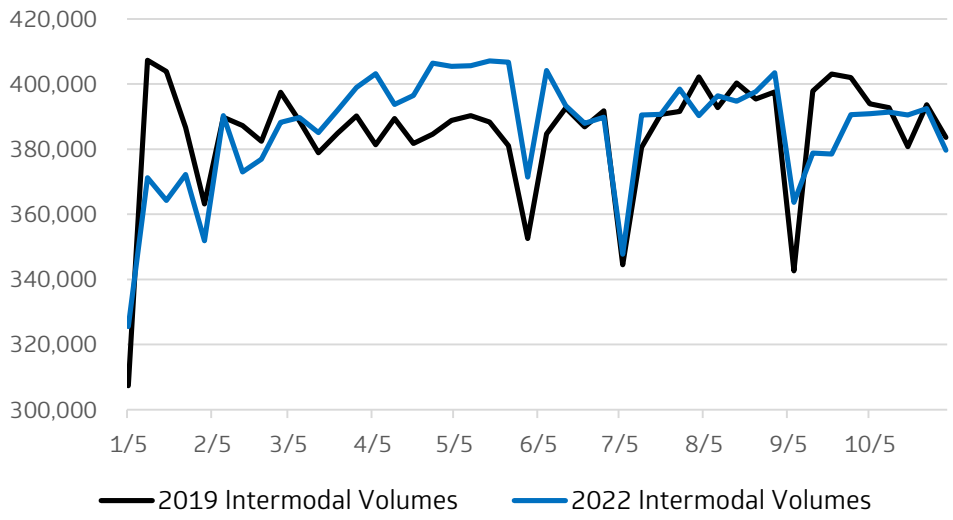
Rail and Intermodal (Jason Seidl)

Total U.S. + Canada carloads continue to trend below 2019 levels (-0.7% in week 44), as service has remained constrained throughout 2022 with gradual improvements. Intermodal volumes are -3.5% YTD in 2022. The year has seen some idiosyncratic pockets of volume strength, however. Auto volume recovery in 2Q and 3Q have supported volumes as chip shortages resolved somewhat and pent-up demand facilitated movement. Auto volumes are up 5.8% YTD in Week 44 with much of the improvements taking place in 2H22 (volumes up 15% QTD). Additionally, coal (up 5.1% YTD) and fertilizer volumes have ticked up significantly on effects of the war in Ukraine.

Network fluidity appears far smoother on the Canadian side translating to comparatively robust volume growth. Both the Canadian Class Is have seen impressive volume growth at their facilities on the East Coast. CP grew intermodal volumes 20% y/y as a result, the only Class I to achieve such a feat in 3Q. By contrast, while NSC reported incrementally improved fluidity metrics these have not yet generated volume growth with intermodal being impacted by a weak peak season and persistent chassis shortages. Even so, the Class Is see improved fluidity starting to support volumes in 4Q and '23.

Presently, capacity rather than demand is the main constraining factor on volumes and although these are coming into balance gradually, we expect volatility will remain a feature of industry trends in the near future. With the demand environment evidently slowing down as of 3Q22, the Class Is have already indicated that a natural attrition rate of ~8%-10% can be leveraged to manage down headcount to preserve earnings. We believe that if the volumes do not come back as rail service continues to improve, the rails may quickly slow the hiring binge, as they have done in the past. With the rails admittedly short in the ability to manage headcount upwards (they fire faster than they hire), this could become a source of volatility again on the other side of the slowdown. Calibrating resourcing with demand may also prove challenging with the impact of the pandemic shock and recovery on peak season predictability. Nearly every large transportation company at 3Q earnings pointed to a muted or non-existent peak season in 2022 with some emphasizing that peak season was simply pulled forward into the summer.

Figure 11 – U.S. + Canada Intermodal Volumes YTD 2019 vs 2022



Source: Railshare and Cowen and Company

Figure 12 – U.S. + Canada Carloading Mix

2021 Carloadings Mix								
Commodity Type	**Class I Total**	**BNSF**	**CNI**	**CP**	**CSX**	**KSU**	**NSC**	**UNP**
Intermodal	50%	55%	46%	39%	47%	42%	58%	46%
Coal	11%	15%	6%	11%	10%	6%	9%	9%
Chemicals	11%	8%	13%	19%	11%	18%	8%	15%
Agricultural Products	9%	10%	8%	16%	6%	10%	5%	10%
Non-Metallic Minerals	5%	4%	4%	5%	8%	5%	5%	7%
Motor Vehicles	4%	2%	3%	4%	5%	5%	5%	4%
Metals	5%	3%	13%	2%	4%	8%	5%	2%
Forest Products	3%	2%	6%	3%	4%	4%	3%	3%
Other	3%	2%	2%	2%	4%	3%	3%	3%
Total Traffic	100%	100%	100%	100%	100%	100%	100%	100%

Source: Company files and Cowen and Company

Trust Erodes between US Class Is and Rail Labor

The rail industry has faced the specter of a nationwide labor strike for the most of 2H22 in a dispute that we believe has far reaching consequences for the sector. The COVID shock flared up deep seated grievances within rail labor resulting in a chain of events that has materially altered the relationship with the Class Is in our view. Rail employment which had already been declining for decades prior to the pandemic recorded a 17% y/y decline in June 2020 when the lockdowns went into full force. Unions and workers view these reductions in headcounts as an attempt to bolster bottom lines at the expense of labor and lament the introduction of the Class Is'

efficiency initiatives like Precision Scheduled Railroading (PSR). Railroad management would counter that they were just being very cautious at the very beginning of the pandemic when proverbial crystal balls were extremely murky. Resentment over benefits was also festering with many unions crying foul over paid time off and sick leave railroad standards. As a result, when demand surged in response to financial stimulus and the Class Is found themselves scrambling to hire to ramp up capacity, unionized railroaders saw an opportunity to negotiate better deals as their 5-year contracts came up on expiry.

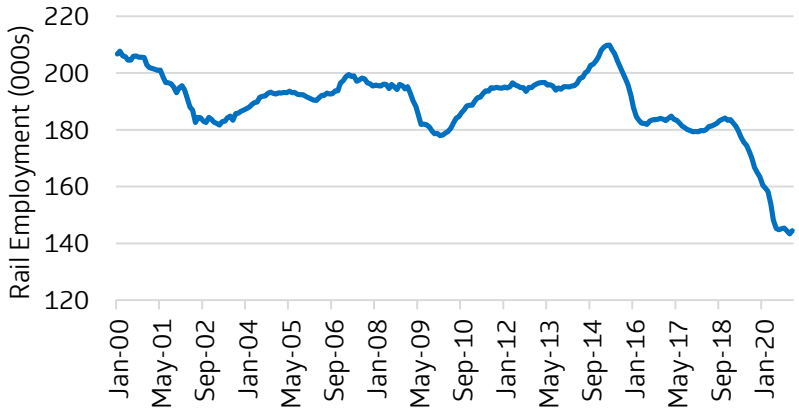
In August '22, a National Mediation Board (NMB) failed to broker an agreement between disgruntled unions and the Class Is and a Presidential Emergency Board (PEB) was established which recommended the Class Is offer workers a 24% wage increase for the 2020-2024 period and $5K bonuses through 2024. The raise constitutes a historic wage increase; NSC noted that the recommendations were two times as large as expectations. Unions nonetheless resisted the deals and threatened to strike and cripple supply chains, potentially costing and estimated $2bn per day. Class Is were forced to embargo hazmat and other shipments for a few days in September as a pre-emptive safety measure. These embargoes were blamed for suppressing 3Q carload volumes during the quarter's earnings calls.

A strike was only narrowly averted by a final push from the Biden administration. Union leaders entered tentative agreements (TAs) with the Class Is based on PEB recommendations and the industry expected ratification of those agreements to come smoothly and put a rest to the dispute. In a notable upset, however, ratification has been fraught with obstacles as three unions at the time of writing voted to reject the TAs in a bid to negotiate more benefits with the Class Is. Paid sick leave has emerged as the single largest source of contention in ratification roadblocks with COVID no doubt playing a role in informing workers' views on the subject. Rail unions played hardball prior to the midterm elections and likely caused substantial animosity with the Class Is and facilitators of negotiations within the government. Presently three rail unions have rejected ratification of their respective TAs - International Brotherhood of Teamsters (BMWED), Brotherhood of Railroad Signalmen (BRS) and International Brotherhood of Boilermakers (IBB).

While rail labor and Class Is have engaged in disputes in the past, the post COVID impasse is protracted and will likely stay in the memories of all involved parties in the years to come. This could potentially produce protracted disputes in the future in a vicious feedback loop. Additionally, the proposed wage increases have arguably permanently shifted the baseline of per employee labor costs for the Class Is, accruals notwithstanding. We expect the rails to pass these costs on to shippers over time (the average intermodal contract is ~3 years, rolling over throughout the year).

Only 10% of CP's total workforce is unionized labor in the US which is not part of the collective bargaining process and as such the Canadian Class I is well positioned from a labor cost and relations standpoint. CNI is also relatively insulated with 32% of its total workforce constituting unionized US labor. We note that CNI's US labor force was subject to collective bargaining. We continue to favor CP as our top rail pick, given the limited union exposure, continued execution across key segments such as grain, potash, and intermodal, and long-term tailwinds from the CP KCS merger. In the near-term, we feel the only negative to CP is that it is the best performing Class I YTD. We believe that U.S. investors have been taking shelter in Canadian names despite parallel macro pictures, which may warrant some near-term volatility.

Figure 13 : Rail Employment 2000-2021



Source: Bureau of Labor Statistics

Figure 14 : PEB Recommendations

Date	Increase	Compounded
7-1-20	3.0% GWI	1.030
12-1-20	$1,000.00 service recognition bonus	
7-1-21	3.5% GWI	1.066
12-1-21	$1,000.00 service recognition bonus	
7-1-22	7.0% GWI	1.141
12-1-22	$1,000.00 service recognition bonus	
7-1-23	4.0% GWI	1.186
12-1-23	$1,000.00 service recognition bonus	
7-1-24	4.5% GWI	1.240
12-1-24	$1,000.00 service recognition bonus	

Source: Presidential Emergency Board

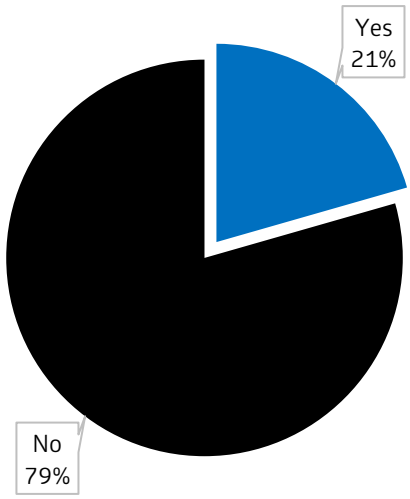
ESG Penetrates the Shippers' Business

ESG factors will gradually make their way into transportation strategies of shippers and warehousing players alike, having permanent impacts on supply chain needs. We note that presently it is larger shippers that are predominantly incorporating ESG considerations into their decision making.

At our 2022 annual transportation conference, CSX noted that larger customers increasingly have internal targets on their carbon footprint that are driving truck conversions and are also compelling the rail giant to more deliberately measure fuel

savings. HUBG echoed this sentiment on the intermodal side, indicating that ESG is a key purchasing requirement for larger global customers, particularly in retail and food and beverage freight. Our panelists confirmed to us those customers are increasingly willing to act on ESG targets where previously these considerations were merely formulated and discussed. Participants at the recent Fall 2022 NEARS conference also suggested that emissions targets had become important to larger shippers. We asked shippers in our proprietary survey whether ESG factors were part of their process and 79% of shippers responded that they were not. We believe this response indicates we are in the early stages of shippers adopting ESG practices across their supply chains.

Figure 15 : Have ESG targets become part of your decision making?



Source: Cowen 3Q22 Rail Shipper Survey, SurveyPlanet.com

ESG targets should make their way into the behavior of small and large shippers alike over the long term in our view. According to the Association of American Railroads (AAR), freight railroads are 3-4x more fuel efficient than trucks on average. By moving freight by train instead of OTR, greenhouse gas emissions can be reduced by up to 75%. Additionally, railroads make up ~40% of the long-distanced freight moves in the U.S., but only ~2% of the related greenhouse gas emissions.

In some prior research notes we looked at a specific lane (from Newark NJ to Saint Louis MO) and compared the fuel consumption of an intermodal move vs a full truckload move. Our analysis suggested that the intermodal route was 3.3x more fuel efficient when compared with an over-the-road alternative. As shippers weigh their carbon footprint from a transportation angle, moving freight via intermodal is the most impactful and effective, at the expense of one transit day.

The intermodal route is ~960 miles, 15 miles of which consist of a drayage move (which requires a truck); the drayage move accounted for 5% of the total diesel output. The truckload route has a slightly shorter distance at 945 miles total. According to the Federal Highway Administration (FHA), the average miles per gallon on the average Class 8 truck is 5.3, which is what we used to calculate diesel consumption. On this same lane, on a dollar basis, shippers can save ~45% by moving their freight via intermodal; at the time of the analysis the rate from Newark to Saint Louis is ~$1,400 for intermodal, and ~$2,050 for truckload.

The Case for Mexico (Jason Seidl)

The disruptions created by the pandemic has re-ignited the case for Mexico, a friendly neighbor in close proximity that may offer an attractive manufacturing opportunity as management teams re-think trans-Pacific supply chains. Companies were caught with vulnerable supply chains as the volatility in supply/demand imbalance grew from COVID, lockdowns, and consumer demands. Differing restrictions by country clouded standard operations while just-in-time management proved to lead to thin inventory levels that led to a supply chain glut.

While manufacturers are still primarily relying on Asia, recent data points have suggested that it may pay to diversify manufacturing/logistics footprints. We focus on the opportunity for Mexico to be a larger U.S. partner given the potential catalyst for North American transportation and logistics.

We will briefly discuss four motives for transitioning to Mexico, and the implications to the NA supply chain.

1. **Labor**
2. **Delivery Proximity**
3. **Geo-political risk, Tariffs**
4. **ESG – Labor rights and Proximity**

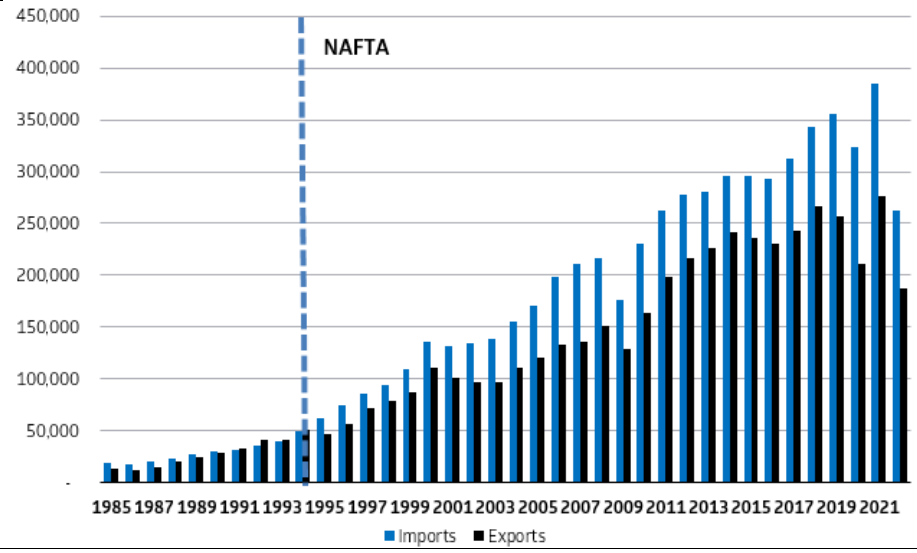
We believe the largest beneficiary of a nearshored supply chain is Canadian Pacific

Assuming the STB clears the transaction with Kansas City Southern, CP will have a unique opportunity in connecting North American freight from Mexico to Canada. Direct access through Lazaro, through rail hubs in the U.S. (near Chicago while avoiding primary hub) to both the East and West coasts of Canada offer a seamless transportation route for manufacturers. Over the longer-term, if the opportunity for Mexico to grow into the manufacturing hub in North America continues to play out, we believe CP will be poised to capture this freight moving north.

The Auto Industry is Already a Powerhouse in Mexico

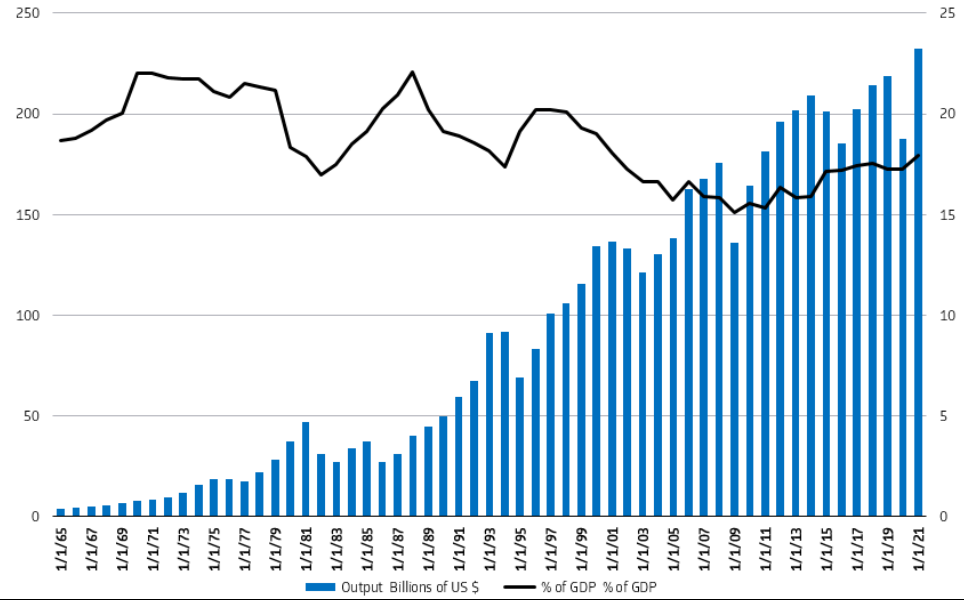
Mexico is currently the world's seventh largest automotive vehicle manufacturer, of which 90% are exported and 76% being to the United States. Manufacturers include Audi, BMW, Ford, GM, Honda, Hyundai, Toyota, among others. Mexico is also a global leader for vehicle parts and heavy-duty vehicles for cargo. How did Mexico become a choice for auto manufacturers? In the 1920s-1930s General Motors and Chrysler first built assembly plants to supply the domestic market. Over the following decades, the market grew into a global leader driven by policy and incentives, most notably the NAFTA (North American Free Trade Agreement) that went into effect in 1994, which sharply lowered barriers and costs. Since then, the market has continued to flourish, and has been a powerhouse for the Mexican economy. We believe the auto industry offers an example for other companies looking deeper into the opportunity in Mexico.

Figure 16 : Trade in Goods with Mexico, Millions of USD



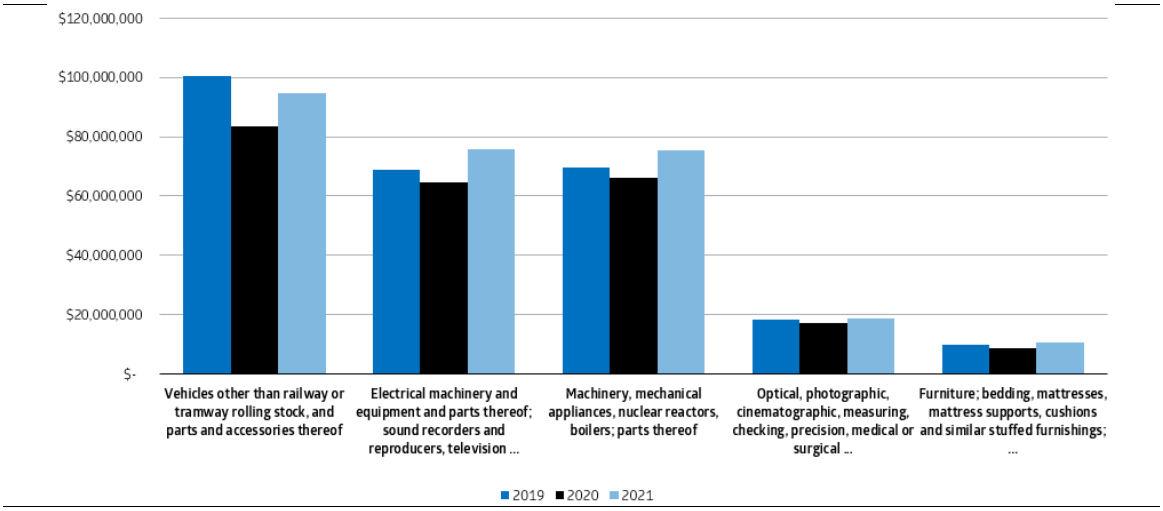
Source: U.S. Census Bureau, Cowen and Company

Figure 17 : Mexico Manufacturing Output and % of GDP



Source: MacroTrends, Cowen and Company

Figure 18 : Mexico's Exports to the United States, Thousands



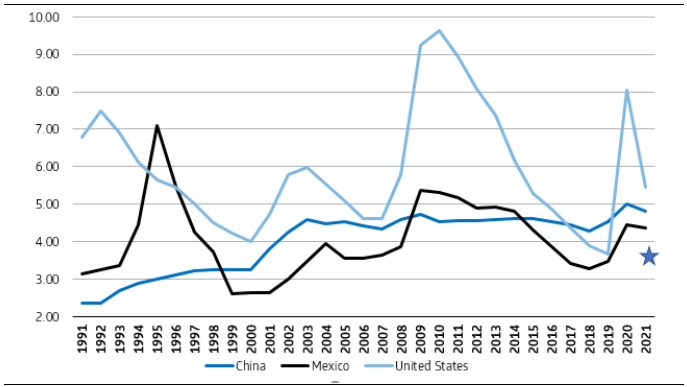
Source: Trademap, Cowen and Company

Labor

Two areas of main consideration are 1) the cost of labor in Mexico vs. China, and 2) labor participation within Mexico. We discussed the notion of reshoring during Cowen's transportation and sustainable mobility conference, where panelists shared both optimism and skepticism on the labor market of Mexico. One highlighted concern that while labor participation is growing, there are significantly fewer people in Mexico (129MM as of 2020) versus China (1.4bn as of 2020) or the U.S. (330MM as of 2020). That said, the access to labor appears to be more stable in Mexico, with less fluctuation in unemployment.

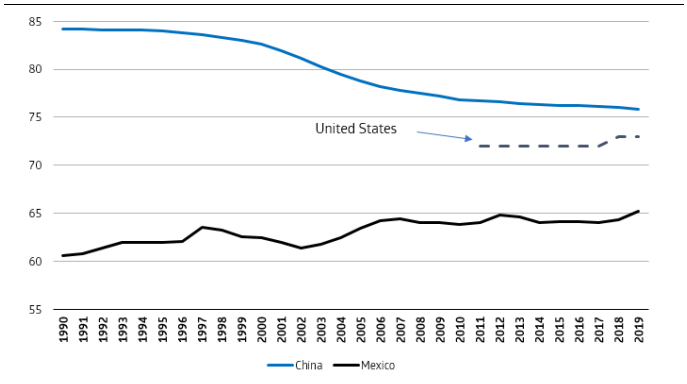
In 2021, the unemployment rate for the United States, China, and Mexico was 5.5%, 4.8% and 4.4%, respectively, according to the World Bank. The current rate of unemployment in the US is now 3.7% (starred on the chart below as of August 2022), and below both China and Mexico.

Figure 19 Unemployment Rate, %



Source: World Bank, Cowen and Company

Figure 20 Labor Participation Rate, %



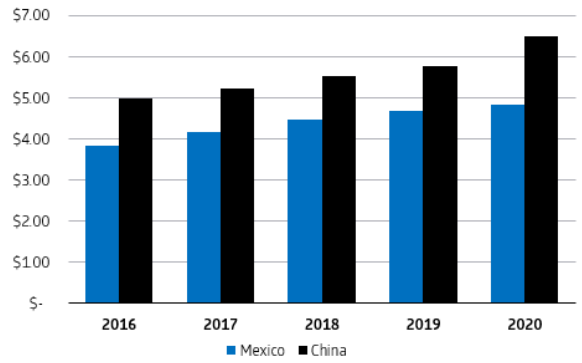
Source: World Bank, Cowen and Company

The labor participation rate in China has declined 10% since 1990, while the labor participation in Mexico has increased 5% to 65% in 2019, still below the United States that has hovered around 72-73% over the last nine years.

The quantity and quality of skilled labor has been a debated topic, specifically as companies weighed the benefits and abilities to move skilled labor positions (think electronics) out of China and into other parts of Asia.

As of 2020 the average hourly wage was $1.68 lower in Mexico than China. Specifically, the average hourly wage in China, according to Statista, was $6.50, and $4.82 in Mexico for 2020. In contrast, the hourly wage in Vietnam in 2020 was $2.99.

Figure 21 : Hourly Wages, USD



Source: Statista, Cowen and Company

Delivery Proximity

Delivery proximity was the most widely discussed merit for Mexico during Cowen's transportation and sustainable mobility conference in September. Companies are already working on the fringes of certain countries to inch closer to the end consumer. Additionally, the evolution of the consumer has led to new demands including sustainability, customization, and speed. The ability to have your manufacturing and supply chain infrastructure substantially closer to the consumer shortens lead times, giving more clarity to a widening SKU market.

Mexico has a freight rail system that is owned by the national government and operates under certain concessions which are granted. Mexico is comprised of six private rail systems, with the two largest by far being Kansas City Southern and Ferromex. Between 1995 (when legislation in Mexico created a more competitive rail system) and 2014, freight rail traffic doubled. The Mexican government is behind the growth of this network, and in February 2021 announced an investment of $525MM USD, half of which will be used for maintenance work, and the other half will be assigned for growth projects in key regions. The Class Is have agreements with the Mexican rails, with KCS having the largest presence in the region.

Figure 22 : Rail Map, Mexico

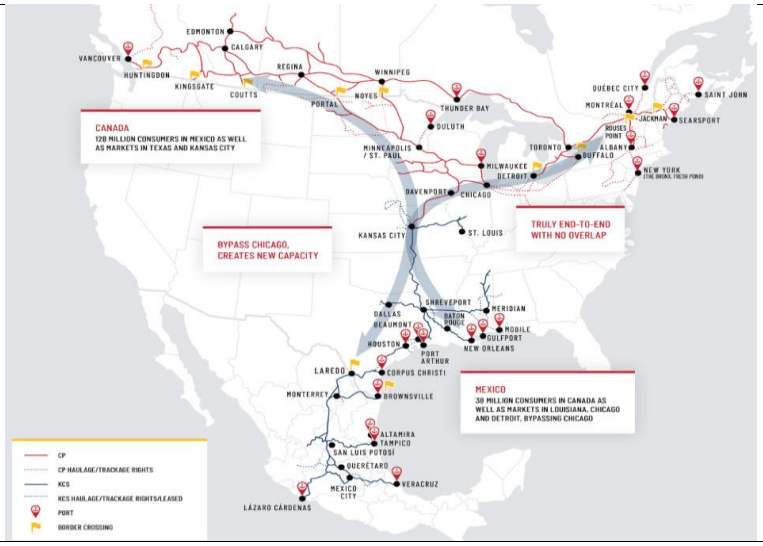
Source: Anuario Estadistico Comunicaciones y Transportes 2014

Lazaro Cardenas is a port city in Michoacan (seen in the map above) that has exclusive rail service with Kansas City Southern. The port of Lazaro Cardenas has grown to be a large and popular port given its proximity to Asian ports and distance to the US. The port also exports a large amount of automobiles. During COVID, more cargo was routed to the port due to the congestion seen at the port of LA/LB.

We will use this Lazaro Cardenas as a focal point to measure the distance, time and cost when compared to China, given its large exposure to its bellwether, automobiles. While some of the largest manufacturing cities are even closer to the US (largest regions are central Mexico and Northern Mexico), we will use this rail comparison because it is one of KCS's longest lengths of haul.

In May, CP debuted their first rail service between Lazaro Cardenas to Chicago, a 7-day journey that if/when formally approved by the STB, could be a gamechanger in terms of intermodal service in North America, in our view. This 7-day journey, compared to setting sail from China, would save ~two weeks in transit time. The average sail time from Shanghai to the Port of LA is 15 days (not including terminal dwell delays which have been the norm for the past two years), and an additional 2-4 days via truck.

Figure 23 : CP/KCS Combined Rail Map



Source: Futureforfreight

In 2Q22, KSC's revenue per carload for an intermodal unit was $418. The average length of haul for Class I rails is ~1,000 miles. Using these as our proxy, and the length of haul from Lazaro to Chicago being ~2,300 miles, we estimate it would cost (as of 2Q), approximately ~$960. Using the same scenario to move a railcar carrying automobiles (which was $2,006 in 2Q), we estimate the cost being $~4,600. Given elevated rail pricing we've seen over the past two years given congestion, we expect these rates to be on the higher end (when compared to $363 in 2021 for an intermodal revenue/unit). We do acknowledge there are other components to this metric that cloud the exact pricing of a carloading (demurrage fees, surcharges, etc.).

As we highlighted in the Ports section, spot pricing from China to the West Coast has come down considerably and is now back to pre-COVID levels of ~$2500. Considering the move via rail/truck after it arrives at the port (plus drayage), clear cost savings are seen from nearshoring a supply chain, all else being equal.

There is a clear opportunity for shippers to consider the long-term approach to bringing their supply chains closer to home, not only for the cost savings described above, but for lead time of approximately two weeks; as shippers have learned navigating through the pandemic, tides can turn abruptly and every day counts.

Geo-Political Risks, Tariffs

In 2021, Mexico was the second largest trading partner with the U.S., behind Canada. Total U.S. merchandise trade (exports + imports) totaled $661bn with Mexico, slightly above total merchandise trade with China at $656bn. Economics largely credit NAFTA for the trade growth which went into effect in 1994. On July 1, 2020, USMCA replaced NAFTA. While most provisions remain intact, some modifications were made; for example, for motor vehicles, raising the minimum level of regional value to 75% from 62.5%, a new requirement that 40%-50% of wages must be made by workers earning at least $16/hour, and requiring 70% of a vehicle's steel and aluminum originate in North America. While the largest area of concern in congress is workers' rights, most politicians and economists are largely in line that the USMCA will likely bolster North American supply chains.

While the trade relationship is aligned, domestic policy has historically been an area of contention. Most notably visible in the country's Mexico City airport cancellation in December of 2018 which scrapped more than $13bn as Mexico's incoming president Lopez Obrador found the project too expensive; large spending and policy shifts may give second thought to large scale investments.

Cowen's Washington Research Group Views on Current China Dynamics (Chris Krueger - Washington Research Group)

The U.S.-China relationship remains on a competitive trajectory, although broader global concerns have temporarily put it on pause in 2022. For now, domestic politics, rising global inflation, slowing economic growth, an unexpected war in Europe and the ongoing pandemic have combined to slow the U.S.-PRC geopolitical competition.

The Biden administration and U.S. Congress continue to debate tougher U.S. policy toward China but the most severe measures (one exception) have been delayed. While there could be some short-term positives (i.e., targeted tariff relief), we believe both governments will continue to implement policies, laws and regulations that will push the U.S. and PRC further apart, drawing their own orbits of allies with them.

Current Expectations

U.S.-China relations remain frozen, and we do not expect a serious or positive thaw anytime soon. The Biden Administration and Congress continue to pursue policies to challenge China diplomatically, economically, technologically, and militarily. While some in the U.S. continue to see reasons for optimism and opportunity in China, and there could be some in the short term (such as targeted tariff relief), we believe both governments will continue to implement policies, laws and regulations that will push the U.S. and People's Republic of China (PRC) further apart, drawing their own orbits of allies with them. Post-November and into 2023, we believe the rhetoric on both sides will intensify.

Tariffs

The Biden White House finds itself wrapped around the self-created Section 301 tariff axle on $300B+ in Chinese goods — largely by its own public comments and external arguments between Treasury/Commerce and the USTR. The Administration is desperate to show/sell the idea that they are doing everything they can to lower inflation. Tariff relief remains the last unilateral option, even though many critics argue it will be fairly minor and a one-day headline.

Figure 24 : U.S.-China Tariffs

Tariffs, by percentage rate, imposed by the U.S. and China on each other since July 2018

	Imposed by the U.S. on China	Imposed by China on the U.S.
July 2018	**Aircraft parts, semiconductors, microscopes** (25%) $34B	**Soybeans, wheat, electric vehicles, whiskey, seafood, cigars** (25%) $34B
August 2018	**Motorcycles, steam turbines, railway cars** (25%) $16B	**Beef, poultry, fiber-optic cables, motorcycles** (25%) $16B
September 2018	**Fabric, modems, chemicals, furniture, seafood** (10% raised to 25% in May 2019) $200B	**Cosmetics, vodka, reptiles, wigs, diamonds, video games** (5% to 10% raised to 5% to 25% in May 2019) $60B
September 2019	**Agricultural products, antiques, clothes, kitchenware, footwear** (15% dropping to 7.5% under an agreement announced December 13 in which China promised a "corresponding" amount of tariff rollbacks) $110B	**Agricultural goods** (5% to 10% on top of existing tariffs ranging up to 25%), crude oil (5%) $25B

Source: U.S. Trade Representative, Cowen and Company

ESG – Labor Rights and Proximity (Jason Seidl)

The USMCA stepped up labor provisions when compared to NAFTA, prioritizing labor obligations and making them fully enforceable. The USMCA requires parties to adopt and maintain labor practice rights in accordance with the International Labor Organization (ILO) to enforce labor laws. The laws also include provisions that address workplace violence, labor rights, sex-based discrimination, to ensure a fair and just work environment. The enforcement comes from the Interagency Labor Committee for Monitoring and Enforcement – since 2016, the ILAB has received approximately $50MM dedicated to the USMCA.

On May 1, 2019, Mexico signed a labor reform bill that significantly improved workers' rights, allowing them to join unions, vote for union representation, and the formation of a council that conciliates in labor conflicts.

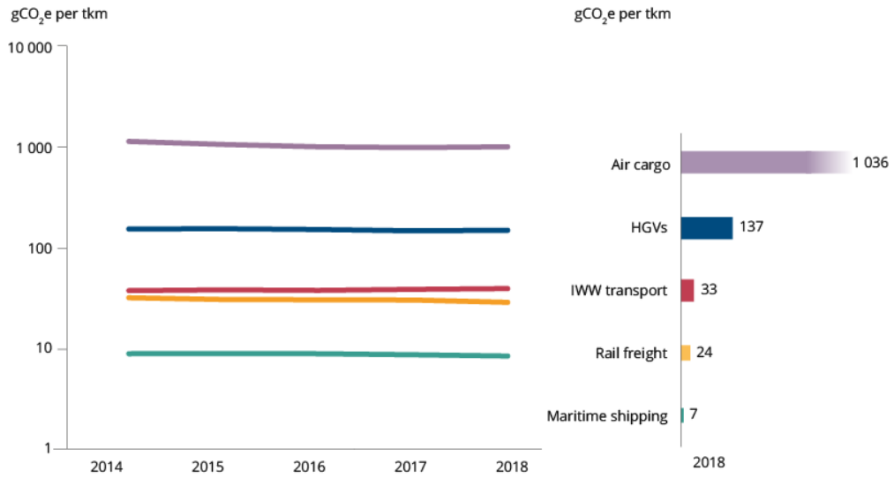
Historically, U.S. labor advocates were skeptical of free trade agreements with developing countries because of lower standards of both labor and wages. With labor reform in Mexico, and if executed properly, we see labor conditions, unionization, and wages benefitting both North American countries.

Figure 25 : Labor Rights - NAFTA vs. USMCA

Source: U.S. Trade Representative

Another benefit bringing a supply chain closer to the consumer is the reduction in carbon emissions. While freight traveling by water produces significantly less carbon emissions (see figure below), there are additional drayage components. According to European Environmental Agency, maritime time shipping is over 3x more fuel efficient than rail freight. The chart below suggests that ocean shipping produces 7 grams of carbon dioxide per ton kilometer, while rail freight generates 24 grams per ton kilometer.

Figure 26 : Average Greenhouse Gas Emissions by Mode of Transportation



Source: European Environmental Agency

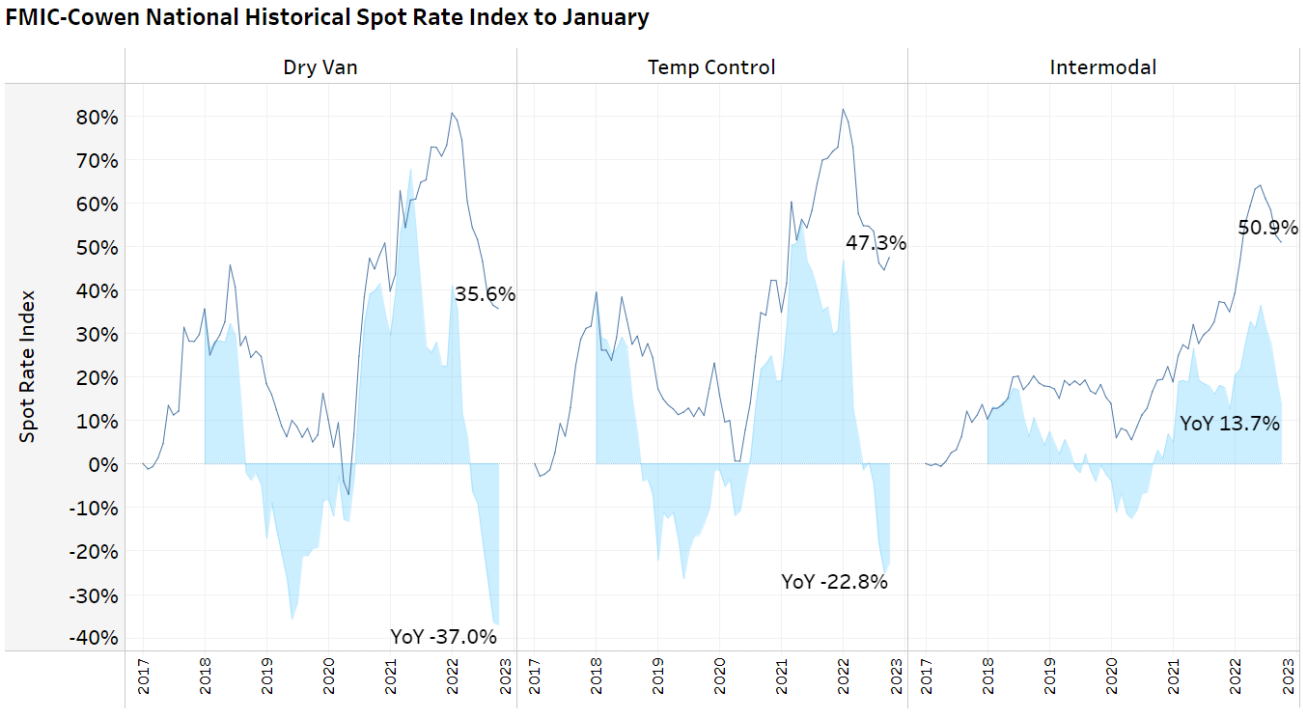
Total emissions will vary greatly depending on the weight of the shipment. Regardless, moving manufacturing closer to the consumer can have other positive impacts on carbon emissions. For example, shortened manufacturing lead times (due to the proximity) would likely lead companies to better manage inventory levels – and reduce overproduction. There have been reports stating that the waste generated from overproduction can have large negative impacts from an environmental perspective.

Closer proximity will also make it easier for management teams to be involved with manufacturing and partners, potentially reducing the risk of unethical behavior. Instead of having a representative travel overseas once a year to Asia to walk the plant, the idea of doing a day trip to Mexico brings more trust and flexibility to the process, in our view.

Trucking (Jason Seidl)

After a frothy 2021, spot markets have made a remarkable turnaround in 2022 as market conditions soften rapidly. Dry van spot rates are down 37.0% y/y bringing them close to 2018 levels though still above pre-COVID levels (noting that 2019 was a down-cycle in the freight markets). Given a grim outlook for 2023, we believe downward pressure on spot rates will likely continue in the near term. Dry van contract rates, though cooling and off from peaks, are still up 17% y/y. The large TL carriers we cover, and industry contacts have both highlighted that persistent inflationary pressures prevent a steep decline in contract rates as costs are passed on to shippers.

Figure 27 : National Long-Term Spot Rate Trends Index; 2017 Contract Baseline (Line), Y/Y (Area)

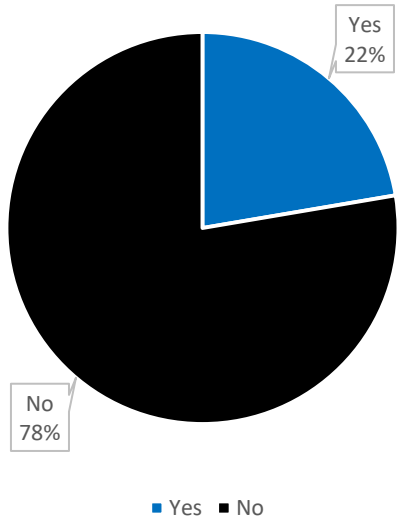


Source: Cowen and Company, FMIC

Equipment Constraints Continue

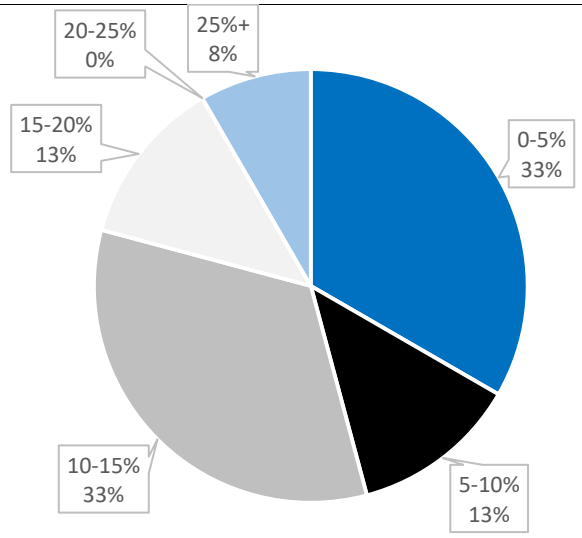
Despite recent improvements in chip supply, carriers report significant difficulty in obtaining equipment. At our annual transportation conference this year, the consensus view from management teams was that truck availability will continue to be challenged into 2023, as new Class 8s were ~10% below the order book this year. This was reiterated during 3Q earnings. Spare parts supply continues to be constrained. Yet, we do not see signs of widespread double ordering among smaller carriers as they scramble to secure capacity. As can be seen in the chart below, 78% of carriers in our proprietary survey responded that they had not placed orders in excess of requirements to ensure delivery. Of the respondents that had placed excess orders, 54% had over ordered more than 10% of their fleet size.

Figure 28 : Are you ordering more trucks than you need given OEMs are struggling to deliver equipment in a timely fashion?



Source: Cowen 3Q22 Carrier Survey

Figure 29 : If so, by what % are you over ordering equipment?



Source: Cowen 3Q22 Carrier Survey

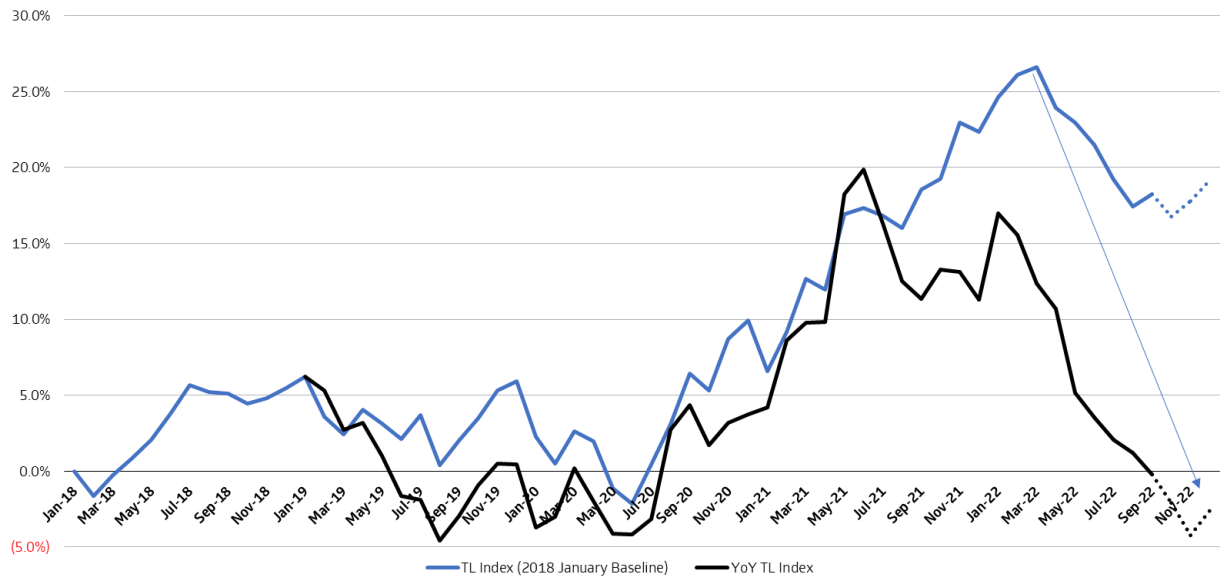
As a result of these bottlenecks, carriers are operating fleets far older than they would like to, placing pressure on NT margins through elevated maintenance costs and lower fuel efficiency. CVLG, for example, witnessed a 51% y/y increase in operations and maintenance costs in 3Q due to an elevated fleet age resulting in an OR miss. We believe this puts pressure on smaller carriers in the industry, which are already reeling from declining spot rates. It is also a major factor in drivers switching from operating under their own authority to company driving as entering the spot market entailed obtaining

capacity that was expensive to procure and maintain. WERN pointed out on its 3Q earnings call that net registrations of carriers have declined fairly consistently over the past 6 months. We anticipate that TL capacity will continue to contract going into 2023 and could accelerate if diesel prices materially spike.

Cowen AFS Freight Index

Our quarterly predictive freight index is driven by AFS's applied machine learning, data science, and the company's $10bn annual transportation spend. The forecast suggests that TL rate per mile will step down in the fourth quarter, with a sequential decrease, to 17.9% off the January 2018 baseline. On a y/y basis, the index turns negative in the fourth quarter, as clear signs of softening are seen in the economy; this was the first time the y/y index was negative since 3Q2020. Growth in TL linehaul cost per shipment declined in 3Q, the second quarter in a row, while still up 6.4% y/y. Sequentially, TL linehaul cost per shipment declined by 0.8%. Overall miles per shipment increased 3.0%. While the data suggests a clear softening in TL rates, we see this story as being very well understood by the market and AFS data suggests that negative rates in 4Q are modestly better than our previous conservative forecasts. This comports with views expressed by industry contacts that inflationary pressures such as driver pay and maintenance costs are preventing a much steeper decline in spot rates.

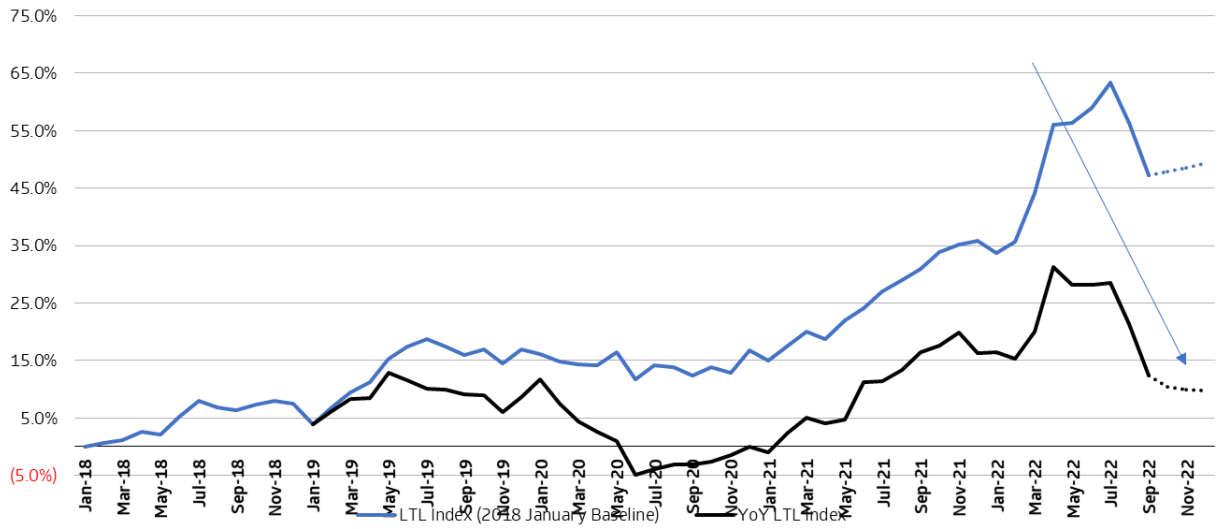
Figure 30 : Truckload Rate Per Mile (Monthly)



Source: AFS and Cowen and Company

The AFS index suggests that the LTL rate per pound is expected to step down again in Q4, to 48.6%, off the January 2018 baseline. This suggests a ~7% quarterly sequential decrease but still a 10.1% y/y increase. This AFS data aligns with commentary from our recent private trucking and logistics call where panelists discussed a muted peak season and surcharges coming down materially – equipment continues to be an issue (see our full note here). Weight per shipment declined in Q3, an indication of weakening demand (less freight in the truck) while LTL cost per shipment decreased 2.4% sequentially and +20.3% y/ y.

Figure 31 : LTL Rate Per Pound (Monthly)



Source: AFS and Cowen and Company

AB5 and CARB Hit Trucking Capacity

With the US Supreme Court having denied review of the California Trucking Association's appeal to stave off independent contractor regulations, drivers, carriers, and shippers in the state are coming to grips with AB5. The law bars drivers from operating under their own authority and will prompt a host of adjustments among supply chain players in the state.

We believe that to comply with AB5 regulation, carriers will either transition to a brokerage model or a pure company driver model. Panelists on our recent trucking call pointed out that smaller carriers with less legal and financial wherewithal are likely to remain non-compliant and face penalties or move to other states altogether, creating an opportunity for larger carriers to take share. Less popular options include the 2-check model (carrier pays driver separately for labor and a truck lease) that introduces tricky tax complications, and a B2B exception that is difficult to qualify for.

Complying with AB5 will entail increased costs particularly for drayage carriers that will be ultimately passed on to shippers, given that the EBITDA margin structure of a drayage business is already only 8-10% — drayage carriers cannot absorb significant cost increases. Independent contractors tend to drive older (albeit well maintained) trucks and are usually not suited for carriers' dedicated services. Transferring these contractors to a company driver model and repurposing their operations for dedicated service (99.9% on-time performance) is therefore costly with a ~20% increase in costs suggested; administrative costs of the transition add on to the burden.

To be sure, enforcement of AB5 will prove tricky, but larger carriers will comply nonetheless to eliminate risk of a costly sanction from the state. Disgruntled O/O's have recourse to the Private Attorneys General Act (PAGA) to dispute AB5 enforcement on behalf of the whole group. By large, O/Os in California prefer operating under their own authority and are highly motivated to find workarounds.

We remain cautious on the prospect of similar regulation spread to other states. Regulation similar to AB5 is already widespread across the country (roughly 30 states, according to one of our panelists) in less draconian forms and is unlikely to be taken down the California path. Our participants flagged NY/NJ and Illinois as states to monitor and emphasized the role of pro-labor politics in supporting independent contractor regulations (the darker the blue state the more likely AB5 will be pushed, according to our panelists). Even so, attempting to force unionization elections is a costly affair which will force unions to be selective in targeting carriers and whipping up support for such legislation.

In our view, the California Air Resources Board (CARB) rule, which takes effect January 1, 2023, could be the largest regulatory burden on the horizon. Beginning next year in California, trucks and busses that were made before 2011 will become obsolete (there are some small exceptions) and not allowed on the road. While aspects of CARB have been in effect for years, the latest requirement puts further tightness on the trucking market that has been under significant pressure the past two years. While used truck prices are starting to decelerate, our panelists stated that truck pricing is still up more than 30% — this will likely put more pressure on the truck market in California. For many O/Os, their truck is their largest asset; making models obsolete should hurt their bottom line and ultimately drive up costs to shippers. There have been estimates that ~80,000 Class 8 trucks will be affected by rules coming January 1.

As addressed previously, some loss of business at the Port of LA/LB resulting from AB5 and CARB will likely be permanent (a negative for someone like UNP), but as stated previously, we remain cautious on the magnitude of the shift with ocean rates to the West Coast slipping rapidly and the potential resolution of labor issues on the horizon. Alternative entry points will be aided by increased infrastructure development allowing larger vessels and the relative cost advantages in real estate for warehousing customers.

Insurance Cost Inflation

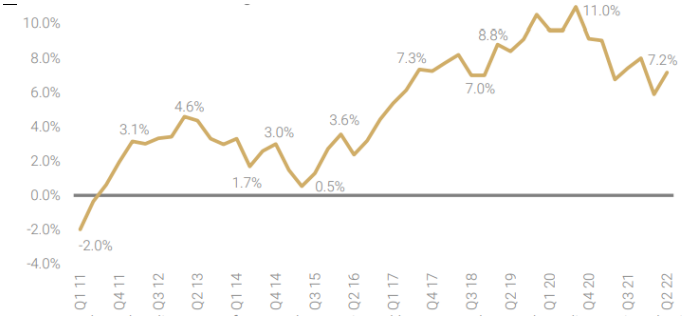
Highway safety had been deteriorating even before the pandemic with highway infrastructure upgrade lagging economic growth and steadily worsening congestion. While crashes involving large trucks had come down slightly in 2020, the figures were still up 39% from the start of the decade according to data from the National Safety Council (NSC). Worsening safety conditions on the roads have naturally coincided with increased insurance costs for carriers across the country. The American Transportation Research Institute (ATRI) estimates that insurance premiums cost carriers ~9 cents/mile in 2020, a 47% increase over the decade, and that smaller fleets faced the largest hikes. Neither the ATRI nor the NSC have published more recent statistics on accidents and insurance costs.

We hypothesized that heightened supply chain congestion, inflation, and a long-in-the-making decline in the number of insurance providers would have put upward pressure on insurance costs post-pandemic. On aggregate, commercial auto renewal premium rates increased 7.2% y/y in 2Q22 per the Council of Insurance Agent & Brokers' (CIAB) Quarterly Commercial Market Pricing Survey. This constitutes 44 consecutive months of premium increases. Our proprietary survey corroborated this pressure on insurance costs with 66% of carriers in our proprietary survey reporting a 5-15% increase in insurance costs as can be seen in the chart below.

Figure 32 Insurance Cost Per Mile (Pre-Pandemic)

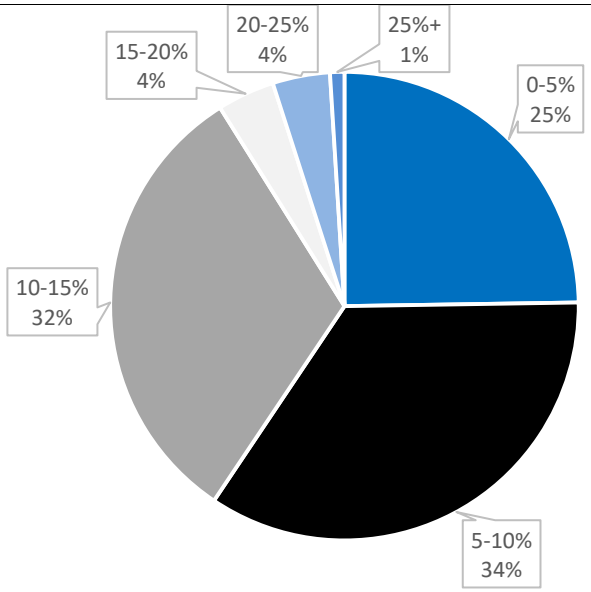
Source: ATA

Figure 33 Commercial Auto Premium Growth



Source: Council of Insurance Agents and Brokers

Figure 34 : How much of an increase in insurance costs have you seen in the past 2 years?



Source: Cowen Carrier Survey, 3Q22; SurveyPlanet.com

Several factors are responsible for elevated insurance costs to carriers. Inflationary pressure on auto parts, equipment and claims administration costs mentioned earlier are passed through in premiums as they prop up claim values. The burden of insurance costs has been amplified in the past 2-3 years by more frequent "nuclear verdicts" or cases where a jury awards more than $10MM. With trucks required by federal law to carry $750,000 in insurance, nuclear verdicts are reportedly leading to premium hikes in the excess liability markets. According to a Fitch Ratings report, the average closed claim payment in commercial auto grew 35% from 2016-2021. These trends are also reinforced by a surge in litigation financing wherein investors supply funds to support legal battles in return for a share of the reward. Per Swiss Re, third party litigation

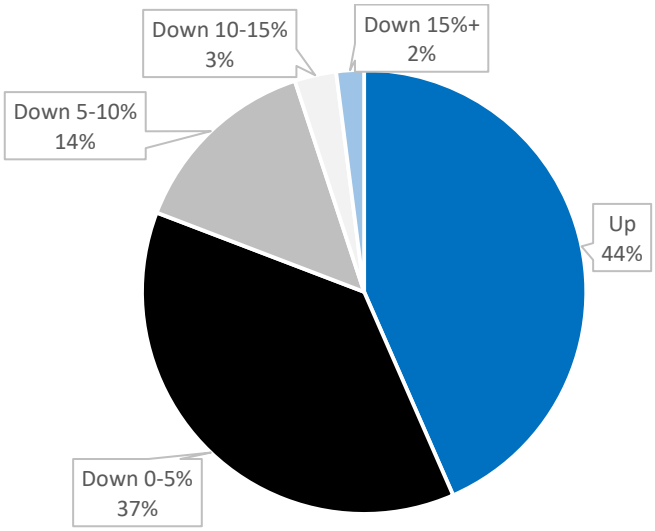
financing amplifies social inflation in insurance premiums by enabling applied psychology strategies, increased advertising, and predictive analytics.

In our view, these cost pressures will squeeze smaller carriers and put them increasingly at risk of bankruptcy in the event of an accident particularly for those that choose to manage costs by purchasing less insurance. Indeed, demand for commercial auto insurance is the lowest among insurance categories according to the CIAB. Insurers are also unlikely to flock back to the commercial auto insurance space en masse and generate competitive pressure on premiums as inflation eats into earnings. It is too early to tell whether increased regulation on litigation financing might come into force and produce some disinflation in premiums. While some states outright prohibit litigation financing, some that allow it (Colorado, Maryland etc.) have introduced regulations on interest rates and accumulation periods. Carriers with stronger safety credentials will be better positioned to mitigate these cost pressures. In our TL coverage space, TFII ranks at the top of the group for critical incident risk management per our Truvalue data.

E-Commerce and Length of Haul

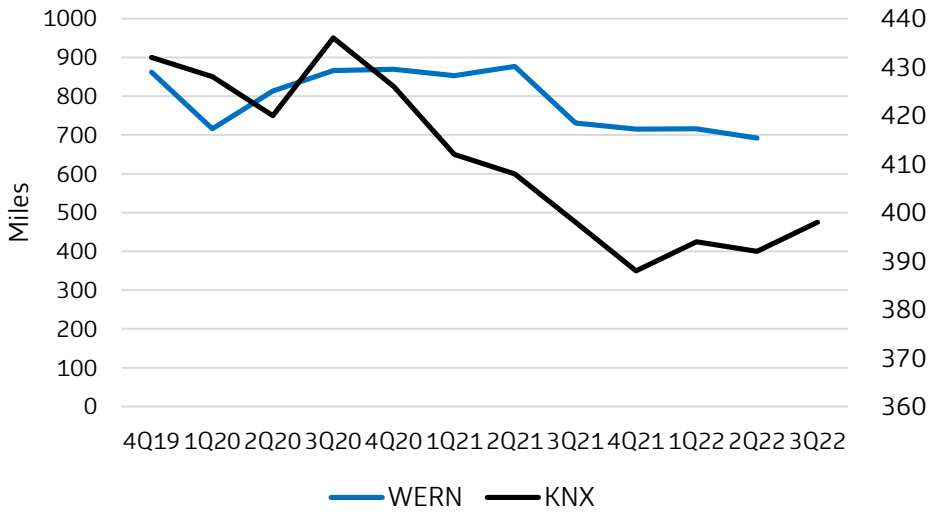
We believe that permanent changes in consumer trends in favor of e-commerce over time will place downward pressure on length of haul. E-commerce as a proportion of retail sales spiked during the pandemic and is expected to remain above pre-pandemic levels, recent declines notwithstanding. With the consumer increasingly reliant on same-day delivery and swift returns, transportation players are choosing to move closer to the final consumer to satisfy demand. This is especially visible on the LTL side. XPO has a target of 900 net new doors to be set up by year-end 2023. On the TL side, we can see that length of haul trended downward since the onset of the pandemic for KNX and WERN despite record levels of freight demand. We also asked smaller carriers how their length of haul has tracked since the onset of the pandemic and 56% reported shorter length of haul as can be seen in the chart below. In our view, the shortening of haul is likely to be pronounced on the LTL side as well.

Figure 35 : How has your length of haul tracked in the past 2 years?



Source: Cowen Carrier Survey, 3Q22; SurveyPlanet.com

Figure 36 : Average Length of Haul in TL Space Trended Downward Since the Onset of COVID-19



Source: Company Reports, Cowen and Company

Shortening length of haul has positive as well as negative ramifications for the trucking industry. Drivers should, by and large, welcome this shift as it will allow them to be home for longer periods, something that could also potentially improve ESG credentials of their employers. Shorter haul should also enable greater Hours of Service (HOS) compliance given drivers receive an exemption for hauls shorter than 150 miles thereby improving productivity. On the other hand, moving closer to the e-commerce customer will entail more trucks in urban centers with infrastructure that is not designed to handle many trucks, potentially worsening congestion and accidents. LTL players are best positioned to benefit due to their expertise in short haul, while TL players will likely have to adapt with a focus on final mile services.

The Autonomous Hedge (Jason Seidl)

The area of autonomous trucking is an ever-evolving space that is as exciting as it is fast paced. Since our last Supply Chain Ahead of the Curve Report in November of last year we have seen some notable changes and milestones to this industry. While the pace of progress towards complete ubiquitous usage of Class 8 freight trucks may be slower than many predicted 7 years ago, progress is being made by many in the industry. Below are updates from some of the major players in autonomy plus some legislation that is expected to help autonomy take hold in several states.

Kodiak Robotics, a California based private autonomous company, has made great strides over the past year, but none has been more important in our opinion than its fallback option on their trucks. Kodiak's fallback system is a controller that was built to run a custom designed safety computer (the Actuation Control Engine) which is set up to work no matter what. The system is constantly monitoring the Kodiak Driver and checking the health of the entire system (in total 1,000+ safety components). Impressively, the system can calculate options for the truck 10 times every second. We had a chance to ride in Kodiak's 4.0 version truck and were given a pair of wire cutters to sever the power cord to the computer system while driving. After we cut the wire, the truck safely pulled over to the side of the road based upon its earlier calculations.

Kodiak also made strides in making it easier to keep its autonomous fleet on the road by developing a unique piece of hardware dubbed SensorPads. This replaces traditional side-view mirrors and allows for quickly swapping out hardware if needed without any specialized training or equipment. In fact, Kodiak ran tests and found that its SensorPads can be changed out quicker than changing a flat tire on the truck. Such a time-saving swap should enable companies to keep trucks on the road more thereby increasing revenues and efficiency.

The company has formed several key partnerships (such as Pilot Co., Werner Enterprises, IKEA, USX and Ceva). Some of these commercial partnerships link Kodiak with carriers to help showcase what their technology can do and how it can help drive their business going forward while others are focused on helping Kodiak develop/improve its operating network. The Pilot agreement allows Kodiak to access Pilot's 750 locations across the US and Canada to provide spaces to pick up/drop off loads, bays for vehicle inspections, maintenance, fueling, and data transfer.

TuSimple also has made some important progress since we published our last Supply Chain AoTC. In December of 2021, TuSimple announced it had successfully completed the world's first fully autonomous semi-truck run on public roads without human assistance. This fully autonomous move took place in the lane from Tucson, Arizona to Phoenix, Arizona, a journey of more than 80 miles.

Since that time the company has announced that it will work to upgrade its fleet of trucks (both hardware and software) to help with eliminating support vehicles that currently lead/follow TuSimple trucks. The elimination of these vehicles is expected to make the company's autonomous trucks a financially favorable choice versus the legacy driver option. TuSimple has stated that it should be able to upgrade roughly 20 trucks per quarter which would put them on track to have the entire fleet done by the end of 2022. The company has also expanded its physical footprint, leasing two new terminals in Texas (South Dallas and San Antonio), and boosting the size of a facility in Arizona. The new facilities in TX will play a crucial role in supporting operations in the extremely important Texas Triangle region.

Waymo also logged some important milestones that are no doubt going to impact the future of autonomy. In January, Waymo took its relationship to the next level with partner J.B. Hunt when it announced it had entered into a long-term strategic alliance with the Arkansas based intermodal/trucking giant. Part of this new agreement calls for a launch of a fully autonomous trucking operations in Texas over the next few years. Waymo also announced new partnerships with transport giants C.H. Robinson and Uber Freight. Waymo initially took part in multiple pilot runs for CHRW in Dallas-Houston lanes. Ultimately, Waymo wants to become a larger option among the ~200K customers of the Minnesota based truck broker. The partnership with Uber Freight will enable them to do something similar with another important transportation provider. The Uber partnership initially looks to utilize Waymo's test fleet trucks and then eventually carriers that purchase the Waymo Driver option.

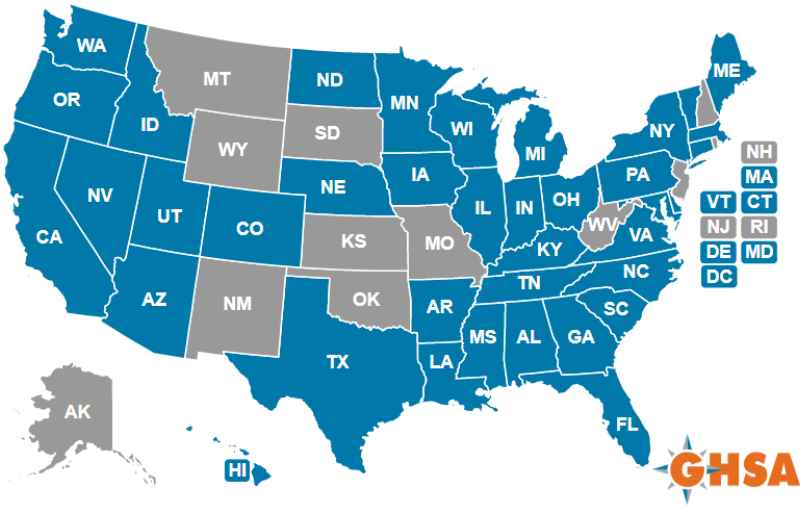
While progress at the autonomous carriers is paramount, we cannot forget the governmental side. Indeed, there have been inroads at the state level where autonomous trucks are widely regulated. Currently 38 states have regulations pertaining to autonomous vehicles, with 16 states (plus DC) authorizing full deployment according to the Governors Highway Safety Association (GHSA). Testing or deployment without a human operator is permitted in 18 states. Over the past year we have seen several new regulations passed in numerous states. Oklahoma passed regulations this year that will allow autonomous vehicles to be fully deployed in their states starting in November. More important, however, was that the language provides for the

recognizing of out of state licenses granted for the operations of vehicles, which will help autonomous interstate commerce deliveries. Kansas was earlier to the proverbial game than Oklahoma, allowing deployment of autonomous vehicles in May of this year. However, Kansas still has more restrictions on the operations of such vehicles (including weight limits that essentially make it impossible to operate 18 wheelers today). While this prohibits the use of larger trucks, these weight restrictions go away in 3 years and should clear a path for operation in the state. The Pennsylvania House and Senate passed bills in support of implementing commercial use of autonomous vehicles. There are differences between the bills, but both should be positives for the industry. We expect further legislation around the country that bolsters the ability to operate autonomous trucks as the industry develops further.

Truckload companies historically have a steady replacement cycle to purchase new Class 8 trucks, with the average age of a fleet being ~24-30 months. The correlation between age of fleet and maintenance costs drives large carriers to actively replace trucks, keeping maintenance costs down and drivers happy. Many of the largest truckload carriers have invested in autonomous startups, embracing the emerging technology while acknowledging the significant headwinds that are ahead, most notably regulatory challenges.

Brad Jacobs, outgoing CEO of XPO Logistics and industry veteran, gave his views on autonomous in July: "I think on the physical truck side, it's a question of time when it will be autonomous. I think that autonomous evolution has slowed down a little bit because of the way that the political winds are blowing, where it's more of an EV focus than an autonomous focus. But the compelling economics of autonomous trucking are extreme. And Adam Smith's hidden hand of capitalism will not allow autonomous trucking to be delayed forever."

Figure 37 : States with Autonomous Vehicle Regulations



Source: Governors Highway Safety Association

Autonomous investments have largely taken place in the truckload market, given some of the stable route dynamics in the TL industry. Truckload names such as KNX, WERN,

SNDR, and USX have all disclosed either autonomous investments and/or partnerships. Truckload carrier Daseke is the only TL carrier we follow that has yet to invest in autonomous, which is due to the fact that the company focuses on specialty hauls (oversize, hazardous) and traditional flatbed moves that will likely require a driver indefinitely, in our view.

LTL players ODFL, SAIA, XPO, and TFII (increasing mix of LTL freight) do not have exposure into autonomous trucks, as inconsistent short-lengths of haul are not the bread and butter for autonomous use-cases. That said, we believe if autonomous TL routes are adopted over time, more use-cases will emerge within the LTL space (specifically with some linehaul moves). On its July earnings call, ODFL did suggest that it would like to try to test some equipment and is waiting on the delivery of a truck – very early and not a significant amount of autonomous exposure, but this was the first sign the LTL bellwether acknowledging interest in the space.

Figure 38 : Trucking Autonomous and ESG Exposure

	Autonomous Partnerships	ESG Initiatives
DASEKE		✓
KNIGHT SWIFT	✓	✓
OLD DOMINION FREIGHT LINE		✓
SAIA		✓
SCHNEIDER	✓	✓
TFI International		✓
U.S. XPRESS	✓	✓
XPO Logistics		✓
WERNER ENTERPRISES	✓	✓

Source: Company reports, Cowen and Company

Knight Swift: In 2022, KNX announced a partnership with Embark Technology to integrate the company's technology within KNX's fleet. This was Knight's first purchase of autonomous trucks and will give them a chance to collect driver feedback on the technology, maintain, inspect and test the autonomous trucks.

Schneider: In 2021, SNDR announced an investment in TuSimple for an undisclosed amount, intending to be on the front end of an emerging technology. SNDR discussed the investment as a way for the company to learn together and discuss how its business model might apply to compliment Schneider in the future.

U.S. Express: In 2022, U.S. Xpress announced that it partnered with Kodiak Robotics to launce level 4 autonomous freight service between Dallas-Fort Worth and Atlanta using self-driving trucks. The announcement was Kodiak's first large truckload partner within its Partner Deployment Program to deploy self-driving tech. A Kodiak truck completed four round-trip journeys (~6,350 miles) from Dallas to Atlanta, driving for nearly five

and half full days straight. There was a rotating team of professional safety drivers that sat in the truck.

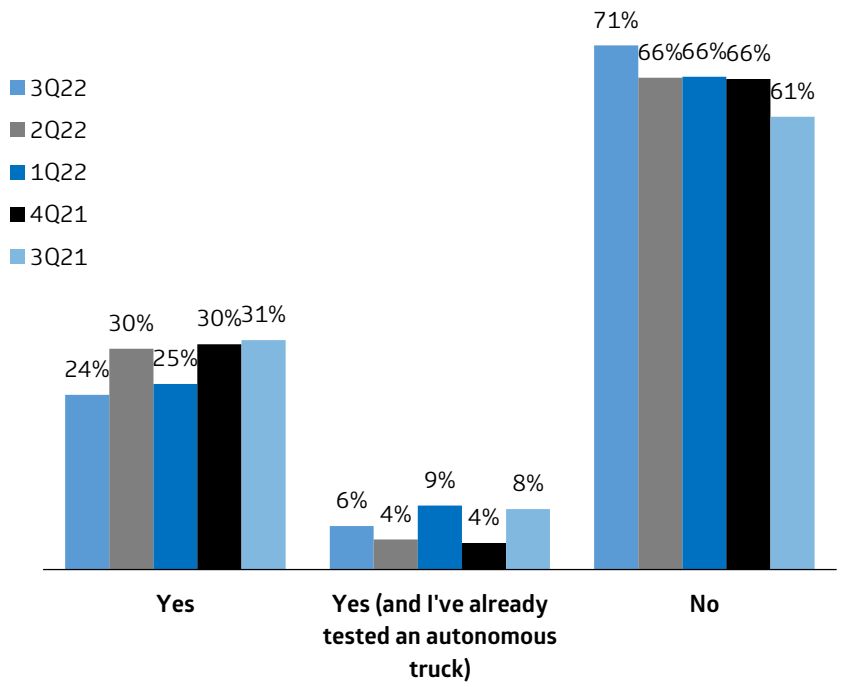
Werner: In 2022, WERN announced a commercial pilot program with Aurora Innovation to test autonomous trucks between Fort Worth and El Paso, which is over 600 miles long and takes about nine hours to drive; this lane sits within one of the busiest corridors in the country. On Werner's earnings call, CEO Derek Leathers discussed the autonomous timeline: "On the autonomous side, we're still a few years away from even marginal impacts around the edges. But my view on it is, today is the day and every day as we go forward is when we need to be preparing for the inevitable reality that things are going to change." More recently (September 2022), WERN announced a collaboration with Kodiak Robotics, to establish autonomous trucking lanes and showcase a transfer hub model between truck ports. This pilot test was a week and consisted of four trips between Dallas and Lake City Florida. With a safety driver in the car at all times, Kodiak completed 152 hours of driving and had 100% on-time delivery.

Cowen Carrier Survey

In our quarterly proprietary survey, which accounts for ~15,000 trucks, (50+% of which have few than 50 trucks), we ask truckers their openness to testing autonomous trucks, and if they have plans (within the next five years) to own autonomous trucks or use a third party.

24% of participants are open to testing autonomous trucks, down 6% from last quarter. 6% are not only open to testing autonomous trucks but have already done so, up 2% from last quarter. Finally, the remaining 71%, are not open to testing autonomous trucks, sequentially up 5%.

Figure 39 : Are You Open To Testing Autonomous Trucks?

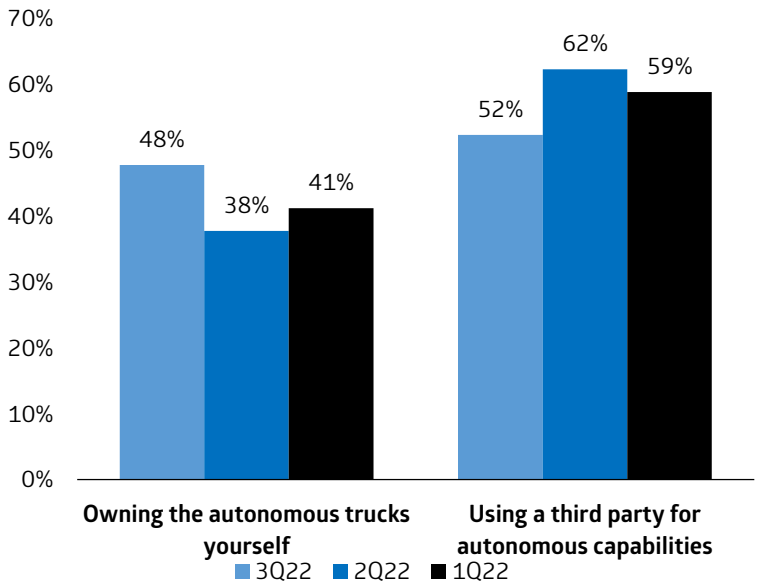


Source: Cowen Carrier Survey, 3Q22; SurveyPlanet.com

We note that our survey largely consists of smaller carriers, which in our view, are less likely to adopt autonomous technology given the capex dollars that come with initiatives. Most of these carriers would be considered "followers" when it comes to technological innovation in the industry. 30% of our survey consisted of drivers with 1-30 trucks, 23% with 26-50 trucks; only 14% of survey participants had more than 250+ trucks.

We asked participants that are open to testing autonomous trucks if they would either a) own the autonomous trucks or b) use a third party for autonomous capabilities. 48% of participants plan to own autonomous trucks themselves in the next five years, up 10% from last quarter, while 52% plan to use a third party for autonomous capabilities, down 10% sequentially.

Figure 40 : Do You Plan (in the next five years) to Own Autonomous Trucks Yourself, or Use a Third Party?

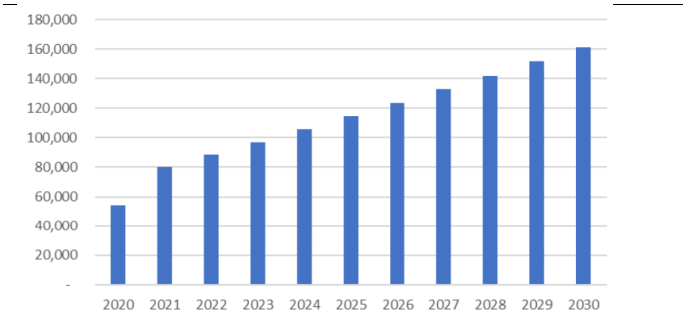


Source: Cowen Carrier Survey, 3Q22; SurveyPlanet.com

In late 2021, the American Trucking Association (ATA) estimated that last year the truck driver shortage hit a high of 80,000 drivers. While the trucker shortage is no new tale (it has always been difficult to hire, train and retain qualified drivers in the TL space), the terminal impact ultimately opens the door for innovation, and we believe autonomy is likely the eventual winner.

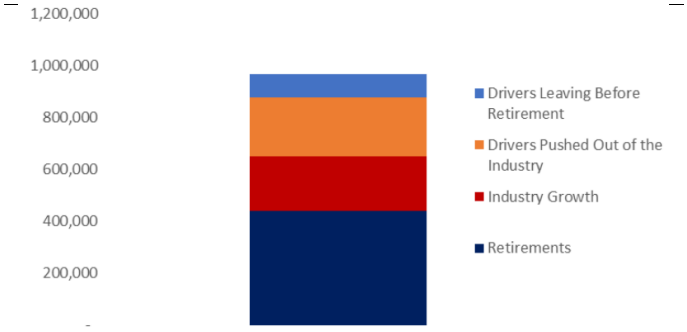
The driver shortage is most impacted by the longer hauls within the for-hire truck market that doesn't allow drivers to be home every night. We believe COVID was a catalyst to the shortage given work-from-home opportunities, and numerous industry headwinds such as high average age of drivers, Drug & Alcohol Clearinghouse drug test requirements, among other lifestyle issues. The ATA believes the shortage could surpass 160,000 by 2030.

Figure 41 Truck Driver Shortage Estimates, ATA



Source: ATA

Figure 42 New Drivers Needed Over Next 10 Years by Reason, ATA



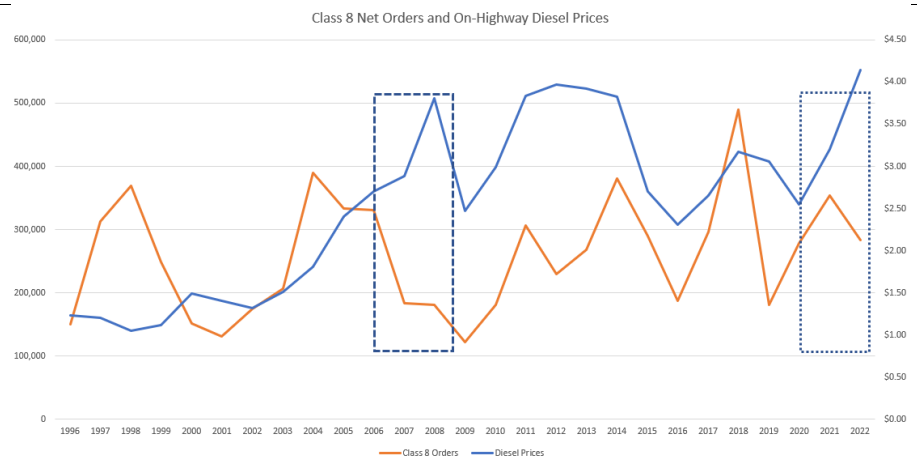
Source: ATA

Truck OEMs – New Truck Availability Constrained but should Begin Easing (Matt Elkott)

The truck OEMs' ability to produce to demand remains constrained by supply chain issues. While we expect this to continue into 1H23, we see it moderating as the year progresses as disruptions ease slowly and because we expect order activity to slow. We remain concerned about rebounding diesel prices, still elevated labor costs, and moderating truckload rates likely eroding the earnings of the roughly 85% of the truckload market that is made up of relatively small carriers. This is a concern we first detailed in our November 2021 note: The Overlooked Risk to Class 8 Cycle, in which we argued that stubbornly high diesel prices could cause the industry's Class 8 orders to fall even if there is continued growth in the economy and freight, two things that are now moderating meaningfully. Our concerns did materialize for a while, but a big rebound in orders happened in September (53K trucks, up from 21K in August and 11K in July); and the October number was a strong 42.5K units. We view the strength as transitory and reflective of pent-up demand pouring in upon opening of more order-boards. It could include a bit of double-ordering as some customers look for ways to work around long lead times.

One striking historical example was from 2006 to 2007, when orders, initially moving in tandem with rising diesel and economic growth, diverged abruptly, falling 44% (Figure 43). Freight had only seen a moderation at the time, and GDP was still growing. One culprit behind the divergence was that the sustained increases in diesel prices as well as higher labor costs had begun to pressure carrier earnings. On the machinery and truck equipment side of our coverage, we favor CMI, CAT, and WAB, while we are cautious on PCAR and DE.

Figure 43 : Class 8 Net Orders and On-Highway Diesel Prices



Source: Cowen and Company and ACT Research

Note: The 2022 order number is YTD annualized; The 2022 diesel price is the YTD weekly on-highway average

Rail OEMs

We expect freight car availability to be tight through at least 1Q23, contributing to supply chain challenges. The North American industry fleet utilization is currently ~83%, up from 68% at the bottom of the cycle in July 2020. We think of full utilization as anything between 85% and 90%, so the fleet is currently nearly fully utilized. Our channel checks with industry contacts in October and November point to tightness and in some cases shortages in several car types, including box cars, grain hoppers, plastic pellets, and auto racks. We see 3Q22 as having been the beginning of an industry manufacturing upcycle, which we project will last at least through 2023. This should begin to alleviate the car tightness meaningfully by 2Q23. Lease rates on existing cars should continue their 9-quarter sequential rate increases well into 2023, with new railcar production potentially helping to moderate such increases beginning in 2H23. We favor TRN, GATX, and GBX in the railcar subsector of our coverage.

Figure 44 : Production Orders Forecast

	Calendar 2017		Calendar 2018		Calendar 2019		Calendar 2020		Calendar 2021		Calendar 2022e		Calendar 2023e	
	Deliveries	Orders	Deliveries	Orders	Deliveries	Orders	Deliveries	Orders	Deliveries	Orders	Deliveries	Orders	Deliveries	Orders
TRN	18,395	12,900	20,115	28,795	21,960	10,220	11,530	5,980	8,875	13,910	13,927	34,290	19,964	21,000
GBX*	15,416	15,900	18,800	19,100	19,900	14,785	11,800	8,600	11,200	16,300	16,800	22,400	20,225	22,450
ARI	4,292	2,419	3,648	12,873	2,350	2,450	-	-	-	-	-	-	-	-
RAIL	4,427	2,560	4,214	3,521	2,276	2,227	751	490	1,731	2,665	3,196	4,010	3,815	4,400
Other (estimate)	2,433	5,872	4,075	14,774	11,605	7,514	8,000	2,075	7,474	4,687	7,500	8,700	9,800	10,100
Total	44,963	39,651	50,852	79,063	58,091	37,196	32,081	17,145	29,280	37,562	41,423	69,400	53,804	57,950
Y/Y change:														
TRN	*-32%*	*66%*	*9%*	*123%*	*9%*	*-65%*	*-47%*	*-41%*	*-23%*	*133%*	*57%*	*147%*	*43%*	*-39%*
GBX*	*-25%*	*85%*	*22%*	*20%*	*6%*	*-23%*	*-41%*	*-42%*	*-5%*	*90%*	*50%*	*37%*	*20%*	*0%*
ARI	*-11%*	*20%*	*-15%*	*432%*	*-36%*	*-81%*	*-100%*	*-100%*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
RAIL	*-20%*	*113%*	*-5%*	*38%*	*-46%*	*-37%*	*-67%*	*-78%*	*130%*	*444%*	*85%*	*50%*	*19%*	*10%*
Other (estimate)	*-26%*	*130%*	*67%*	*152%*	*185%*	*-49%*	*-31%*	*-72%*	*-7%*	*126%*	*0%*	*86%*	*31%*	*16%*
Total	*-28%*	*73%*	*13%*	*99%*	*14%*	*-53%*	*-45%*	*-54%*	*-9%*	*119%*	*41%*	*85%*	*30%*	*-16%*

*Estimated calendar year periods excluding international orders and deliveries

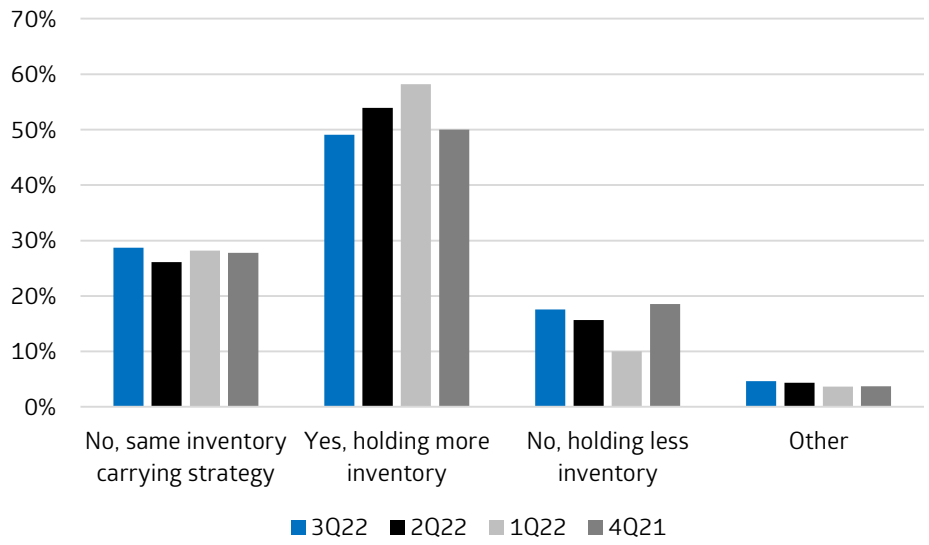
Source: Cowen and Company estimates; RailShare; Bloomberg; TRN; GBX; ARI; RAIL; AAR; UMLER

Note: The 2022 order number is YTD annualized

Warehousing and Logistics (Jason Seidl)

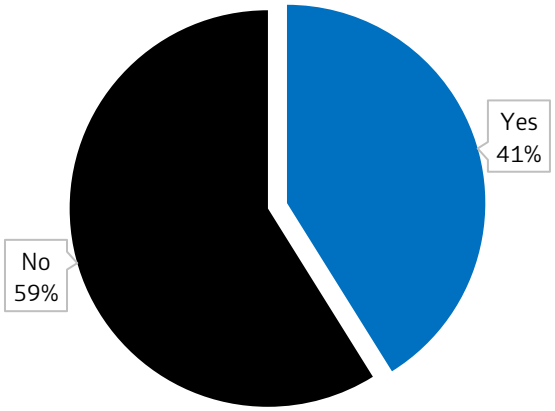
Participants in our recent trucking and logistics happy hour suggested that warehousing capacity continues to remain very tight despite weakness in the macro backdrop as the stock of inventories remains high with retailers and shippers trying to beat supply chain congestion. We asked participants in our shippers' survey whether their inventory carrying strategies have shifted due to the pandemic. Close to 50% of respondents report a permanent switch to holding more inventory, which means shippers are increasingly utilizing just-in-case strategies. We note that this proportion has come down slightly since we started asking this question. It is likely that some players will move back to just-in-time inventory management as we move further into an economic slowdown and cost management takes center stage among businesses. However, with economic and geopolitical uncertainty looming we do not expect a return to the pre-pandemic normal. Of our survey participants, 41% said they were considering using a 3PL service to satisfy their warehousing and supply chain management needs.

Figure 45 : Has your/your customer's inventory carrying strategy changed permanently due to pandemic-related disruptions?



Source: Cowen Carrier Survey, 3Q22; SurveyPlanet.com

Figure 46 : Are you/your customers using/considering using more 3PL services given complexity of post-pandemic supply chain operations? (Yes/No)?



Source: Cowen Carrier Survey, 3Q22; SurveyPlanet.com

The Rise of Reverse Logistics and the ESG Angle

With the rise of e-commerce in a post-pandemic environment, reverse logistics has emerged as a rapidly growing and important supply chain consideration for shippers across the globe. According to the National Retail Federation, the reverse logistics market is expected to reach $604bn by 2025, accelerated by online purchases of apparel in particular (30% of deliveries in fashion e-commerce are reportedly returned). Presently, just 16% of reverse logistics needs are outsourced to 3PLs as opposed to 30-40% in the case of regular contract logistics. As such, we believe the 3PL industry has room to further penetrate the global reverse logistics market. While the apparel industry is currently at the forefront of reverse logistics needs, we anticipate this service will gain popularity in retail more broadly (shoes, accessories, consumer electronics, food & beverage etc.). Pure-play logistics name, GXO, places a heavy emphasis on reverse logistics capabilities and is poised to benefit from these trends in the long term from both a business and ESG standpoint.

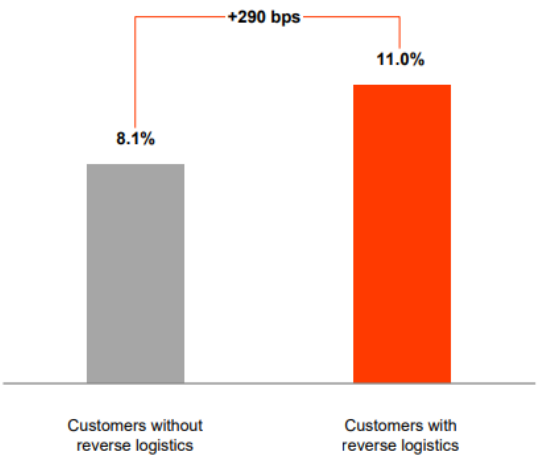
Reverse logistics enhances ESG credentials by enabling greater recycling, improving manufacturing efficiency and reducing wastage. In fashion e-commerce for example, GXO sends less than 1% of returned items from its customers to landfills compared to the industry average of 25%. This not only improves the profits for companies that outsource their reverse logistics needs to GXO but also allows them to quantify improvements to their environmental scorecard. GXO estimates that ~8% of the e-commerce supply chains' emissions comes from the returns cycle. The company's reverse logistics solution uses predictive analytics to help customers mitigate overstock; in the fashion industry up to 30% of inventory can reportedly remain unsold, constituting avoidable emissions. GXO estimates that a 10% reduction in overstocked inventory reduces CO2 emissions by ~9% in the fashion industry.

More than 96% of items returned to GXO are resold. This can be valuable to shippers seeking manufacturing efficiency and margin improvements (see Figure 22 below) particularly during times when inflationary pressures are prevalent. According to GXO,

handling the same items at multiple stages serves as a ~6x revenue multiplier. We believe GXO is well positioned to expand its reverse logistics service and lead the segment. Management noted that 40% of new business wins in 2Q22 were contracts with reverse solutions and that just 7% of total revenues fell into this category in 2021 (this gave GXO just under a 2% market share in reverse logistics). We expect these numbers to rise for the company as reverse operations are projected to grow to be as large as outbound logistics in the coming years. GXO presently handles nearly all the reverse logistics needs of supermarkets in the UK and plans to expand partnerships with players in consumer electronics, pharmaceuticals, and aerospace. The Clipper acquisition plays into GXO's reverse logistics ambitions as its Servicecare offering specializes in electronics returns.

GXO's proven success with Nike offers a good case study for investors, when in 2017 Nike looked for a logistics partner to handle and manage returns and chose the Greenwich, Connecticut based logistics provider to handle the business. Nike continues to be a bellwether customer for GXO and showcases the high-quality offering despite Nike having over 4 million SKUs. GXO's partnership with Nike has grown from two to seven sites and revenues from the contract have grown 400% since 2017.

Figure 47 : Reverse Logistics Drives EBITDA Margins



Source: GXO

Nike DTC/Digital Transformation (John Kernan, CFA)

The shifts to digital and direct to consumer models are enabling brands to scale with increasing growth rates and higher returns on capital than we have ever calculated in the sector, no doubt enhanced by a consumer shift to digital during the COVID-19 pandemic. This pace of growth is creating greater competitive separation in the form of market share and profitability among those brands able to invest in digital transformation and those than are constrained or playing catch-up. Nike Direct is guided to reach 60% of Nike's business by FY25. This penetration rate implies Nike Direct revenues reach $39B from 40% or $16.4B in FY21, led by digital. We are modeling FY25 Direct revenues of $31B including e-commerce revenues of $23B, and Wholesale revenues of $25B. Management is guiding to Wholesale revenues that are flat with FY21 at $25.4B through FY25 as NKE accelerated its exit from undifferentiated Wholesale accounts and recaptures that business through its DTC channel. Nike's DTC

target is fueled by secular trends favoring health & wellness, digital, growth in sport and sustainability. As digital scales, it enhances economics and margin expansion which can then be reinvested into the company to support growth in supply chain transformation, innovation and technology.

Figure 48 Nike's Digital Transformation

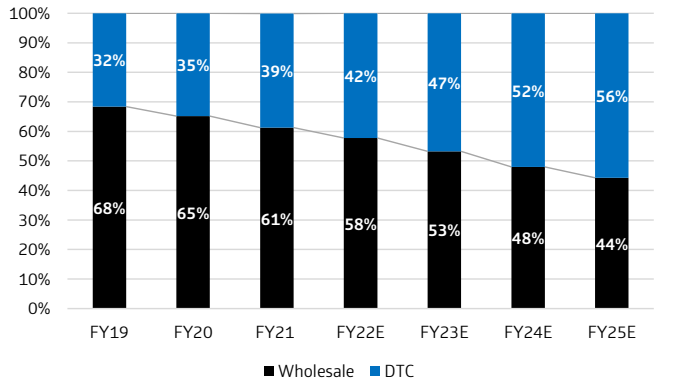
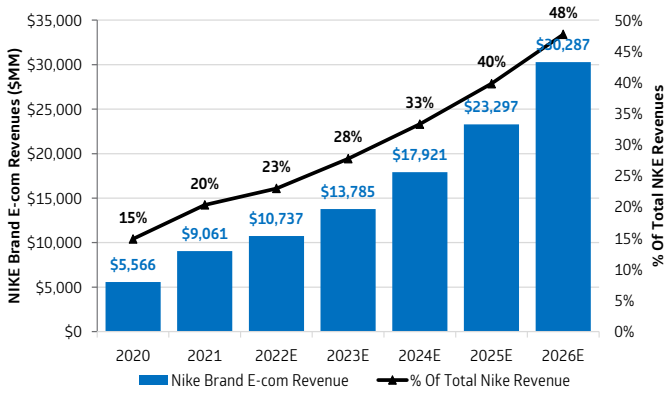


Figure 49 Nike's Digital Sales Penetration Could Reach Near 50% By FY26E



Source: Company Reports, Cowen and Company

In a 4/19/22 paper, Nike commented on "how reverse logistics can save millions of shoes," especially as it relates to the company's refurbished circularity model and program – Nike Refurbished. Within Nike's ESG goals is its "Move to Zero," a strategy that positions the company on a path to zero carbon, zero waste. Utilizing the Nike Rebound reverse logistics facility, located in Indiana, enables the company to process all of its returns in N. America, roughly thousands daily, from consumers and wholesale partners. Returns are then sorted among never-been-worn which return to shelves, and the slightly worn with prospects for a second chance within Nike Rebound rather than being ground down in Nike Grind. The Nike Grind program, several decades old, collects and recycles its shoes for re-purposing into apparel, footwear and accessory applications, retail store materials construction, and track and field construction.

The Nike Rebound initiative enables "thousands of its shoes a second chance" daily, through cleaning and restoration back to "as close to its original state as possible." In turn, these refurbished shoes can then complete the cycle, returning to the retail shelf via outbound logistics in Nike Refurbished boxes, highlighted as either "like new, gently worn or cosmetically flawed" and priced at a discount to never worn shoes. As of April 2022, Nike reports that to date over 225,000 pairs of its shoes have been refurbished and sent back to the retail shelf within its stores. Long-term, Nike envisions having Nike Refurbished in each of its stores, having initially launched this program in early 2021 in three stores, which grew to 30 stores by April 2022. Distribution capacity is being expanded to support this target for N. America.

Figure 50 Among The Many Facets Of Nike's Move To Zero Initiative Is The Nike Refurbished Circularity Model

Source: Company Reports

Figure 51 Nike Rebound's Reverse Logistics Facility Processes All Returns For N. America, Including Candidates For Nike Rebound -

Source: Company Reports

Nike has made a goal of lowering carbon emissions by 30% in 2030 and reaching net-zero carbon emissions by 2050. The Company's sustainability initiatives fall into two segments: 1) Manufacturing, which accounts for approximately 30% of Nike's carbon emissions, and 2) Materials which comprise the remaining 70%. Nike Manufacturing strategy is reportedly comprised of four pillars: 1) Expanding ongoing efficiency improvements, 2) Maximizing the use of onsite photovoltaic (PV), 3) Procuring offsite renewable grid electricity, and 4) Phasing out coal to switch to lower-carbon fuels - with 25% of Nike's Tier 1 factory waste being reused for footwear, and 50% of Tier 2 suppliers agreeing to coal elimination plans.

With respect to Materials, Nike set the target of removing PFC-based finishes in 2017, expecting to reach that goal this fiscal year. The Company has made 85% of its footwear and 72% of apparel with PFC-free material. Nike reduced solvent use by 96% per pair of shoes by switching to water-based adhesives. The final aspect of Nike's shift toward using sustainable materials is its circular business model. In 2025, Nike reports that it wants 50% of polyester and 40% of leather to be reused or come from alternative sources. Moreover, the above-mentioned sales channel for refurbished products, "Nike Refurbished" should aid in increasing awareness around its circularity model. The product pipeline increasingly reflects a broader assortment of clothing and footwear made with sustainable and recycled materials (polyester and nylon). The nike.com site now features a sustainable materials section, offering footwear and apparel that is "at least 20% sustainable material."

Semiconductors—The Key Enablers for Supply Chain Modernization (Matt Ramsay)

Matt Ramsay
matt.ramsay@cowen.com
415-646-7373

Josh Buchalter, CFA
joshua.buchalter@cowen.com
646-562-1303

Ethan Potasnick
ethan.potasnick@cowen.com
646-562-1425

Sean O'Loughlin, CFA
sean.oloughlin@cowen.com
646-562-1327

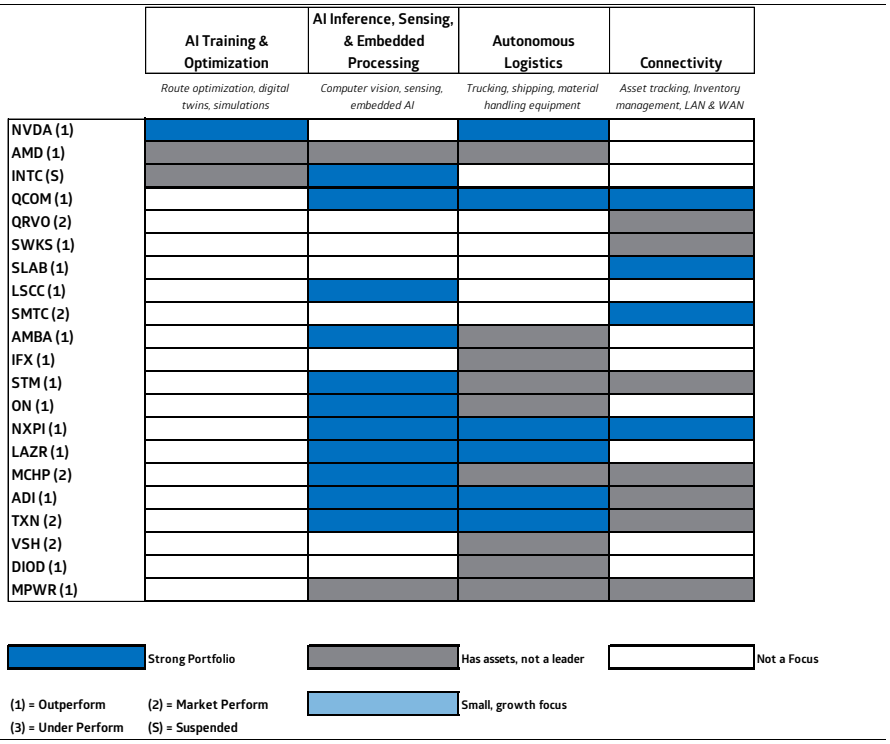
Lannie Trieu, CFA
lannie.trieu@cowen.com
415-646-7217

While the focus for most semis investors has been the industry's own supply chain, many companies in our universe are making significant contributions to the modernization and digitization of supply chains across the global economy, helping to alleviate such issues as labor shortages, network congestion, asset tracking, and asset optimization.

A thematic in semis we have discussed in the past is differentiating between ex-growth "Old Guard" markets and new AI-infused markets that we believe will drive durable semiconductor content and ASP expansion in the long term. Industrial/IoT is one of these markets, and themes such as AI inference at the edge, factory automation, and others are integral to some of the permanent changes we are observing in the global supply chain.

As firms continue to invest in their supply chains, the companies in our coverage enabling those changes have the opportunity to grow into larger TAMs than they have served in the past and drive above-market growth. In our view, these opportunities align with four main themes: 1) AI Training and Optimization; 2) AI Inference, Sensing, and Processing; 3) Autonomous Logistics; and 4) Connectivity. While each company will vary with its thematic exposure, and, given the relatively fragmented nature of these markets it is likely not material for even some of the leading company's stocks (yet), supply chain modernization as a case study is yet another example of how increasing semiconductor content across the economy is likely to drive durable, above GDP growth for the broad semis ecosystem for the foreseeable future.

Figure 52 Key Semiconductors Enabling Supply Chain Modernization



Source: Cowen and Company

What Problems Are Semis Helping Companies Solve?

Covered in greater depth by our colleagues, in our view the key supply chain challenges that semis can most effectively be leveraged to solve include:

- **Labor Shortages:** Solutions leveraging semiconductors include automation, as well as using AI to either improve the utilization of labor (scheduling algorithms, for example) or AI inference and sensing to improve worker safety and increase overall labor utilization (while providing a safer and more attractive work environment overall).

- **Route & Network Inefficiencies:** Traditionally some of the most difficult optimization problems to solve (search "travelling salesman problem"), increased computing power and the development of improved algorithms, plus the ability to employ computational heuristics, are allowing for greater optimization of routes for not only goods moving through the supply chain, but applications such as more efficient warehouse layouts and others.

- **Inventory Management & Asset Tracking:** Increasing the granularity of asset tracking requires not only the physical shrink of the tracking device itself, but also the expansion of the network fabric used to communicate to a central hub as well as increasing the complexity of asset management systems to track an exponentially increasing number of items.

- **Inflexible Supply Chains:** Through real-time application of route optimization, combined with asset tracking and up to date inventory management, companies can begin to envision a future in which if there is a disruption in one node of a supply network (perhaps a COVID-induced shut down), the rest of the supply chain can rapidly shift to an alternate node, re-routing trucks/ships/rail cars and having an up to the minute understanding of the impacts to inventory and timing to communicate to partners and customers.

Many of the described solutions above are early days, or even aspirational given the investment required. But from our point of view, the underlying *technology* has gone from limiter to enabler, such that we now have the capability to solve many of these challenges *today*. Implementation and wide-spread penetration will likely take time, but we view these trends as "when" rather than "if."

Enabling Theme #1: AI Training & Optimization

Without going into a dissertation, in brief "artificial intelligence" in this context describes the application of algorithms such as machine learning, neural networks, and deep learning, to a large data set that can answer specific questions such as, "what is the optimal route for this delivery truck given these stops?" **Training** is when a compute engine is fed massive amounts of data, running simulations and self-correcting errors until it can answer AI problems at a sufficient confidence level. Training is highly compute-intensive, and lends itself to accelerators such as GPUs, which can run many simple calculations in parallel much more quickly than a traditional CPU (contrast training with inference, below).

NVIDIA is *the* leader in AI training, by a country mile (or two). It commands this lead not only through exceptionally powerful and innovative hardware but also through its increasingly diverse and vertical specific software stack (see our team's note following recent investor meetings with the company's CEO and Founder, Jensen Huang, **here**). Specific to supply chain optimization and training, NVIDIA offers the cuOpt software development kit (see Fig. 52).

Route optimization is one of the most complex operations research problems in the industry. Consider that what appears to be the relatively simple question, "what is the optimal route between 15 stops?" has more than 1.3 *trillion* possible permutations. NVIDIA's cuOpt uses GPU acceleration to apply heuristics, metaheuristics, and optimization algorithms to calculate optimal or near-optimal solutions for networks containing thousands of nodes and multi-dimensional constraints—aka, the real world. Further, the software enables planners to adjust to real time conditions such as weather or down drivers. According to the company, this dynamic re-routing alone can save 15% in travel time and fuel costs, a material benefit to operating expenses.

In addition to NVIDIA, AMD and Intel provide AI accelerators as well, not to mention the competing software providers such as Oracle, SAP, and many others. NVIDIA's unique ability to optimally map the data inputs through software onto the hardware acceleration gives it an advantage over its competitors, in our view, but whether applying NVIDIA's SDKs or a competitors', AI acceleration effectively demands hardware from AMD, NVIDIA, or Intel.

- Key Companies Include: NVDA (leader), AMD, INTC

Figure 53 NVIDIA's cuOpt Software Accelerates Optimization Problems for Route Planning Across Applications

Source: NVIDIA Developer Blog

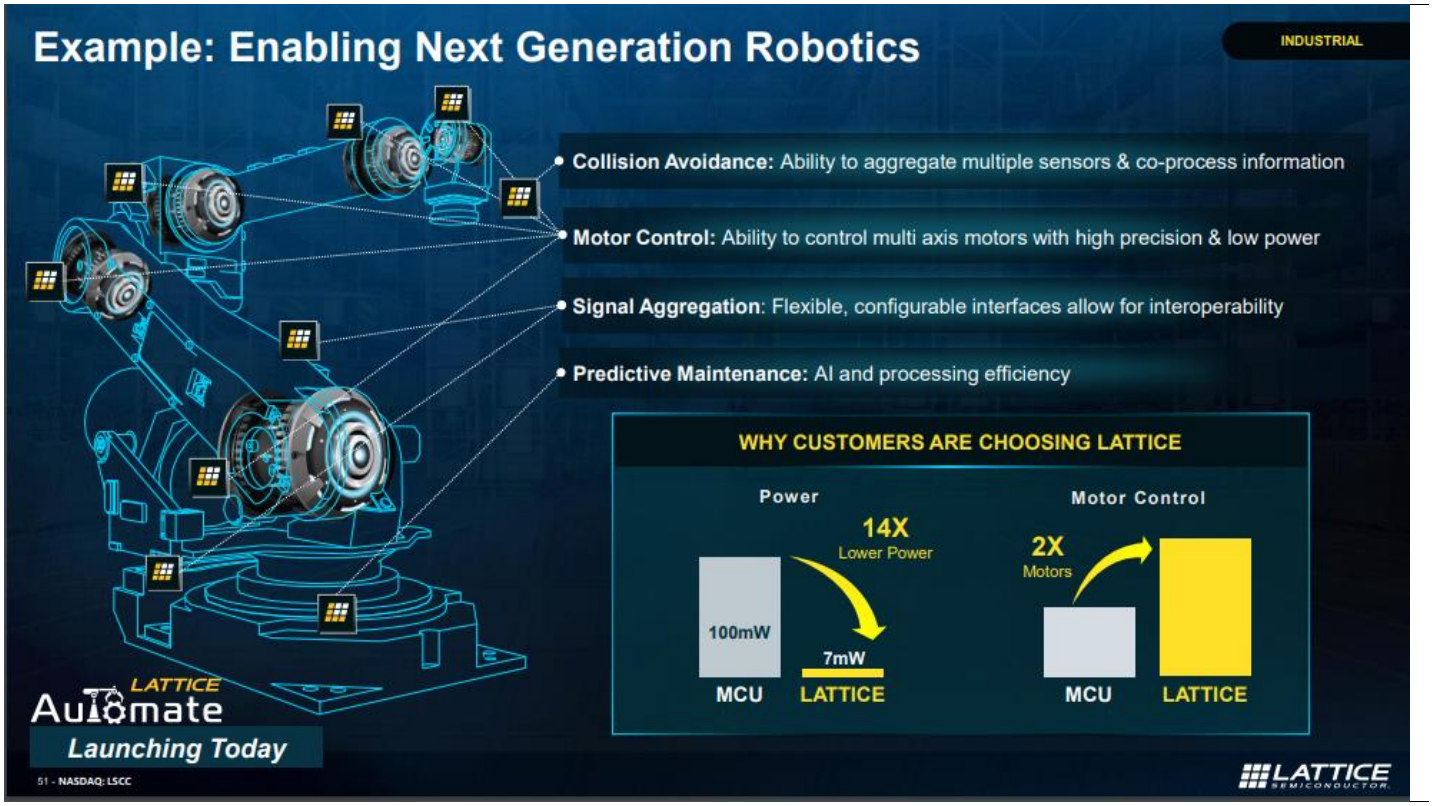
Enabling Theme #2: AI Inference, Sensing, & Embedded Processing

Moving out of the datacenter, trained AI models become real world reaction functions via **inference** and embedded processing. Inference enables devices to apply models to a variety of tasks, such as visual object identification or "computer vision," automated operation, sensor fusion, or predictive maintenance. While inference is less compute intensive than training, these "smart" devices will still require more demanding compute, better I/O, more complex sensors, more storage, and more in-device security than compared to last-gen devices. This all results in increased semiconductor content in these devices, both in units and ASP. We cover embedded processing in depth in our report, *Livin' on the Edge II: Accelerating Toward the Edge* (**here**).

Specifically, the increased processing demands for embedded AI inference is changing the nature of the embedded processor itself. Devices that traditionally had on-board 32-bit MCUs will increasingly incorporate higher order and more complex logic devices, including application processors and dedicated application specific ICs. We are increasingly seeing MCU players emphasize their SoCs and software stacks that enable AI workloads to address these edge use cases. Further, due to the increasingly complex and dynamic nature of these workloads we believe FPGAs will increasingly have an important role.

- Key Companies Include: NXPI, STM, IFX, ON, QCOM, ADI, TXN, LSCC, INTC, MCHP, MPWR

Figure 54 More Embedded Computing Will Require More Complex Processors Such as FPGAs



Source: Lattice Semiconductor 2021 Analyst Day

Enabling Theme #3: Autonomous Logistics

As described above with a greater emphasis on the implementation, the area of autonomous trucking is an ever-evolving space, with much of the TL industry having announced either investments in autonomy or partnerships with autonomy-focused OEMs such as TuSimple. From the semiconductor side, we have highlighted increasing semiconductor content driven by autonomous vehicles in past work (**here**), and many of those themes apply to trucking and logistics as well.

Briefly, in our view the key enablers of the automation megatrend currently defining the mobility industry today are **sensors** and **semiconductors** (highlighted below).

Sensors are the vehicles "eyes," capturing data about the vehicle's surroundings. In addition to cost, there are performance tradeoffs of each type of sensor across the spectrum of range, resolution, power consumption, and operating environment that all factor into an OEMs decision of which sensor architecture to use. Due to physical and cost constraints, there is no perfect sensor that can address all advanced autonomy and ADAS functions. The ultimate value of an autonomous system will be driven by increased safety and convenience to the driver. Simply put, the more sensors that are incorporated onto a vehicle, and diversity of sensing types, the safer the vehicle will be, and the more responsibilities can be transferred from the driver to the vehicle. Separately, our discussions with members of the automotive supply chain reveal the inherent focus on automotive grade and ASIL-certification will mean the sensing and computing suite will need to have full redundancy.

As higher levels of autonomy transfer driving responsibilities from humans to the vehicle, the vehicle and its processing engines will need to have an increasingly detailed and accurate view of its surroundings. As these sensors capture a higher amount of data, they will also need to incorporate a higher level of embedded processing power as well in order to manage, filter, and make decisions to either complement or add to the processing power of a centralized computer or domain controller. Perception will be based on a massive amount of data collected from a large and diverse suite of sensors on a vehicle. There will be no universal sensor suite/architecture as different vehicles will have different requirements and constraints. In addition to the sheer number of sensors increasing on higher levels of autonomy, we believe the sensors themselves will become more complex with more data and compute resources.

Likewise, as the data collected by a car's sensors increases in amount and complexity, the processing of that data will need to change. In our view, processing will occur on a spectrum between a sensors/domain controller or sensor fusion hub, and a central processor. There is a clear correlation between level of autonomy and the required sensing and processing power. To put it simply, the more decisions the vehicle needs to make, the more processing is required on the vehicle. Over the last twenty years, in-vehicle processing has increased significantly. Since 2000, the number of processors has increased from ~10 to ~45, and the lines of code running the software onboard has grown from ~4k to 100-200M. For the last 40 years, all of a vehicle's major systems have been digitized, including the brakes, engines, climate control, steering, etc. Looking forward, we believe the industry is increasingly moving to a domain focused modular architecture that is less flat and more segmented to streamline dataflow within the vehicle. All of this hardware is controlled by software that will increasingly define vehicle architecture and how data flows through the vehicle.

- Key Companies Include: NVDA, QCOM, MBLY, AMBA, STM, NXPI, IFX, ON, MCHP, TXN, ADI, LAZR, ARBE

Figure 55 Sensors and High-Performance Computing Are Integral to Autonomous Logistics Platforms

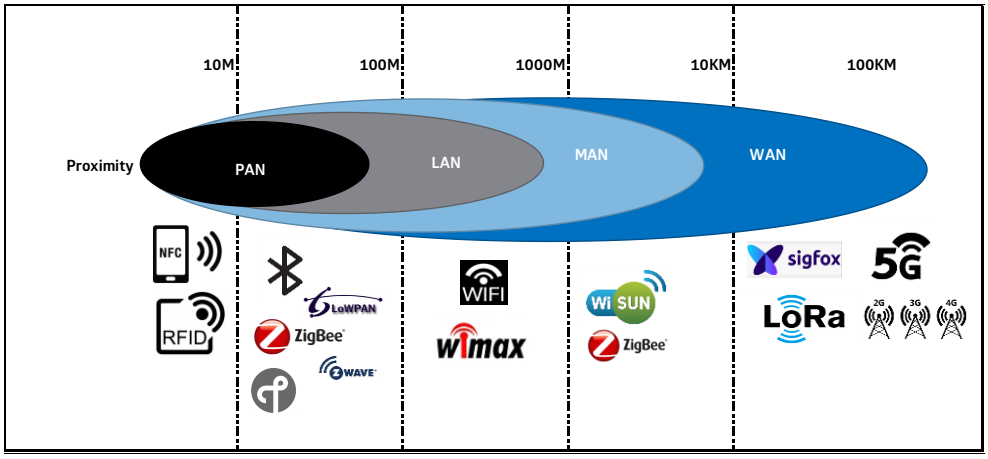
Source: TuSimple

Enabling Theme #4: Connectivity

Radio Frequency Identification (RFID) revolutionized supply chain management three decades ago, enabling asset tracking for large containers across geographies. Today, we are on the cusp of a revolution in asset tracking such that RFID and similar technologies can be used to track in increasing granularity, shrinking from containers to packages to now even individual products across the supply chain from factory to customer. Added to this is the development and scaling of next generation wide and local area networks, not only 5G (both public and private), but also LoRaWAN, and other low-power networks.

Ubiquitous wireless network connectivity to edge assets (e.g., cars, industrial machinery, agricultural assets) for data generation is achievable through leveraging existing radio access networks (i.e., 4G/5G), though it is economically unfeasible and not operationally pragmatic to do so. Similarly, local area networks simply lack various capabilities required to create IoT platforms at scale. To fill this gap, Low-Power Wide Area Networks ("LPWANs") are becoming ideal platforms for connectivity deployments worldwide. These LPWANs include Sigfox, LoRaWAN, and NB-IoT/LTE-M.

Figure 56 Wireless & Connectivity Protocol Categories

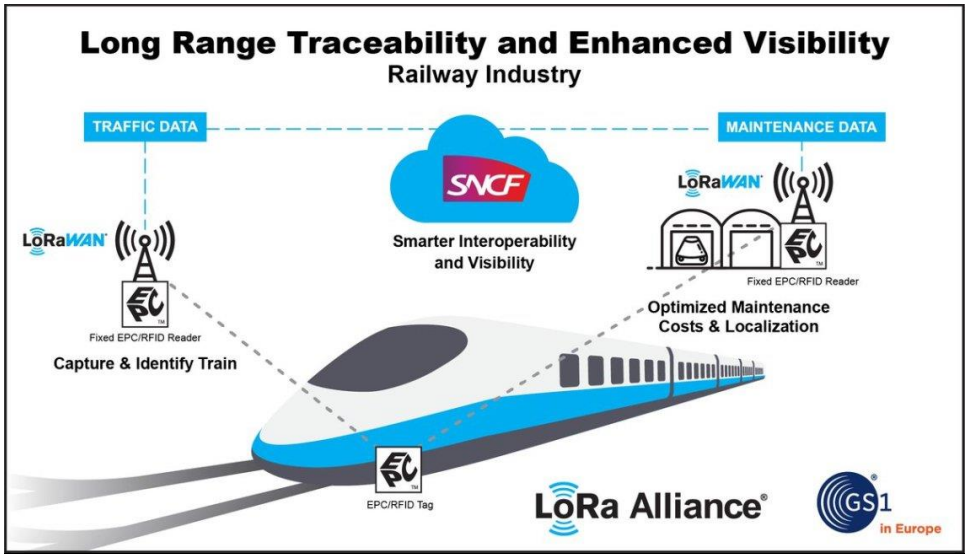


Source: Cowen and Company

The use cases for improved asset tracking and connectivity are varied and numerous (and extend well beyond supply chains). Granular data on inventory locations or equipment status can enable real-time optimization and re-routing (such as diverting shipments to a different port of debarkation), can reduce downtime due to unexpected maintenance activities through predictive technologies, and can enable greater application of artificial intelligence inferencing by offloading some compute to centralized resources at the edge. While still early days, increasingly connectivity in the supply chain and broader industry is likely to be a multi-decade trend.

- Key Companies Include: SMTC, SLAB, NXPI, QCOM

Figure 57 SNCF Applying LoRaWAN Technology to Track Rail Assets



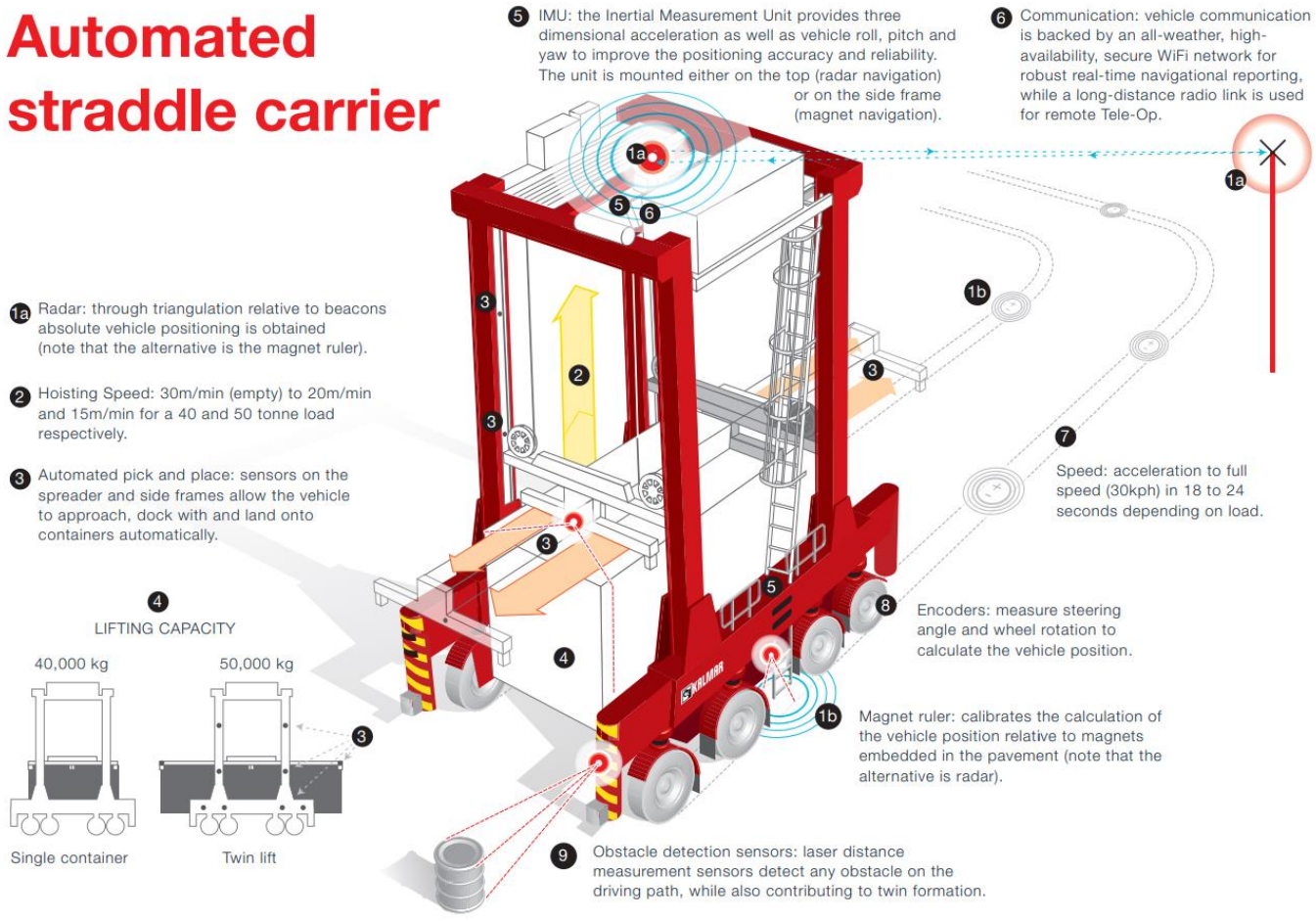
Source: Cowen and Company https://enterpriseiotinsights.com/20210303/channels/news/sncf-tests-lorawan-to-track-rail-assets-as-lora-alliance-bids-for-gs1-certification

Putting The Pieces Together: Automated Cargo Handling At the Port of Los Angeles as a Case Study

Above, our colleagues discuss the ongoing automation efforts at the Ports of Los Angeles and Long Beach. In our view, this port automation is a neatly packaged illustration of all four thematics for how semiconductors are enabling long-term changes in the supply chain.

As part of its automation efforts, the Port of Los Angeles has ordered an automated carrier from Finnish manufacture Kalmar, which is a subsidiary of the Cargotec Corp. (not covered). Stepping through the functionality of an automated straddle carrier allows us to observe not only automated logistics, but also AI training & optimization, inferencing and sensing, and connectivity.

Figure 58 Port Automation Upgrades Capture All Four Semiconductor Enabling Themes



Source: Kalmar

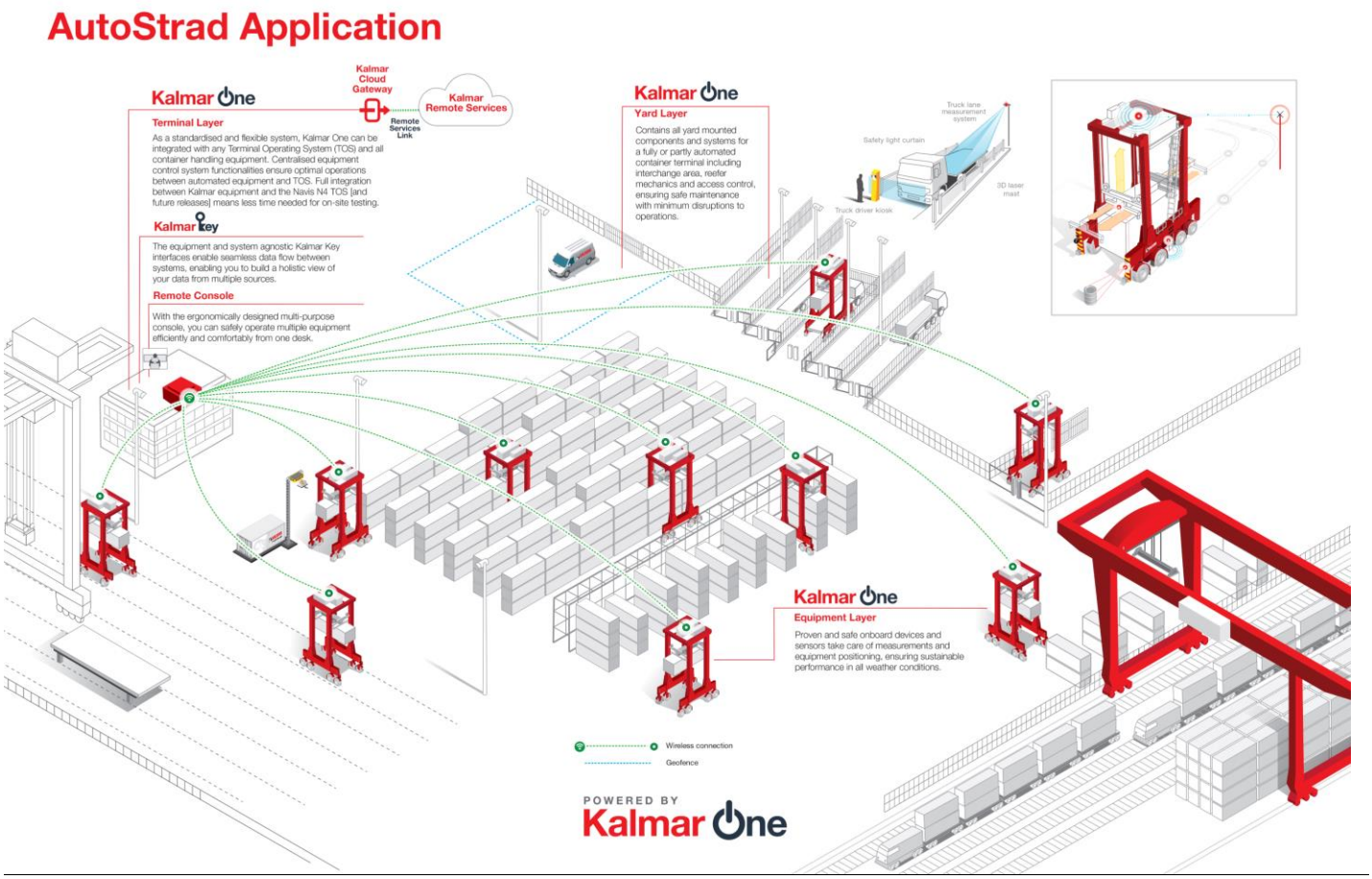
Clearly, the automated straddle carrier is an example of **Autonomous Logistics**, but the sum is greater than the whole:

- In terms of **AI Training And Optimization,** computing power and acceleration combined with software such as NVIDIA's cuOpt can be used to optimize the routes taken by the automated carriers, reducing cycle times for loading/unloading both ship and truck.

- For the automated straddle carrier to follow its planned route and avoid collisions, it needs **AI Inference, Sensing, & Embedded Processing**. In the case of Kalmar's AutoStrad, radar and LiDAR are both used, demonstrating the redundancy in sensor applications common across automation.

- Finally, with regards to **Connectivity**, the automated system is supported not only by the connectivity assets on the carrier itself but also by the LPWAN infrastructure in the broader port, including geo-fencing to ensure some areas remain off-limits (such as personnel work areas, the ocean, etc).

Figure 59 One Automated Carrier is Part of A Network of Automated Enablers



Source: Kalmar

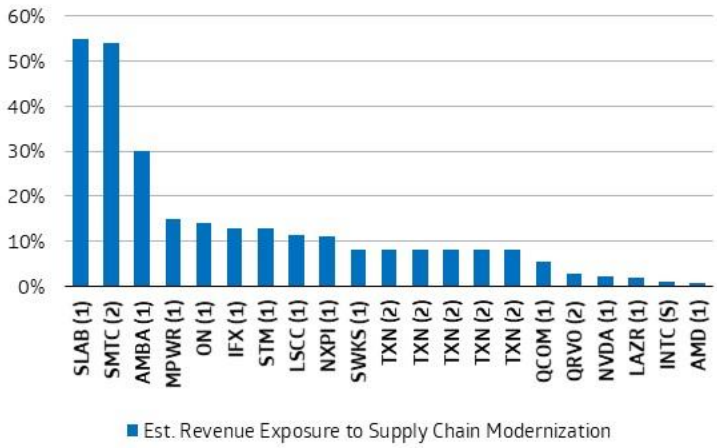
The "But"—Supply Chain Modernization Unlikely to Drive [Most] Semis Stocks

Semiconductors are critical to the modernization efforts taking place across the supply chain, as we have demonstrated. That being said, the materiality of these applications to many of the companies we have discussed is relatively low—for example, while we would argue NVIDIA is one of the most innovative and important companies for the application of AI training and network optimization, direct revenues derived from that specific application of NVIDIA's technology is likely <2%. There are two notable exceptions to highlight from our coverage:

- **Silicon Labs (SLAB):** Following the divestiture of its Infrastructure and Auto business to Skyworks, Silicon Labs now represents an IoT pure-play with an approximate 50/50 split in exposure between industrial and infrastructure applications, and home and life. The company offers a broad suite of MCUs and sensors with possibly the broadest suite of wireless connectivity standards in our universe. Silicon Labs' Industrial and Commercial segment sells into such applications as smart lighting, smart shelf labeling, asset tracking, predictive maintenance, product optimization, and more. Our most recent note can be found **here**.

- **Semtech (SMTC):** Semtech is the primary beneficiary of the proliferation of the LoRa low-power networking standard. Semtech is the sole provider and licensor of chip solutions that are fundamental to the construction of IoT-purposed Low-Power Wide-Area Networks (LPWANs), and more specifically, LoRaWAN deployments. Furthermore, the company recently acquired Sierra Wireless (deal pending), arguing that that there is not likely to be one single technology that dominates the connectivity landscape, but rather a combination of protocols that permit use cases across differing applications. As a result, Semtech's IoT portfolio now stands at >50% of sales comprised of LoRa and Cellular capabilities that management anticipates will be complementary, not cannibalistic, and enable greater application use cases where customers desire both functionalities. Our most recent note can be found **here**.

Figure 60 While Semis Are Key Enablers, Supply Chain Not A Key Driver for Most



Source: Estimates based on Cowen C2022E revenue estimates, company data
Note: 1- Outperform, 2 - Market Perform, S - Suspended

Semiconductor Manufacturing - Read-Throughs: TSM, AMAT, LCRX, ASML, KLAC, MU, AAPL, HPQ, DELL (Krish Sankar)

A very well-known effect of the pandemic is it accelerated the movement of the supply chain away from China and into US, Europe, India and other Asian countries like Vietnam and Malaysia. In semiconductor manufacturing, we estimate that there are $110B of fabs that will start construction (or already started this year) in 2022 and 2023 with production starting 2024. This is led by Intel contributing to 35% of the $110B as it starts construction in Arizona (production 2024) and Ohio (production 2025) followed by TSMC (20% of total) fabs in Arizona (2024 production) and Japan. Others include Samsung's investment in Arizona (2H:24 production) and Micron's Idaho announced plant. It's no surprise that these fabs are leading edge logic/foundry, which is critical to HPC, AI, and military applications. Indeed, US latest round of restricting leading edge equipment to China's domestic manufacturers is part of a strategy that aims to limit China's access to leading edge technology that can be used in military applications.

Figure 61 – Announced New Fabs/Expansions by Leading Semiconductor Companies Outside China

Company	Location	Announce Date	Construction Date	Production Target	Capex Est ($B)	Capacity (wspm)	Tech Node	Comments
TSMC	Phoenix, Arizona	5/15/20	8/1/22	2024	$12B	20K	5nm	$12B to be spent 2021-2029; possibility of site expansion to reach 100K wspm @ $35B
	Kumamoto, Japan	11/9/21	5/1/22	Late 2024	$8.6B	55K	22/28nm	w/ Japan govt, Sony, Denso co-investing; Feb '22 Denso added (10% stake), original 45K wspm @ $7B
Intel	Chandler, Arizona	3/23/21	9/1/21	2024	$20B		Leading-edge	$20B for 2 leading edge fabs (52 & 62, brings Ocotillo campus to 6 fabs); captive and foundry
	Licking County, Ohio	1/22/22	9/1/22	2025	$20B		Leading-edge	$20B for 2 leading edge fabs; possibility of site expansion to reach 8 fabs @ $100B; captive and
	Magdeburg, Germany	3/15/22	1H:2023	2027	€17B		Angstrom-era nodes	Plan to invest €80B in EU over 10 years; €17B for Germany fab, design hub in France, manufacturing & foundry services in Ireland, Italy, Poland, and Spain
	Leixlip, Ireland	3/15/22		expansion	€12B		Intel 4	expansion will double mfg space; will also add foundry space
	Italy	3/15/22		2025 - 2027	€4.5B		Back-end Packaging	in conjunction w/ planned TSEM acquisition
Samsung	Taylor, Texas	11/23/21	7/1/22	2H 2024	$17B		sub-7nm (est)	captive and foundry services (est); $11B WFE cost and $6B construction
Micron	Idaho, US	9/1/22	1H:2023	2025+	$15B			Micron intends to make 40% of its global DRAM output in NA by 2030
	Clay, NY	10/4/22	2024	2025-2030	$100B			$100B investment over 20 year period. Initial phase is $20B "by end of the decade"
Hynix	US, TBD	8/12/22	1H:2023	2025-2026			Advanced Packaging	
Texas Instruments	Sherman, Texas	11/17/21	5/18/22	2025	$15B (est)		Analog	up to 4 fabs over decades @ $30B cumulative cost; construction of first two 300mm fabs start in 2022 with production in 2025
	Lehi, Utah	6/30/21		early 2023	$900M+		65/45nm analog and	acquired 300mm fab from MU for $900M
UMC	Singapore	2/24/22		late 2024	$5B	30K	22/28nm	new fab next to existing Fab 12i; new Phase 3 (Fab 12i P3); tech will also include HV, RF-SOI, embedded
	Tainan, Taiwan	4/28/21		Q2 2023	NT$100B			expand capacity at Fab 12A Phase 6 (P6) w/ customer commitments
GlobalFoundries	Malta, NY	7/19/21		2H 2022	$1B	150K		expansion of exisitng Fab 8
	Malta, NY	7/19/21		2026+ (est)	$5B (est)			new fab in Malta dependent on US CHIPS Act funding
	Dresden, Germany			expansion	$2B			
	Singapore	6/22/21		mid-2023 (est)	$4B	450K		new Fab 7H at existing site

Source: Company Data, Cowen and Company

Beyond leading edge processing, the diversification efforts of the supply chain outside China are well documented. For instance, Apple's latest supplier report (here), shows that of more than 180 Apple suppliers, 48 had manufacturing sites in the US as of September 2021, up from 25 a year earlier. We've also seen this extending beyond smartphones into server and PC manufacturing. Below, we highlight diversification plans by leading server/PC ODMs:

Wiwynn: We estimate Wiwynn's share at more than 30% of the total ODM server market with two hyperscale customers corresponding to +90% of Wiwynn's revenues. Following the pandemic breakout, Wiwynn, which was spun-off its parent company, Wistron, announced that it plans to increase geographical diversification for its motherboard facilities. For its motherboard manufacturing, around 40% of capacity is currently allocated in China with 60% in Taiwan. By 2024, the company aims to increase motherboard capacity by 50% with 90% of capacity in Taiwan and Malaysia and 10% in Mexico.

Pegatron: A few months ago, Pegatron announced that it will invest close to $100M in an assembly plant for tablets and smart home equipment in Vietnam. The company targets to scale its capacity outside China from 5% currently to 20% by 2025 with

investments in Vietnam, Mexico (automotive) and India (iPhone assembly plants). In addition to being a notebook ODM, Pegatron is also a manufacturing partner for Apple.

Hon Hai (Foxconn): Hon Hai, which is a hyperscale and Apple manufacturing partner, is targeting to have 30% of its capacity outside China over next 2-3 years up from 25% today. The company announced in August that it's investing $300M in Vietnam and is investing in a US-based server and networking manufacturing facility in Wisconsin. In smartphones, Hon Hai is accelerating its investments in India for iPhone assembly and is planning to increase output from 5% of iPhone mix today to 2% by 2025.

Diversified Industrials + Robotics, Supply Chain Implications (Joseph Giordano, CFA)

Covid and its aftermath has caused significant rethinking and retooling of industrial supply chains. Long established practices showed inherent flaws and limitations, and management teams are now more willing to think bigger and deploy technologies that are geared to efficiency and resilience. We look at these **behavioral** and **technological** changes below and highlight **ABB**, **CGNX**, and **SYM** as our favorite ways to play supply chain related investment within our coverage universe.

Behavioral Changes As Result Of Recent Events

After gaining an understanding and catching up to the first-degree impacts, organizations have had to completely reimagine their supply chains to future-proof business continuity and ensure a mitigation of the risk of potential revenue loss. In the current environment, product availability has often become more important than pricing.

It has become imperative for corporations to get a deeper understanding of their suppliers' network and mapping their full supply chain – knowing the suppliers of the suppliers. This is a long and expensive process, but a necessary one – supply availability has become an important driver of share gain and loss. Companies are now looking at metrics such as risk of revenue loss per supplier as well as the timing and cost to find an alternate source. Suppliers of critical components were exposed during and post Covid and supply chain managers are looking at solutions to mitigate the risk associated with them. Diversification of supply is the clear goal but adding an additional supplier who itself gets material from the same source as your existing supplier doesn't add the benefit intended. Essentially it creates an inverted pyramid that all stems from the same source. This is particularly relevant to those sourcing components – where are the constituent parts coming from and are they different vs. my other suppliers?

The long march towards just in time (JIT) inventory is likely halted – at least in part. JIT makes the supply chain more efficient and less capital intensive but is also more fragile. As volume volatility increased, so did the issues on factory floors due to lack of absorption. In most cases, production had been optimized to deal with minimal variability. The pursuit of lean management, cost reduction, and productivity enhancement has been revisited and the notion of working capital impact on free cash-flow has become less important than the prospect of business continuity. Large companies have used their size as an advantage to adjust their buyer-supplier relationships and commit to large non-cancelable orders to secure the availability and the cost of critical components. Companies, at least for a while, will likely keep higher levels of buffer inventory on hand, which will increase working capital usage and obsolescence. The process of adapting has also led most to make orders much earlier

than typical or order in excess with the expectation of receiving less. This has led to bloated backlogs that (we believe) have more duration and cancellation risk that normal.

In weighing the JIT practice with the cost of potential disruptions, management teams have come up with a few solutions. In the near-term, some products were re-engineered to utilize other components that were more readily available. Products that weren't core and hard to source were simply discontinued (essentially inadvertently pushing an 80/20 concept).

Below we present some commentary from our coverage this earnings cycle related to these ideas:

ABB (ABB, Outperform) – as mentioned in a recent earnings call, the company has committed to growing inventory consistently in relation to the size of backlog and has been similar over the last few years (around 30%). Additionally, CFO Timo Ihamuotila believes the company's long-term net working capital-to-revenue levels are not likely to increase from where they have historically.

Amphenol (APH, Market Perform) – the company's new segment structure (breaking into three separate reporting units) has afforded the company faster response times to the changing businesses environment as three division presidents (rather than one CEO) are now able to take action. This has translated to greater collaboration with regional managers on supply chain technology.

Fortive (FTV, Market Perform) - The penetration of IoT and sensors everywhere, coupled with the challenges of power and battery life create long-term opportunities for FTV. For its own supply-chain, the company recently noted that they still see a lot of issues with electronic components, although more predictable. Lead times hover around 50-70 weeks for some components, but management is more comfortable now that they've had a year of experience dealing with this dynamic.

ITT (ITT, Outperform) – as we highlighted in our takeaways from our recent investor meeting at ITT HQ (HERE)***,*** the company is focused on best execution through speed of action on adjusting costs and researching the "suppliers of their suppliers" to be to be more proactive with their supply chain. Additionally, management indicated they have received authorization from some European customers of their MT segment to shift production to Mexico or China, if necessary. We see this as a testament to the consistency of production quality globally (contracts specify which specific lines at a particular facility are to be used).

Pentair (PNR, Outperform) – recent channel checks have confirmed the company has rolled out new variable speed pumps with on-board automation systems that allow for easier install and easier customer connectivity. While this was already on the product roadmap, it does reduce the amount of componentry that would have otherwise been required to achieve the desired result in a challenged supply environment.

Parker-Hannifin (PH, Underperform) – the company's CEO spoke at a conference in November 2022, mentioning demographic shifts have played an integral role in company strategy moving forward as capex budgets are expected to move from 1.5% to 2% of sales to make up for lost productivity from decreasing labor supply. This will also enable progression to their 5-year margin target of 25% set in their March Investor Day (our takeaways from the event HERE).

Rockwell Automation (ROK, Underperform) – at last year's investor event the company mentioned they were planning to invest $40MM in its supply chain to ensure the

company can support an incremental $500MM in quarterly revenue. This spend was focused in three key areas: (1) automation of assembly lines, testing equipment, and workforce retention, (2) enhancements to internal systems such as FactoryTalk and more effectively manage internal distribution, (3) redesign initiatives that focus on improving resiliency and sustainability of new product (particularly where component supply could be limited). On its most recent quarterly call, management did note what sounded like more severe near-term component supply issues in their Software & Control segment vs. what others are calling out with an expected severe impact on NT margin.

Robotics And Automation Are The Logical Solutions

Please see our robotics deep dives focused on :
Warehouse and mobile robotics – HERE
Human Augmentation and Collaboration – HERE
Robotics as tools in the climate change fight - HERE

Over the last several years, three major themes have fundamentally accelerated industrial automation and robotics markets: significant strains on global supply chains, tight labor market conditions, and significant acceleration of E-Commerce. These interrelated themes incorporate applications like autonomous mobile robots, machine vision, collaborative robots, and digital twins/simulation.

The pandemic brought these Next-Gen solutions to the forefront of the logistics sector, as current (and more importantly, anticipated) demand simply cannot be met through the existing labor force. There has also been a push from providers to match the consistency of Amazon that has led to considerable supply chain technology investment more broadly. As companies ultimately look to coordinate their supply chain priorities within the context or larger sustainability initiatives, robot decisions will have broader implications. Suppliers will have to think about not only what they can do for customers, but how they operate themselves. We believe that robotics will eventually become a tool in the climate / sustainability toolkit as the world looks to maximize output per unit of carbon – a concept we explored in a recent Ahead of the Curve report (HERE) using Locus Robotics as a test case.

Companies like Amazon are far more advanced in this journey than most. Outside of some big leaders, the broader landscape is much earlier stage. Our discussions with major integrators suggest that globally only ~10% of warehouses are fully automated, 30-40% have some automation (mainly infrastructure like conveyors), while the remaining 50-60% are completely manual. Those percentages likely shifted more towards penetration this year, but the overall takeaway is the same. The international opportunity is likely larger than that in the US given the US was an earlier adopter (something CGNX suggested on its last call as well).

Our Favorites In The Space

ABB (ABB, Outperform)

ABB is uniquely positioned as the only major global automation solutions provider with a full scale robotics platform. ABB is one of the market leaders in industrial robots (#2 market share behind Fanuc) and offers various Next-Gen solutions like digital twins (through partnership with Dassault), collaborative robots, and AMRs/AGVs. In July 2021, ABB announced the $190MM acquisition of ASTI Mobile Robotics, a leader in autonomous forklifts, box-movers, autonomous disinfection solutions, and other heavy payload applications. The acquisition strengths ABB's exposure to high growth end-markets like logistics, warehouse automation, and intralogistics operations. See HERE for highlights from our recent discussion with CEO Bjorn Rosengren.

Symbotic (SYM, Outperform)

Symbotic's unique technology is attacking one of the most challenging aspects of supply chain automation – distribution center case picking. The company is a provider of standalone, fully automated depalletizing, storage, retrieval, and mixed case palletizing solutions for medium-to-large scale distribution centers. SYM's systems offset labor constraints by reducing the number of workers required, changing the complexion of jobs to be filled, while easing high turnover conditions historically plaguing operators.

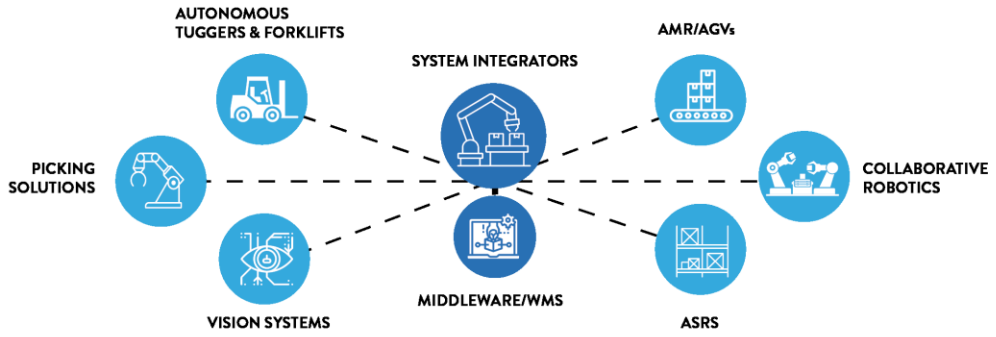
We dive into the company's value proposition and highlight our industry expert interview takeaways in our recent initiation report HERE.

Cognex (CGNX, Outperform)

CGNX remains in an interesting position among robotics and automation providers, as the company's primary solutions (machine vision systems, ID products and related software), are critical enabling technologies in many of the other company applications we describe.

Recently, the company has released products that are integrated with deep learning capabilities – we discuss products in greater detail and provide an overview of the deep learning space (HERE). CGNX is also in the process of expanding the reach of its solutions to a much larger audience with standardized product and modular platforms. The newly introduced In-Sight 2800 series vision solution is expected to be the flagship product for this new strategy – we discuss this strategy shift in more detail described in their September 2022 Investor Day (HERE).

Robot And Automation Ecosystem Overview



SYSTEM INTEGRATORS	Ownership	Amount Rasied ($MM)*
Bastian Solutions (Toyota Industries)	Acquired	$260
BEUMER Group	Private	-
Daifuku	Public	-
Dematic (Kion)	Acquired	$2,160
Fortna (Merging w/MHS Global)	Merger	$8
Intelligrated (Honeywell)	Acquired	$1,500
JR Automation (Hitachi)	Acquired	$1,430
KNAPP AG	Private	-
MHS Global (Merging w/Fortna)	Merging	$195
Murata Machinery	Private	-
Siemens Logistics	Private	-
SSI Schaefer	Private	-
Vanderlande (Toyota Industries)	Acquired	$1,310

AMR/AGVs	Ownership	Amount Rasied ($MM)*
6 River Sytems (Shopify)	Acquired	$394
ASTI Robotics (ABB)	Acquired	$196
Berkshire Grey	Public	-
Caja	Private	$26
Fetch Robotics (Zebra)	Acquired	$290
Geek+	Private	$531
GreyOrange	Private	$196
IAM Robotics	Private	$21
Locus	Private	$312
Tompkins Robotics	Private	$25
Waypoint Robotics (Locus)	Acquired	-

VISION SYSTEMS	Ownership	Amount Rasied ($MM)*
Adept Technologies (Omron)	Acquired	$200
CloudMinds	Private	$470
Cognex	Public	-
Flexiv	Private	$132
Incesoft	Private	$41
ISRA Vision (Atlas Copco)	Acquired	$1,130
Xnor.ai (Apple)	Acquired	$200
Zebra	Public	-

PICKING SOLUTIONS	Ownership	Amount Rasied ($MM)*
Covariant	Private	$147
Dexterity	Private	$212
inVia Robotics	Private	$60
Pickle Robot Co.	Private	$21
RightHand Robotics	Private	$100
XYZ Robotics	Private	$63

MIDDLEWARE / WMS	Ownership	Amount Rasied ($MM)*
Blue Yonder (Panasonic)	Acquired	$7,100
CYNGN	Public	-
Highjump (Körber)	Acquired	$750
Manhattan Associates	Public	-
READY Robotics	Private	$44
SVT Robotics	Private	$32

ASRS	Ownership	Amount Rasied ($MM)*
Alert Innovations	Private	-
Autostore	Public	$328
Exotec	Private	$448
Fabric	Private	$336
KNAPP AG	Private	-
Ocado	Public	$3,440
OPEX Corp	Private	-
Swisslog (Kuka)	Acquired	$330
Takeoff Technologies	Private	$171
Urbx	Private	-

*If available for private companies, Acquired using takeout price

AUTONOMOUS TUGGERS & FORKLIFTS	Ownership	Amount Rasied ($MM)*
AGILOX Systems	Private	-
Autoguide (Teradyne)	Acquired	$189
Fox Robotics	Private	$13
MAXAGV	Acquired	-
MiR (Teradyne)	Acquired	$198
Omron	Public	-
OTTO Motors (Clearpath Robotics)	Private	$82
Seegrid	Private	$152
Third Wave Automation	Private	$59
Vecna	Private	$139

COLLABORATIVE ROBOTICS	Ownership	Amount Rasied ($MM)*
ABB	Public	-
Fanuc	Public	-
Franka Emika	Private	-
KUKA	Public	-
Mitsubishi	Public	-
Staubli	Private	-
Universal Robots (Teradyne)	Acquired	$315
Yaskawa	Public	-

*Note many companies offer solutions which fit into multiple categories shown above

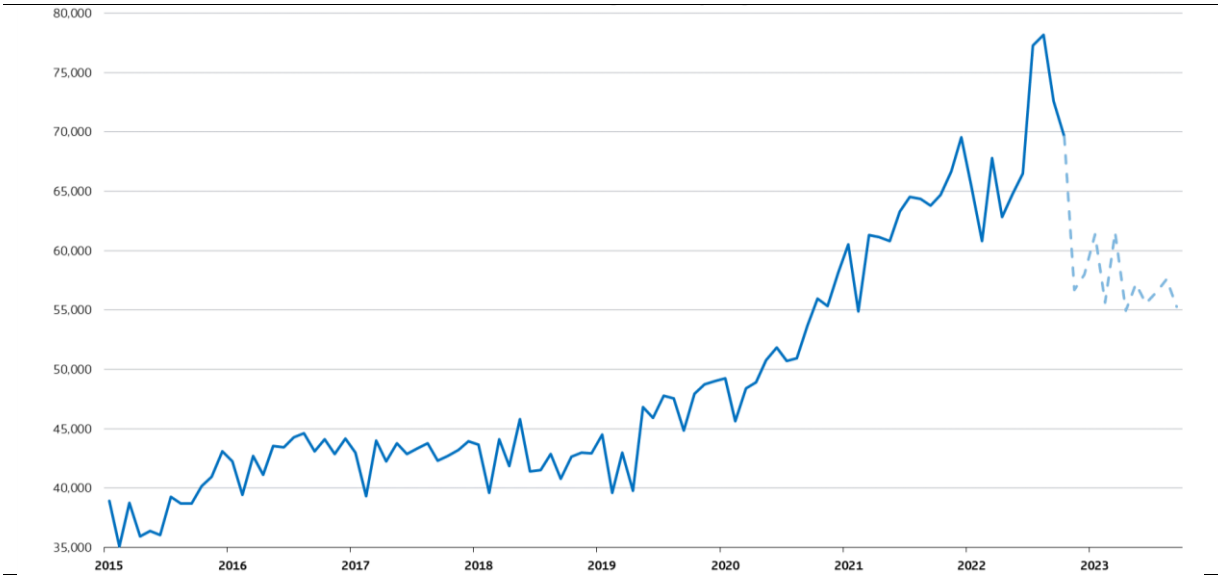
Source: Company reports, Cowen and Company

Airfreight and Airlines (Helane Becker)

The pandemic upended airline passenger traffic over the last several years, especially in the transpacific market. The transatlantic is starting to return to normal, but the future of air freight is changing significantly led by several major macro issues discussed here.

Passenger airliners reduced international capacity during the pandemic when Covid-related restrictions caused a significant downturn in passenger demand in the markets. International traffic started to recover in 2021 as covid-restrictions were removed, and growth accelerated in the summer of 2022. The airlines started adding back capacity, so we expect shippers will again have access to belly capacity to move freight. In general, the major passenger airlines left the main deck cargo market to companies like Cargolux, DHL, FedEx, and UPS while they focused on their core passenger business.

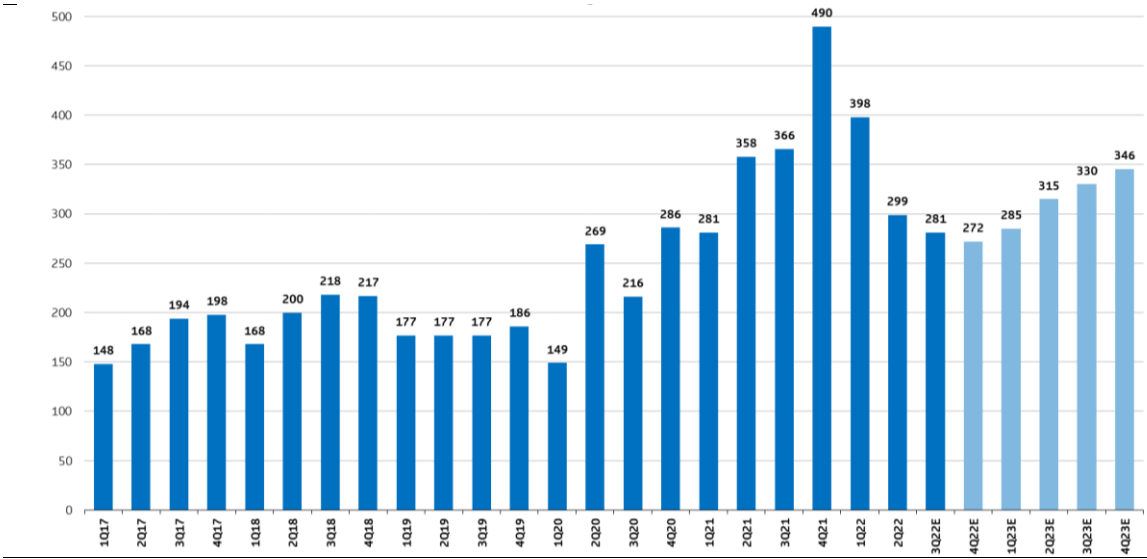
Figure 62 : Global Non-Stop Cargo (Air Only) Flights



Source: Cirium, Cowen and Company

Air Canada is the exception. The company did so well with its preighters (passenger aircraft acting as freighters where the boxes are strapped into seats) that it made the decision to convert two B767s to freighter configuration and put them into service. Two additional 767s have been converted and redelivered but will not go into service until next year. There are also another six 767s that will be converted into freighters over the next few years and then put into service as they continue to expand their cargo business. Finally, they ordered two B777Fs directly from Boeing for long haul cargo movements.

Figure 63 : Air Canada Cargo Revenue



Source: Company Reports, Cowen and Company

The major passenger airlines are adding passenger aircraft back to their network and with that comes belly capacity. We expect the level of belly capacity to grow with passenger capacity, but we do not think the transpacific passenger market will return until 2024 at the earliest. Japan is just now opening its markets and China still has not fully reopened. In China, visitors have a 10-day quarantine period, so it is unlikely tourists will return to the market in the near term. Passenger airlines move about half of all global air cargo in the bellies of their aircraft. The other half moves on the main deck carriers mentioned above. We expect the relationship to remain constant.

Another development we are seeing is an increasing number of the smaller US passenger airlines operating air cargo flights. Sun Country Airlines, a scheduled service airline based in Minneapolis, MN, flies 12 B737-800Fs for Amazon. This is a six-year contract with two two-year extension options for a maximum term of 10 years. Amazon has warrants to purchase up to 9.48 MM shares at $15.17/ share. Upon execution of the agreement, 632,183 warrants vested and 63,217 warrants vest for each $8000 in qualifying payments made by Amazon to Sun Country. As of June 30, 2022, the cumulative vested warrants held by Amazon were worth just over 2.0 MM.

Hawaiian Airlines announced in October 2022 that it will be flying 10 A330-300Fs for Amazon, beginning in 2023. The Hawaiian/ Amazon contract is an eight-year contract with the ability to extend the contract beyond that time. Amazon will own the A330s, and Hawaiian will provide the crew, maintenance, and insurance (CMI) on flights between Amazon's fulfillment centers in the lower 48. The aircraft are certified overwater and will be able to fly to Hawaii as well.

It is Amazon's standard operating procedure to take warrants in the airlines with which it does business. We have identified 114 Prime Air aircraft operating in the US, Europe, and Canada with seven different providers.

Figure 64 : Amazon Prime Air Contracts

Amazon Prime Air Contracts	
Partner Airline	**Contract Details**
ASL Airlines Ireland	9 B737-800Fs
Atlas Air	19 B767s (2 operated by ATSG), 8 B737-800Fs
ATSG	49 B767-300Fs
Cargojet Airways	2 B767-300Fs
Hawaiian	10 A330s (beginning in 2023)
Silver Airways	5 ATR72s
Sun Country	12 B737-800Fs

Source: Company Reports, Cowen and Company

Atlas Air and ATSG (doing business as Air Transport International) have the largest Prime Air fleets, but neither one operates ATRs nor A330s, which is why Amazon branched out to other providers. There are also a limited number of B767s available for passenger to freighter conversion due to delivery delays from the manufacturers on the replacement aircraft (B787s and A330neos). There are also a limited number of conversion slots available, so Amazon needed to branch out to another aircraft type.

Over the next half decade, we expect cargo volumes to continue increasing as online ordering continues growing. Supply chain constraints and inventory shortfalls means replacement product is going via air more frequently than in prior decades. In addition, port delays over the past two years also caused major changes in ocean freight shipping. The Ports of Los Angeles and Long Beach, the two largest US ports for imported goods from Asia, are losing market share to East Coast Ports, like the Port Authority of New York and New Jersey and the Port of Savannah, GA, and to the Port of Houston, TX. We expect this share shift to continue, especially because ground transportation networks on the west coast are seeing increasing bottlenecks due in part to a lack of automation.

Mesa Air, a regional US airline based in Phoenix, AZ, transports passengers on an ACMI basis for American Airlines and for United Airlines. They also fly three B737-800Fs for DHL in the US. This is a major departure for a regional airline, but, in Mesa's case, is turning out to be a necessity as the airline was seeing significant pilot turnover. Offering pilots the opportunity to fly B737s enables them to attract and retain pilots while the pilots build hours and experience.

FedEx and UPS continue to build their businesses in areas beyond e-commerce. Both companies were instrumental in vaccine distribution during the early days of the COVID-19 vaccine push. The companies continue to focus on high margin, high touch businesses like pharmaceuticals, cold-chain, technology, health care, and medical devices. FedEx fired Amazon as a client in September 2019, while UPS notified Amazon that they would determine what volumes they are willing to handle going forward. FedEx and UPS prefer to focus on their own businesses and leave low-margin businesses to others. We expect this trend to accelerate over the next few years as changes in health care (as an example) necessitate easier distribution of pharmaceuticals. As the US population ages, it is probably easier to get drugs in the mail than it is to go to the pharmacy.

Retail (Oliver Chen, CFA)

Costco: Impressive Scale, Limited SKU's, and Immense Buying Power Drive Supply Chain Efficiency

Over the course of FY22 (ended 8/28/22), management attributed the largest supply chain disruptions to port congestion, container and packing challenges, component shortages, labor cost pressures, Covid-19 disruptions, and trucking delays. We believe Costco's impressive scale, limited SKU's (less than 4,000), and immense buying power lends to an agile supply chain response as evidenced by effectively chartering ocean freight, periodically switching vendors, and focusing the business on items rather than categories. Throughout the fiscal year, Costco demonstrated an effective supply chain response by maintaining average comp sales strength of +10.5% and relatively stable core-on-core gross margin contraction of -28bps while prudently managing inventory levels relative to sales at an average spread of -5.2% to keep shelves full.

- **1Q22:** Management notes 79% of import containers are delayed by an average of 51 days primarily resulting in seasonal inventory arriving out of season. Costco responds by chartering 3 small container vessels for 3-years to provide additional flexibility on container shipping.

- **2Q22:** Costco charters 4 additional ocean vessels, for a total of 7 through FY25, and leases containers to accommodate 1/4th of annual transpacific shipment needs. Further, management anecdotally notes that Costco has begun to diversify suppliers on SKU's between $300mm and $1bn.

- **3Q22:** Management sees benefits in immense buying power given less than 4,000 SKU's contributing to TTM average sales of ~$53bn as shelves remained stocked based on an item focus rather than a category focus. Costco notes receival of delayed seasonal inventory will be held ahead of holiday season.

- **4Q22:** Costco acknowledges slight improvement in supply chain pressures relative to past quarters as commodity prices fall, port delays decrease, and delivery times improve. Real estate issues mount as 4 fewer stores are projected to open in the quarter given electrical supply chain delays.

Figure 65 - Costco FY22 Select Financials

	1Q22	2Q22	3Q22	4Q22
Price Inflation	4.5% to 5%	6%+	7%+	8%+
Comp Sales Growth (ex-gas)	9.8%	11.1%	10.8%	10.4%
Core Gross Margin Expansion	-18 bp	-28 bp	-39 bp	-26 bp
Inventory to Sales Spread	2.9%	-3.0%	-9.9%	-10.9%

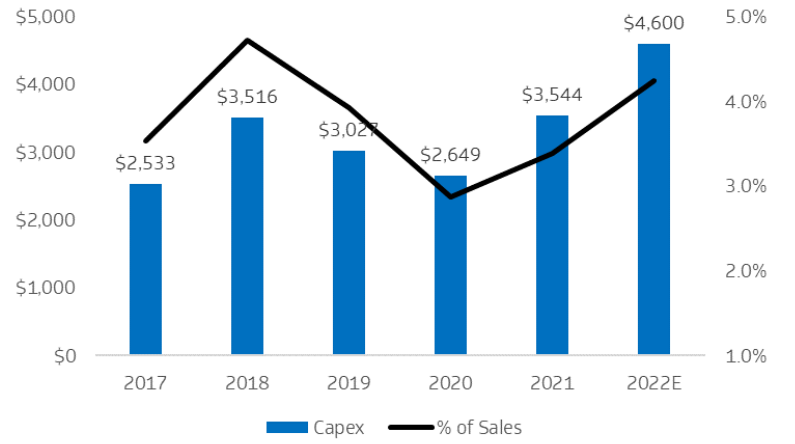
Source: Costco Company Filings and Cowen and Company

Target: $5bn Investment Towards Stores & Supply Chain Agility

In early March, Target announced plans to invest up to $5bn in FY22 (~4.5% of sales) towards the physical stores, digital business, and fulfillment and supply chain to stay competitive within the dynamic retail environment. Specifically on the supply chain side,

TGT plans to: (1) enhance the same-day offering, (2) invest in sortation centers, and (3) grow the number of distribution centers across the U.S. On average, TGT has invested ~3.8% of sales back into the business, primarily on store refreshes and maintenance. Management has increasingly focused on investing in the supply chain, particularly within fulfillment in stores and additional capacity outside the stores to support the growing sales base.

Figure 66 TGT Capex (in $mm)



Source: Cowen and Company

"In-Store" Supply Chain Working for Customer: One of TGT's key priorities for the company's supply chain investment includes increased efficiency at the store level. Alongside store remodels, TGT has set out to reconfigure portions of the store to optimize the same-day operations, including Drive-up, In-Store pickup, and Ship-from-Store services. The company's same-day fulfillment options have grown nearly 400% since 2019, which accelerated during the pandemic but is now fully integrated into TGT's omni shopping experience. In FY22, TGT aims to expand the offering through adding Starbucks orders and easy returns to the Drive-up option.

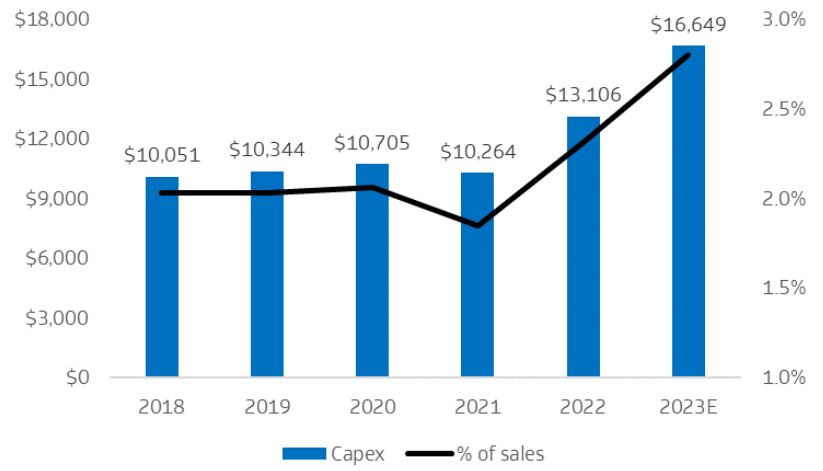
Increasing Efficiency & Capacity Outside the Store: TGT is also keenly focused on building supply chain efficiencies outside the store through distribution centers and sortation centers to drive additional capacity. As part of TGT's $5bn investment, the company plans to open six new DCs over the next several years, including two set to open in 2023 to support the incremental $27bn of sales TGT added between 2020 and 2021. The sortation centers are small facilities that increase TGT's ship-from-store capabilities through improved delivery speed and reduced shipping costs to compete in the online retail space. Further, TGT is adding incremental holding capacity near U.S. boarders to improve flexibility and speed, and to keep the DC network operating below the target 85% maximum capacity for optimal efficiency.

Walmart: Leaning into Automation and Capacity to Keep Up with Demand

Walmart's accessibility (4,700 stores located within 10 miles of 90% of the U.S. population) makes the company ripe for optimizing last mile efforts, specifically automating the fulfillment portion of the supply chain. The company can then leverage this technology to further increase the B2B offering, including adding fulfillment services to sellers on WMT's marketplace platform. These efforts further culminate to

deliver items faster to the customer and replenishing items in the store faster in order to maintain in-stock levels. We highlight two core aspects to WMT's supply chain investments: (1) automation and (2) B2B services.

Figure 67 WMT Capex ($mm)



Source: Cowen and Company

WMT's Investments in Robotics & Automation Set a New Standard for Retail: The company has been particularly acquisitive in the robotics and automation space to improve the speed and efficiency of fulfillment centers. For instance, WMT acquired Alert Innovation for an undisclosed amount in early October 2022. Alert Innovation's technology is tailored specifically to Walmart's Market Fulfillment Centers (MFCs) that operates bots to store, retrieve, and dispense orders by moving throughout the MFC without the use of lifts or conveyors. Additionally, Walmart began using the VizPick technology that support sales associates in retrieving product for customers quickly from the backroom to the sales floor.

Leveraging Current Fulfillment Capabilities for Marketplace: Walmart boasts over 240mm items on the U.S. e-comm site through Walmart's own inventory, as well as through the addition of the marketplace. The marketplace is a meaningful customer unlock as the company can offer more items. On the supply chain side, WMT leverages the company's current fulfillment capabilities through the crystallization of Walmart Fulfillment Services (WFS). This is having an immediate benefit to the third party sellers: the sellers that are using WFS to fulfill orders are seeing 50% sales growth for the items channeled through WFS.

AEO: Building A Logistics Platform For Creating Higher Efficiency

AEO has made significant strides in optimizing their supply chain by acquiring two logistics platforms – Quiet Logistics and Air Terr in 2021. These acquisitions are meant to bolster and streamline AEO's logistics operations and create speed within the supply chain. We believe AEO's acquisitions could provide synergies and margin expansion as digital penetration increases and ensuring fast and efficient fulfilment is key to unlocking higher customer satisfaction.

Quiet Logistics: Quiet Logistics is a leading logistics company that operates a network of in-market fulfillment centers in Boston, Chicago, Los Angeles, Dallas, St. Louis and Jacksonville, locating products closer to need, creating inventory efficiencies, cost benefits and affordable same-day and next-day delivery options to customers and stores.

- Revenue is estimated at ~$120-130mm (~2% of AEO's FY21E revenue), with ~60 other retailers as customers. AEO is seeing solid demand at Quiet Logistics and expects ~30% y/y growth annually, which should drive the business' profitability.
- Quiet Logistics drives inventory allocation efficiencies and reduced split shipments for orders; ultimately it reduces shipping costs and leverages store labor more efficiently as store associates fulfill less online orders.

AirTerra: AirTerra is a logistics and supply chain platform that solves ecommerce fulfillment and shipping challenges in a unique and innovative way for retailers and brands of all sizes. AirTerra is in the business of moving freight and middle mile transportation. Demand for AirTerra's services has been strong especially as freight costs increase and retailers look for cheaper regional transportation options. Based on the latest disclosed information, six retailers have contracted AirTerra in addition to AEO; note that management has not yet disclosed expected revenue for AirTerra.

Luxury Companies Focus On Delivering With Speed

We believe delivery speed is especially important in luxury as consumers expect the best-in-class customer service, including fast delivery, given the high ticket price associated with luxury items. We are seeing an increasing focus among luxury retailers to integrate speed to the supply chain and perfect last mile delivery to ensure that consumers are satisfied with their purchase. Further, luxury companies, such as FTCH, are leaning into data to optimize cross-border delivery by locating closest items to consumers to save costs and reduce delivery time.

FTCH's Fulfilment By Farfetch Service Underpins Supply Chain Modernization In Luxury

FTCH offers a luxury logistics solution (Fulfilment by Farfetch) via third-party logistics warehouses in Italy, the Netherlands, the United Kingdom, the United States, Hong Kong, and China. These warehouses are used for FTCH's first-party stock and luxury sellers on FTCH can utilize to handle their fulfilment and allocate stock closer to consumers. FTCH uses proprietary data insights to predict where the product should be sitting with stock stored in strategically placed locations. Through its proprietary technology, FETCH is able to service consumers more efficiently, limits the distance the product travels in carrier networks, provides advantages for consumers, and removes friction from the growth of supply for FTCH's luxury sellers.

HD and LOW Supply Chain Differentiation (Max Rakhlenko, CFA)

Both HD and LOW have placed their supply chain at the center of recent investment cycles. HD is investing across a number of different nodes to enhance supply chain efficiency. That said, we view the Flatbed DCs as the crown jewel of its next-generation supply chain. The Flatbed DCs will help the retailer take share with the Large Pros which demand reliability and accurate delivery forecasting from their retail partners. HD is enhancing its supply chain through Flatbed Delivery Centers which house big and bulky building material SKUs generally bought by Pros. This facility helps take SG&A away from stores which previously had to stage building material SKU deliveries and into FDCs which can centralize and deliver these items more efficiently.

LOW is focusing its supply chain efforts on moving big and bulky SKUs such as appliances one node up the supply chain to market level centers. Previously stores had to house and deliver these items, which was inefficient for labor and working capital. Through market level centers and a corresponding network of cross-dock delivery terminals, LOW can streamline transportation and labor to create SG&A efficiencies while improving working capital through centralized inventory planning and delivery.

Ultimately, we expect supply chain investments at both retailers to drive meaningful cost efficiencies, and support SG&A leverage, partly offset by modest gross margin pressure.

HD's Differentiated & Low Cost Delivery Network To Fuel Productivity

HD has undertaken a nearly six-year and $1.2bn investment cycle in re-engineering its supply chain. HD is standing up 140-150 buildings to achieve the most productive and low-cost delivery network in the home improvement sector. The company initially planned to open 150 facilities across five different types of centers by 2022-end, but given Pandemic delays, and the acquisition of HD Supply, a smaller number will be pushed out into 2023, and potentially 2024. The 140-150 buildings are split between five different types of facilities: 1) Rapid Deployment Centers; 2) Flatbed Delivery Centers; 3) Market Delivery Centers; 4) Direct Fulfillment Centers; 5) Market Delivery Operations.

Rapid Deployment Centers (RDC): Upstream facilities which efficiently sort, label, and transport products to stores. HD is investing in technology to increase automation (implemented Mechanized Floor Loading system in majority of facilities) and reduce product touches from 3 to 1, and accelerate flow of goods.

Flatbed Delivery Centers (FDC): These facilities are the key to HD's new supply chain and specialize in big and bulky building material SKUs (lumber, building materials, flooring, etc) that are most efficiently delivered on flatbed trucks.

The centers accomplish several important goals. 1) Take pressure off stores which previously were responsible for staging and storing the orders the morning of deliveries. This will allow store associates to focus on value added activities and improve customer satisfaction. (2) Expand the assortment beyond what is stocked in the stores. Average orders are significantly larger than previous orders fulfilled in stores. (3) Helps drive market share with pro customers in lumber, building materials, and other big and bulky items

HD expects to open 15 centers by FY22-end, with another ~15 to open over the medium-term (most likely to be open by end of 2023, with a small number potentially pushed to 2024)

Market Delivery Centers (MDC): HD has opened a small number of facilities as the roll-out will take longer than initially anticipated following the acquisition of HD Supply as management re-thinks the scope of the facilities. MDCs were initially intended to carry the most delivered store and MRO SKUs. Management now is leveraging the legacy HD Supply network for the MRO fulfillment, which frees up capacity in the MDCs to better operate as a local, direct fulfillment center for store-based SKUs. These centers are typically for higher margin categories.

Direct Fulfillment Centers (DFC): Local facilities which carry the most delivered store and MRO products as well as select big and bulky items. These facilities are traditional pick-pack-ship e-comm facilities which enable HD to deliver products on a same-day or

next-day basis to its top markets. These centers can ship products significantly more efficiently than when they come from stores. Management's goal is to deliver orders to 90% of shoppers in one day. HD has 11 DFC facilities open today, which is about half of the total projected facilities.

Market Delivery Operations (MDO): Smaller cross-dock facilities for big and bulky products (particularly appliances) which receive and transfer products onto trucks, and send to customers' home or job site. MDOs receive products from the FDC, which then get sent out. These facilities consolidate outbound delivery to customers and reverse logistics returns for immediate dispatch, and do not hold inventory. Previously, HD outsourced the last-mile portion of deliveries, but now through MDOs it has full control of the supply chain journey. At-least 85 of 100 centers are operational today.

Once deployed and fully scaled, HD will operate the most efficient supply chain in the home improvement sector. This will allow HD to both leverage SG&A and re-invest some of the efficiencies back in the business to further improve its value proposition for shoppers, strengthen revenue and share growth, and accelerate its flywheel. On the Pro side, the enhanced capabilities will allow HD to win the large Pro's planned purchases by increasing assortment breadth and depth, delivery speed, and on-time reliability.

LOW's Supply Chain

LOW has also invested heavily in an upgraded supply chain, which is forecasted to cost~$1.4bn and be complete by FY23-end. Previously, the supply chain worked through multiple complicated stages with the store as the hub. Vendors would send product to either regional, flatbed, or appliance DCs. These DC's, depending on the item, could ship directly to consumers, ship to store, or ship to a central delivery terminal. On the back end, this infrastructure required modern systems to execute, which LOW previously lacked. LOW had slow systems that utilized various platforms that were complex and did not speak to each other. Ultimately, this complex and old supply chain resulted in volatile inventory levels, out-of-stocks, lost sales, and unhappy customers.

LOW's new supply chain is focusing on three pillars: (1) Improve flow and inventory visibility; (2) Improve the parcel shipping network; (3) Optimize infrastructure for fulfillment and delivery.

Improved Flow And Inventory Visibility: Stores first and foremost receive smaller and more frequent shipments from DCs which ensures more consistent in-stocks. Having a clearer and dependable delivery schedule then allows stores to plan labor more efficiently and not waste hours loading/unloading large truckloads of inventory. More frequent shipments have higher transportation costs, but the savings from enhanced labor scheduling and increased productivity from improved in-stocks and higher velocity inventory more than offset the increase. The improved flow and visibility works its way to the customer level through more accurate delivery estimates.

Market Delivery Model Provides Significant Productivity Unlock: LOW's market-level bulk distribution centers and enhanced cross-dock network are key unlocks to improving distribution efficiency. In this network, market level DCs house big and bulky goods which then move to a cross-dock network which then delivers shipments to customers. Overall, LOW is modernizing its network of bulk distribution centers, regional distribution centers, cross-dock delivery terminals, flatbed distribution centers, and direct fulfillment centers

As the Bulk DCs get stood up, larger inventory that was traditionally housed in-store will be removed from the store. When customers make a purchase either online or instore,

the delivery will originate from the closest market delivery point to that customer rather than whichever store had the available inventory, creating delivery efficiencies through optimized transportation planning. The goods then move to cross-dock terminals which are then delivered to the customer. These cross-dock facilities can also supply big and bulky goods to stores for those customers that prefer cash-and-carry.

By moving inventory one step up in the supply chain, SG&A will be removed from stores as fewer payroll hours will be spent moving big and bulky inventory in the back rooms. Simultaneously, removing that inventory from stores will reduce touches and improve breakage costs. Further, the logistics efficiency from planning deliveries at the market level will cut down on unnecessary trips and costs

Managing inventory at the market level will also improve working capital as stores no longer need to carry a full big and bulky assortment. Since inventory is managed at market level, all stores will have access to all inventory.

Improving The Parcel Shipping Network: In 3Q18, LOW opened its first direct fulfillment center (DFC) in Tennessee which served ~75% of the U.S. for 2-day ground demand. The DFC relieves DC stress by handling break pack for the entire network. LOW then opened a second DFC in Southern California to cover 100% of the U.S. Ahead, construction is underway for additional smaller e-comm FCs that can handle more oversized packages.

For next-day and same-day delivery, LOW can also use its "old-reliable" in the supply chain – the store network. LOW stores have nearly 10,000 sq. ft. of space in the back room due to the old process of keeping appliances in the backroom. As those goods move from stores to the market-level bulk DCs, the backroom can house key online-only SKUs for delivery.

LOW is rolling out its new supply chain on a market-by-market basis. Therefore, at the onset of the supply chain transition, LOW essentially operates two supply chains simultaneously. Once utilization of the new market-delivery ramps toward 70% (typically takes six to eight months), the economics inflect and become a tailwind to margins. The pressure works its way through the P&L in gross margin, while the productivity enhancements are seen through SG&A leverage.

Given the rollouts completed in FY21 and FY22, the market-delivery model has modestly benefitted store operating expenses for FY22 through lower store labor and damage related expenses. Additionally, management has noted that appliance sales increase, profitability improves, inventory turns increase while overall inventory is down, delivery on-time rates are increasing, and overall customer satisfaction is improving with each rollout.

Key eCommerce Supply Chain Issues into Year-end '22: AMZN and Wayfair (John Blackledge)

Home eCommerce Expert Call: Container Costs Ease; Excess Inventory Remains an Issue

On 10/13, we hosted a call with one of the largest Home sellers on Amazon & Wayfair whose business is largely comprised of Outdoor Home Goods Products sold across several online marketplaces; key products include hammocks, fire pits, accessories, and decorative items. He expects his company's revenue to be ~$70MM in '22, down from ~$90MM in '21, with ~52% of revenue generated on Amazon, and, historically, 15-17% on Wayfair. Overall, his company's sales were down y/y in 3Q22, with +5% y/y on AMZN offset by a 15% decline y/y on Wayfair.

The revenue decline improved vs 2Q (25%) y/y, helped by having more inventory in stock vs 3Q21. For more details on our Home Goods check call, see our 10/14 note (LINK). Our expert attributed the improvement to inventory stock outs in 3Q22 that created easier comps. Given the much better inventory situation, he had been hoping for better 3Q22 results, while also acknowledging lower industry-wide demand, exacerbated by macro / inflationary factors and COVID pull forward.

Container Prices Are Approaching Pre-Pandemic Levels: Container prices continue to improve sequentially, with our seller noting that he's now paying $2K for container delivery to the West Coast (and $7500 to Wisconsin); this $2K matches pre-pandemic levels and has dropped dramatically vs $15K per container that our seller was paying only 4 months ago. Our seller is still sitting on high-cost inventory, and believes it will be next summer before he has lower cost inventory to help fight inflation. He is also spending ~30% more on AMZN advertising vs. a year ago (he has historically spent 8% of sales on AMZN ads, though he is now spending ~10-11%); part of the ad spend inflation reflects stockouts in 3Q21.

Asia Suppliers See Big Drop in Orders; Our Home Goods eCommerce Seller Is Wary of Order Deposits: Our seller stated that he is concerned about paying his suppliers the typical 30% deposit because he believes some may go out of business following a stretch of significantly lower orders (with some suppliers citing 50% lower orders y/y). 80% of his Asia suppliers agreed to no deposits. Meanwhile, our seller is ordering 20% of the containers that he ordered a year ago, and given the lower volume of overseas shipping, he expects excess capacity in '23 to help drive container shipping rates even lower.

As such, our seller expects to be able to lower wholesale prices on his SKUs around summer '23, with timing depending on how quickly he sells through his current inventory (he estimates that a recession could extend how long it takes him to work through this high-cost inventory by several months). In addition, our seller is sitting on 35% more inventory than normal, which equates to ~$9MM-$10MM of extra inventory.

eCommerce Seller Utilizes China Shipping / Logistics Services From Amazon & Wayfair: Our Home Goods seller stated that he uses both Amazon and Wayfair's overseas logistics services "whenever he can," though he added that these SKUs end up directly in Castlegate and Amazon facilities in the U.S., which can be a problem when demand is lower, such as the current environment. For example, he is currently spending ~$250K per month bringing inventory back to his own company's warehouse in Eau Claire, Wisconsin. Looking ahead, he plans to dramatically lower his orders for '23; for some SKUs, if he sold 1K/month in '21, he is now selling only 500/month, and thus he only plans to order 250/month for next year's inventory.

2023 Outlook: Budgeting for Flat Y/Y eCommerce Sales, Price Normalization in Summer '23: Looking to 2023, our Home Goods eCommerce seller is budgeting flat y/y sales growth for the full year. While our expert hypothesized that sales could benefit from consumers looking to replace home goods purchased in the 2020 eCommerce surge, he also noted that lowering sales prices could put a dent into revenue. Our seller's inventory is largely high cost at the present time, having been purchased when freight costs were upwards of $20k / container, as such, he expects that he will be able to lower prices beginning in Summer '23 when inventory and freight costs are right sized.

AMZN Remains Focused on Driving Down Inefficiencies Following Massive Pandemic-Era Investments & Inflation Related Costs (Including Shipping, Labor, Etc): On the 3Q22 call on 10/27/22, AMZN mgmt. cited roughly ~$1BN in sequential operations cost improvements, reflecting better fixed cost leverage and higher productivity following the historic capex cycle during the pandemic. However, mgmt. stated that these improvements came in lower than expected by ~$500MM, impacting 3Q Op Income. Going forward, mgmt. expects continued improvements in productivity and network optimization as they bring the cost structure back toward pre-pandemic levels; improvements at the retail biz may be partially offset near-term by persistent high fuel costs (especially in Europe), while AWS also faces wage inflation.

As a reminder, AMZN in 1Q22 called out roughly $6BN in incremental costs related to inflation, reduced fulfillment productivity, and fixed cost deleveraging. The company lowered this figure to $4BN in 2Q, despite ongoing higher fuel and shipping costs. At the time, the 2Q improvements were attributed to better fulfillment network productivity and greater efficiencies in transportation. Looking ahead to 4Q22, AMZN has stated that capacity is historically constrained in 4Q (due to seasonal challenges) and noted that it will be difficult to further improve productivity. They also called out inflationary pressures that they expect to continue through 1H23. For more details on Amazon's 3Q22 results, see our 10/28 recap note (LINK).

For Wayfair, 4Q22 Gross Margins Are Expected to Benefit From Lower Supply Chain Transport Costs: Wayfair mgmt. indicated on the 3Q22 earnings call (on 11/3/22) that they expect 4Q22 gross margin guide in the 28-29% range, above their recent 27-28% guide range, driven by increased CastleGate penetration and lower supply chain transport costs, which are beginning to return to near pre-Pandemic levels. This implies gross margins near or above our 28.0% pre-print estimate. Of note, mgmt expects slight seq. pressure on 4Q gross margins relative to 3Q (29.0% margin) due to typical holiday product mix shift.

Wayfair's Castlegate Penetration to Reach Record Levels: Mgmt. on the 3Q22 earnings call cited continued uptake from suppliers using CastleGate in 3Q, noting that they expect the logistics offering will reach record levels of use after returning to 25% penetration of revenue in the US last quarter. As a reminder, CastleGate penetration dropped in '21 as suppliers faced Pandemic-induced inventory shortages. Now, suppliers are taking advantage of the ship cost savings, improved delivery speeds, and reduced damage rates offered by Castlegate. Given that the offering drives cost efficiency for both W and suppliers, mgmt. cited rising CastleGate penetration as a major driver for improved gross margin in 3Q and going forward. For more details on Wayfair's 3Q22 results, see our 11/4 recap note (LINK).

Cost Deflation is a Tailwind But Largely Captured in Consensus Estimates (John Kernan, CFA)

Cost Deflation Is A Tailwind But Largely Captured in Consensus Estimates

Both freight and raw materials costs have meaningfully come down since the start of the summer as supply chain disruptions have begun to moderate in the retail sector. Container costs from Shanghai to the Port of Los Angeles have come down from the peak of over $12,000 per container to current levels of under $3,000 per container (-78% y/y). Shipping container costs nearly flat relative to 2019 levels and down 78% over the past twelve months. The average prices of U.S. gas and diesel are also below their summer peaks, with the average gallon of Gas in the U.S. now costing $3.76 as of October 31st.

The average prices of U.S. gas and diesel are also below their summer peaks, with the average gallon of Gas in the U.S. now costing $3.76 as of October 31st. Current gas prices are still up +11% y/y but have fallen 24% from their peak of $5 seen in June. Diesel prices have remained more elevated than gasoline prices and have risen +43% y/y to current levels of $5.32 per gallon. However diesel prices have also fallen from their summer peak, down -8.5% since June.

Figure 68 U.S. Average Gasoline Price Per Gallon

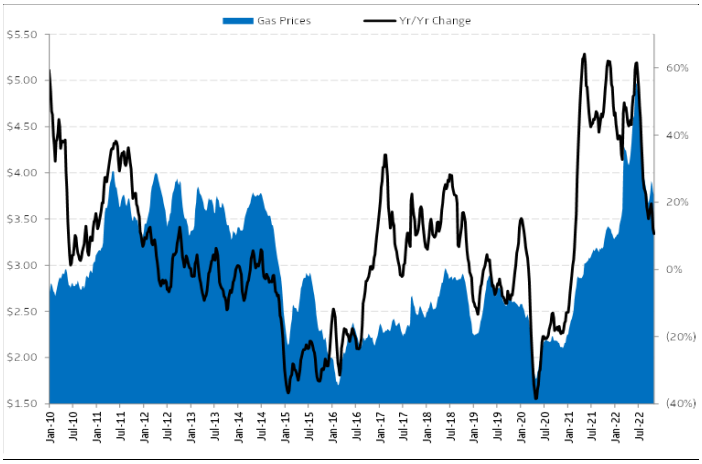
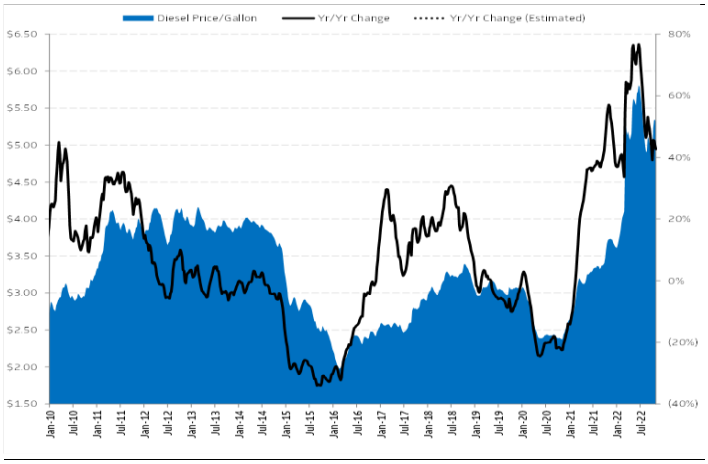


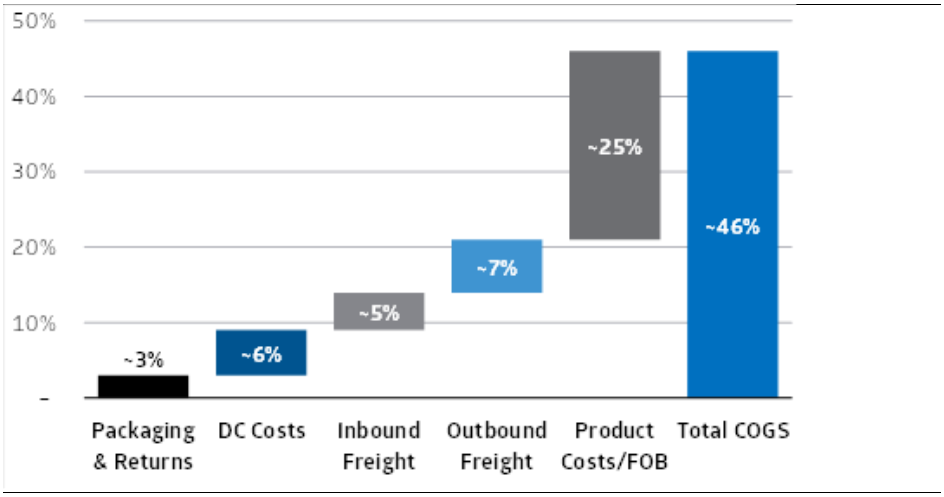
Figure 69 U.S. Average Diesel Price Per Gallon



Source: AAA, Cowen and Company

We believe that while deflationary pressures within the supply chain will be a tailwind to gross margins across the companies in our coverage, these reduced costs are likely already baked into Consensus margin expectations for FY23. We note that Consensus has gross margin estimates in our sector up an average of 105bps between FY1 and FY3, which we feel like largely due to reduced supply chain costs. We estimate that inbound and outbound freight costs comprise roughly 25% of total COGS, so reduced freight costs would meaningfully drive COGS lower and gross margins higher.

Figure 70 Components of COGS



Source: Cowen and Company

Figure 71 Softlines Consensus Margin Estimates

				Gross Margin						EBIT Margin					
Company	Ticker	Rating	Price	FY(1)	FY0	FY1	FY2	FY3	FY1 to FY	FY(1)	FY0	FY1	FY2	FY3	FY1 to FY
Nike	NKE	1	$105.36	44.2%	46.3%	43.9%	45.5%	46.5%	265 bps	14.0%	14.7%	11.3%	13.2%	14.5%	-342 bps
adidas	ADS	2	€ 129.20	49.7%	50.8%	47.9%	48.5%	49.0%	111 bps	3.7%	9.7%	3.7%	5.9%	7.5%	216 bps
VF Corp.	VFC	2	$32.60	53.7%	55.2%	53.5%	54.3%	54.8%	130 bps	8.0%	13.3%	10.6%	11.5%	11.9%	95 bps
Lululemon	LULU	1	$354.27	55.8%	57.7%	56.8%	56.9%	57.4%	65 bps	19.2%	21.6%	22.2%	22.3%	22.7%	8 bps
Under Armour	UAA	2	$9.45	48.6%	50.4%	46.0%	47.0%	47.6%	166 bps	0.0%	9.3%	5.1%	6.5%	7.1%	133 bps
Puma	PUM	2	€ 51.44	46.8%	47.9%	47.1%	46.5%	47.0%	-2 bps	4.0%	8.2%	7.9%	7.7%	8.5%	-29 bps
On Holding	ONON	NR	$17.32	NA	NA	56.0%	58.3%	58.9%	296 bps	NA	NA	6.9%	10.6%	12.0%	372 bps
FIGS	FIGS	2	$6.17	NA	NA	69.9%	69.4%	69.4%	-45 bps	NA	NA	7.9%	7.8%	9.8%	-4 bps
Deckers Outdoors	DECK	1	$352.95	53.9%	51.5%	50.6%	51.4%	52.1%	157 bps	19.5%	17.5%	17.5%	18.4%	19.3%	90 bps
Columbia Sportswear	COLM	1	$80.98	48.4%	53.7%	48.6%	48.9%	49.3%	75 bps	4.8%	13.1%	12.4%	12.5%	13.2%	12 bps
Skechers	SKX	2	$39.89	47.6%	49.4%	47.1%	47.6%	48.1%	100 bps	3.9%	9.7%	7.5%	8.6%	9.4%	114 bps
Ralph Lauren Corp	RL	1	$102.07	65.4%	66.6%	65.3%	65.6%	66.5%	121 bps	2.1%	13.4%	12.0%	12.4%	13.1%	43 bps
PVH Corp	PVH	2	$59.73	53.0%	57.7%	57.4%	57.2%	57.6%	14 bps	-0.9%	9.9%	8.9%	8.9%	9.7%	-2 bps
Capri Holdings*	CPRI	1	$53.29	63.6%	67.5%	66.4%	66.6%	66.6%	27 bps	7.8%	18.7%	18.2%	18.1%	18.7%	-16 bps
Canada Goose*	GOOS	1	$17.86	61.3%	66.8%	65.8%	68.6%	68.7%	287 bps	13.5%	15.3%	17.4%	19.0%	18.7%	156 bps
Levi Strauss & Co.	LEVI	NR	$15.57	54.3%	57.7%	57.9%	57.8%	58.5%	61 bps	3.8%	12.5%	11.5%	11.5%	11.9%	-1 bps
Hanesbrands	HBI	NR	$7.00	37.9%	39.7%	36.4%	36.4%	36.9%	53 bps	11.8%	13.5%	9.3%	9.9%	10.5%	57 bps
Gildan Activewear	GIL	NR	$27.85	14.8%	30.2%	29.7%	28.9%	29.1%	-54 bps	-2.7%	19.2%	19.6%	18.6%	19.2%	-94 bps
Foot Locker	FL	2	$33.00	28.0%	35.5%	30.7%	30.4%	30.3%	-37 bps	5.2%	11.9%	7.3%	6.7%	6.8%	-60 bps
Dick's Sporting Goods	DKS	1	$102.41	31.1%	38.0%	35.1%	34.4%	34.8%	-35 bps	7.8%	16.1%	11.9%	11.2%	11.4%	-71 bps
Yeti	YETI	1	$42.90	57.1%	57.7%	52.6%	54.5%	55.3%	268 bps	20.1%	20.8%	16.8%	18.2%	18.9%	138 bps
Crocs	CROX	NR	$98.31	53.6%	61.1%	55.2%	55.5%	55.2%	3 bps	17.1%	29.8%	26.5%	25.3%	25.0%	-122 bps
Steve Madden	SHOO	NR	$33.32	38.8%	41.3%	41.0%	41.1%	42.6%	158 bps	5.0%	13.7%	13.6%	13.3%	13.2%	-32 bps
Stitch Fix	SFIX	NR	$3.74	44.7%	44.4%	42.2%	42.8%	43.3%	107 bps	-4.9%	-8.8%	-10.7%	-8.0%	-5.3%	271 bps
Allbirds	BIRD	1	$2.94	NA	NA	49.3%	51.2%	52.3%	299 bps	NA	NA	-22.4%	-15.7%	-10.6%	678 bps

*Covered by Oliver Chen

Source: Refinitiv as of 11/18/22, Cowen and Company

TJX is our top pick within off-price retail for supply chain margin recovery as both ROST and BURL have seen their margin structures contract since the COVID-19 pandemic, partially due to supply chain and inflation costs. TJX maintained its FY22 gross margin at pre-covid levels of 28.5% despite a 200bps headwind from supply chain and freight costs. We're modeling gross margin contracting a modest 40bps in FY23 despite a 230bps impact on merchandise margin due to elevated shipping costs in H1:23 and estimate TJX can expand its gross margin to 28.8% in FY24. We're modeling EBIT margin up 20bps in FY23E to 9.8% and model it expanding to FY20 levels in FY24E of 10.6%, which is modestly below Consensus estimates.

Supply Chain Disruptions Likely To Cause More Working Capital Volatility

COVID-induced supply chain shocks have led to longer and less predictable lead times for retailers when they're planning their inventories for coming seasons, many of whom source their goods from Asia. This is caused many companies to place orders further out than they otherwise would in a normalized supply chain environment to ensure that they have sufficient goods to meet consumer demand. However, now that supply chain and port congestion is beginning to ease many retailers are receiving goods early, which is causing inventory to build up on the balance sheets of many of the companies in our coverage. This is most noticeable when looking at the rapid inversion of the sales-inventory spread for many of the retailers in our coverage.

We anticipate many of the companies in softlines retail to continue to experience elevated inventory levels as supply chains continue to normalize and it takes retailers several quarters to clear through their excess inventory. These elevated inventory levels are likely to result in higher levels of working capital and FCF volatility into 2023 as company take steps to right-size their inventory levels and improve their supply chain management processes.

Figure 72 Specialty Retail Consensus Margin Estimates

Specialty Retail Valuations

				Gross Margin						EBIT Margin					
Company	Ticker	Rating	Price	FY(1)	FY0	FY1	FY2	FY3	FY1 to FY	FY(1)	FY0	FY1	FY2	FY3	FY1 to FY
Footwear/Sporting Goods															
Dicks's Sporting Goods	**DKS**	1	$102.41	31.1%	38.0%	35.1%	34.4%	34.8%	-35 bps	7.8%	16.1%	11.9%	11.2%	11.4%	-49 bps
Foot Locker	**FL**	2	$33.00	28.0%	35.5%	30.7%	30.4%	30.3%	-37 bps	5.2%	11.9%	7.3%	6.7%	6.8%	-52 bps
Hibbetts	**HIBB**	NR	$63.50	NA	NA	35.3%	35.5%	N/A	N/A	9.9%	13.6%	10.0%	10.2%	N/A	N/A
Specialty			-												
Gap Inc.*	**GPS**	2	$12.71	33.9%	39.6%	34.4%	37.1%	37.6%	321 bps	-6.1%	5.1%	-0.1%	2.7%	3.5%	358 bps
Lululemon	**LULU**	1	$354.27	55.8%	57.7%	56.8%	56.9%	57.4%	65 bps	19.2%	21.6%	22.2%	22.3%	22.7%	52 bps
Ulta Salon*	**ULTA**	1	$434.70	31.0%	39.3%	39.3%	39.1%	39.2%	-11 bps	4.1%	14.6%	15.0%	14.7%	14.7%	-30 bps
Urban Outfitters	**URBN**	NR	$25.42	25.3%	32.8%	30.2%	30.9%	31.8%	160 bps	0.2%	9.3%	4.8%	5.5%	6.1%	131 bps
Fashion Accessories			-												
Tapestry*	**TPR**	1	$34.89	70.5%	69.7%	69.4%	69.9%	70.7%	132 bps	18.8%	18.1%	17.4%	18.0%	19.3%	185 bps
Capri Holdings*	**CPRI**	1	$53.29	63.6%	67.5%	66.4%	66.6%	66.6%	27 bps	7.8%	18.7%	18.2%	18.1%	18.7%	44 bps
Ralph Lauren	**RL**	1	$102.07	65.4%	66.6%	65.3%	65.6%	66.5%	121 bps	2.1%	13.4%	12.0%	12.4%	13.1%	110 bps
Canada Goose*	**GOOS**	1	$17.86	61.3%	66.8%	65.8%	68.6%	68.7%	287 bps	13.5%	15.3%	17.4%	19.0%	18.7%	129 bps
Discounters			-												
TJX Companies	**TJX**	1	$77.99	24.0%	29.0%	28.1%	28.6%	29.1%	97 bps	2.3%	10.2%	9.9%	10.4%	10.9%	98 bps
Ross Stores	**ROST**	2	$97.93	21.7%	27.5%	25.7%	26.4%	27.2%	146 bps	4.1%	12.2%	10.5%	11.4%	11.9%	139 bps
Burlington Stores	**BURL**	2	$150.87	38.2%	42.0%	40.4%	41.0%	41.7%	124 bps	-5.7%	9.0%	4.7%	6.2%	7.2%	242 bps
Five Below	**FIVE**	NR	$153.09	33.2%	36.1%	35.6%	35.9%	36.2%	68 bps	7.3%	13.3%	11.0%	11.6%	12.2%	127 bps
Broadlines			-												
Wal-Mart*	**WMT**	1	$148.00	24.5%	24.7%	23.8%	24.0%	24.1%	31 bps	4.3%	4.6%	3.9%	4.1%	4.3%	42 bps
Costco*	**COST**	1	$521.32	12.8%	11.8%	11.7%	11.7%	11.6%	-9 bps	3.4%	3.5%	3.6%	3.7%	3.9%	28 bps
Target*	**TGT**	1	$162.01	28.4%	28.7%	24.3%	26.4%	27.2%	288 bps	7.0%	8.2%	3.6%	5.6%	6.3%	268 bps
Department Stores			-												
Macy's*	**M**	1	$22.67	28.5%	38.7%	37.2%	37.3%	36.4%	-82 bps	-7.0%	9.1%	6.9%	6.4%	6.0%	-89 bps
Nordstrom*	**JWN**	2	$21.09	27.4%	35.1%	35.6%	35.8%	35.4%	-23 bps	-9.3%	3.1%	4.2%	4.3%	4.4%	21 bps
Kohl's*	**KSS**	2	$31.42	31.3%	37.7%	35.7%	36.2%	36.6%	94 bps	-2.3%	9.0%	4.5%	4.5%	4.6%	5 bps
Fast Fashion			-												
Inditex	**ITX**	NR	€ 24.12	56.4%	57.3%	57.0%	56.7%	56.6%	-36 bps	8.9%	17.2%	16.7%	16.6%	17.1%	43 bps
H&M	**HMB**	NR	SEK 117.70	50.0%	52.3%	51.7%	51.0%	51.3%	-40 bps	1.4%	7.3%	5.6%	5.7%	7.0%	139 bps
Fast Retailing	**9983**	NR	JPY 82,360	50.3%	51.6%	50.0%	51.3%	59.6%	960 bps	NA	15.3%	14.0%	14.0%	NA	NA
Luxury			-												
LVMH*	**MC FP**	1	FRF 698.20	64.2%	67.3%	68.9%	68.9%	69.1%	15 bps	15.9%	25.7%	27.5%	27.5%	28.0%	53 bps
Kering	**PRTP**	NR	FRF 551.10	73.0%	73.8%	74.4%	74.5%	74.7%	32 bps	23.0%	28.0%	28.5%	28.4%	28.8%	24 bps
Hermes	**HRMS**	NR	FRF 1,470.00	67.6%	70.5%	71.1%	71.0%	71.2%	10 bps	27.7%	38.1%	39.7%	39.8%	40.0%	31 bps
Moncler	**MONC**	NR	FRF 49.83	75.2%	76.3%	76.4%	76.6%	76.8%	32 bps	22.6%	28.9%	29.9%	30.2%	30.7%	80 bps
Farfetch^	**FTCH**	2	$9.14	47.4%	45.1%	45.8%	47.0%	47.9%	215 bps	-36.4%	-12.9%	-22.0%	-15.9%	-10.3%	1173 bps
Restoration Hardware**	**RH**	1	$288.50	46.3%	48.9%	51.7%	51.7%	51.9%	20 bps	21.4%	25.4%	21.4%	21.4%	22.0%	65 bps
Lululemon	**LULU**	1	$354.27	55.8%	57.7%	56.8%	56.9%	57.4%	65 bps	19.2%	21.6%	22.2%	22.3%	22.7%	52 bps
Ecommerce Platforms			-												
Poshmark*	**POSH**	2	$17.78	NA	84.1%	83.3%	83.6%	83.9%	53 bps	NA	-14.0%	-23.1%	-18.4%	-13.3%	979 bps
The RealReal^	**REAL**	2	$1.56	63.8%	60.3%	57.2%	60.9%	62.6%	543 bps	-48.8%	-36.9%	-26.4%	-18.2%	NM	NM
Revolve^	**RVLV**	1	$25.97	51.9%	54.7%	54.3%	54.2%	NA	NA	9.5%	16.0%	6.7%	7.3%	8.6%	195 bps
Farfetch^	**FTCH**	2	$9.14	47.4%	45.1%	45.8%	47.0%	47.9%	215 bps	-36.4%	-12.9%	-22.0%	-15.9%	-10.3%	1173 bps
Hardlines			-												
Best Buy	**BBY**	NR	$70.03	22.4%	22.5%	21.5%	21.7%	21.9%	48 bps	5.7%	6.0%	4.0%	4.4%	4.9%	83 bps
Bed Bath & Beyond	**BBBY**	NR	$3.45	33.7%	34.1%	27.7%	30.8%	32.6%	487 bps	-1.7%	0.0%	-12.7%	-6.4%	-2.5%	1016 bps
Sally Beauty*	**SBH**	2	$11.89	50.5%	51.1%	50.3%	50.3%	50.3%	-4 bps	11.6%	10.5%	9.2%	9.1%	9.6%	39 bps
Ulta*	**ULTA**	1	$434.70	31.0%	39.3%	39.3%	39.1%	39.2%	-11 bps	4.1%	14.6%	15.0%	14.7%	14.7%	-30 bps
Golf			21.07												
Topgolf Callaway Brands	**MODG**	2	$21.07	42.8%	58.8%	60.5%	62.2%	63.7%	325 bps	6.5%	8.0%	8.5%	8.8%	9.7%	120 bps
Acushnet Holdings Corp.	**GOLF**	NR	$47.04	51.1%	51.9%	52.0%	52.1%	N/A	N/A	8.7%	12.4%	12.1%	12.0%	NA	NA

*Covered by Oliver Chen **Covered by Max Rakhlenko ^Covered by John Blackledge and Oliver Chen

Source: Refinitiv as of 11/18/22, Cowen and Company

Figure 73 Retail Quarterly Sales vs Inventory Spread

Sales vs. Inventory Spread		Q1:19	Q2:19	Q3:19	Q4:19	Q1:20	Q2:20	Q3:20	Q4:20	Q1:21	Q2:21	Q3:21	Q4:21	Q1:22	Q2:22	Q3:22
Department Stores																
Macy's	M	(5%)	(2%)	(6%)	0%	(35%)	(7%)	6%	9%	70%	39%	17%	12%	(4%)	(8%)	(8%)
Nordstrom	JWN	2%	2%	1%	4%	(14%)	(28%)	11%	(17%)	12%	48%	(36%)	1%	(5%)	2%	
Kohl's	KSS	(2%)	(6%)	(1%)	(2%)	(40%)	3%	13%	17%	95%	30%	15%	(13%)	(45%)	(56%)	(41%)
Dillard's	DDS	(2%)	(3%)	1%	(0%)	(31%)	(15%)	(5%)	8%	82%	83%	45%	34%	17%	(6%)	(4%)
Broadlines																
Target	TGT	0%	4%	13%	7%	17%	27%	10%	3%	1%	(17%)	(4%)	(21%)	(39%)	(33%)	(11%)
Walmart	WMT	(2%)	(3%)	0%	2%	17%	13%	5%	6%	(10%)	(14%)	(7%)	(25%)	(30%)	(17%)	(4%)
Sporting Goods																
Yeti Holdings	YETI	11%	(9%)	(16%)	(4%)	(11%)	30%	64%	51%	51%	(15%)	(74%)	(110%)	(106%)	(104%)	(46%)
Dick's Sporting Goods	DKS	(16%)	(15%)	(11%)	(16%)	(28%)	32%	33%	31%	123%	13%	7%	(10%)	(48%)	(54%)	
Hibbett Sports	HIBB	16%	11%	15%	(0%)	(19%)	108%	47%	50%	112%	(24%)	(8%)	(8%)	(89%)	(75%)	
Big 5 Sporting Goods	BGFV	13%	8%	1%	(6%)	(17%)	10%	33%	38%	46%	47%	(5%)	(17%)	(33%)	(53%)	(34%)
Footwear																
Crocs	CROX	11%	6%	1%	20%	(43%)	(45%)	1%	33%	61%	80%	41%	8%	(64%)	(89%)	(84%)
Skechers	SKX	10%	7%	(3%)	(1%)	(36%)	(62%)	(22%)	5%	7%	125%	3%	(20%)	(9%)	(36%)	(24%)
Designer Brands	DBI	4%	(10%)	6%	0%	(28%)	(6%)	19%	(1%)	44%	54%	(17%)	11%	(6%)	(32%)	
Foot Locker	FL	3%	2%	4%	3%	(64%)	20%	18%	22%	113%	19%	(5%)	(30%)	(36%)	(61%)	(30%)
Off-Price Retail																
The TJX Companies	TJX	(9%)	(8%)	(7%)	3%	(50%)	(5%)	17%	1%	125%	45%	(9%)	(11%)	(24%)	(41%)	(28%)
Ross Stores	ROST	10%	(2%)	(1%)	3%	(48%)	7%	22%	14%	148%	22%	(15%)	(32%)	(62%)	(60%)	(12%)
Burlington Stores	BURL	(6%)	13%	14%	29%	(21%)	(13%)	7%	8%	152%	83%	16%	(24%)	(76%)	(63%)	
Athletic Brands																
lululemon athletica	LULU	2%	(4%)	(4%)	(8%)	(58%)	(34%)	(1%)	(1%)	71%	43%	7%	(26%)	(42%)	(56%)	
Nike	NKE	(3%)	(4%)	(5%)	(2%)	(69%)	(16%)	11%	(13%)	102%	16%	(6%)	(10%)	(24%)	(41%)	
Under Armour	UAA	25%	27%	22%	16%	(30%)	(65%)	(16%)	(3%)	45%	117%	29%	18%	7%	(8%)	(27%)
Puma	PUM.GR	(3%)	(2%)	(9%)	(1%)	(26%)	(53%)	0%	0%	11%	83%	8%	(15%)	(9%)	(17%)	(48%)
Adidas	ADS.GR	4%	0%	(5%)	(7%)	(57%)	(85%)	(40%)	(20%)	29%	74%	25%	9%	(15%)	(25%)	(61%)
Apparel Brands																
Canada Goose	GOOS	(36%)	6%	(34%)	(47%)	(64%)	(80%)	(48%)	7%	65%	121%	20%	15%	(8%)	(1%)	(4%)
Columbia Sportswear	COLM	(20%)	(16%)	(2%)	(12%)	(24%)	(50%)	(30%)	4%	19%	95%	21%	7%	(14%)	(40%)	(28%)
Hanesbrands	HBI	(1%)	(3%)	2%	6%	(12%)	8%	(4%)	25%	49%	27%	24%	(9%)	(18%)	(50%)	(38%)
G-III Apparel	GIII	(4%)	(21%)	(0%)	3%	(29%)	(22%)	2%	(6%)	59%	76%	26%	19%	(26%)	(83%)	
PVH	PVH	(4%)	(6%)	(2%)	11%	(40%)	(21%)	(2%)	(7%)	62%	60%	17%	21%	6%	(27%)	
Ralph Lauren	RL	(9%)	(8%)	(1%)	3%	(5%)	(44%)	(18%)	(14%)	(2%)	178%	21%	19%	(10%)	(38%)	(31%)
VF Corp	VFC	14%	5%	11%	5%	(21%)	(49%)	(8%)	19%	41%	117%	21%	2%	(24%)	(89%)	(91%)

Source: Company Reports, Cowen and Company

Figure 74 Softlines Free Cash Flow ($MM)

Free Cash Flow ($MMs)							P/FCF	P/FCF	Yield	Yield	3-Year	4-Year
Company	Ticker	2019	2020	2021A	2022E	2023E	2022E	2023E	2022E	2023E	CAGR	CAGR
Nike	NKE	$4,152	$3,106	$4,046	$4,861	$4,696	33.9x	35.1x	2.9%	2.8%	-5.4%	0.4%
adidas	ADS	€ 1,708	€ 495	€ 1,913	€ 115	€ 1,610	216.2x	15.4x	0.5%	6.5%	12.2%	-46.0%
VF Corp.	VFC	$1,467	$979	$343	$943	$774	13.4x	16.4x	7.4%	6.1%	-37.6%	-9.6%
Lululemon	LULU	$395	$426	$423	$797	$567	56.7x	79.7x	1.8%	1.3%	8.5%	24.5%
Under Armour	UAA	$254	-$183	$363	NA	$48	NM	82.7x	NM	1.2%	-7.5%	NM
Puma	PUM	€ 132	€ 210	€ 246	€ 227	€ 440	34.5x	17.8x	2.9%	5.6%	21.1%	13.1%
On Holding	ONON	NM	NM	-$36	-$52	$59	NM	92.1x	NM	1.1%	NM	NM
FIGS	FIGS	NM	NM	$21	$1	$60	1715.2x	17.0x	0.1%	5.9%	NM	NM
Deckers Outdoors	DECK	$225	$230	$322	$160	$395	58.4x	23.6x	1.7%	4.2%	3.2%	-14.0%
Columbia Sportswear	COLM	$230	$156	$175	$133	$493	37.8x	10.2x	2.6%	9.8%	-7.9%	-12.2%
Skechers	SKX	$240	-$171	$161	-$92	$313	-67.3x	19.8x	-1.5%	5.1%	-27.7%	#NUM!
Ralph Lauren Corp	RL	$592	$581	$12	$490	$445	13.8x	15.1x	7.3%	6.6%	-75.5%	-11.9%
PVH Corp	PVH	$583	$588	-$192	$438	$305	8.9x	12.8x	11.2%	7.8%	NM	11.2%
Capri Holdings*	CPRI	$391	$666	$448	$857	$800	8.2x	8.7x	12.3%	11.4%	-21.9%	-2.4%
Canada Goose*	GOOS	$96	$107	$213	$198	$186	9.5x	10.1x	10.5%	9.9%	28.7%	18.6%
Levi Strauss & Co.	LEVI	$232	$215	$394	$149	$591	41.2x	10.4x	2.4%	9.6%	14.7%	-13.1%
Hanesbrands	HBI	$625	$407	$586	-$427	$363	NM	6.7x	NM	14.9%	1.7%	NM
Gildan Activewear	GIL	$252	$342	$472	$278	$414	18.1x	12.2x	5.5%	8.2%	3.1%	-10.4%
Foot Locker	FL	$400	$425	$504	$446	$247	6.9x	12.5x	14.5%	8.0%	-2.2%	-4.6%
Dick's Sporting Goods	DKS	$487	$207	$806	$1,330	$741	6.1x	11.0x	16.4%	9.1%	43.6%	48.7%
Yeti	YETI	$73	$197	$47	$53	$284	69.3x	13.0x	1.4%	7.7%	-32.6%	-23.4%
Crocs	CROX	$48	$131	$345	$417	$697	14.6x	8.7x	6.9%	11.5%	50.0%	42.1%
Steve Madden	SHOO	$179	$73	$198	$195	$252	13.3x	10.3x	7.5%	9.7%	11.7%	8.3%
Stitch Fix	SFIX	$55	-$8	-$12	-$4	-$73	NM	NM	NM	NM	NA	NM
Allbirds	BIRD	NM	NM	-$29	-$98	-$44	NM	NM	NA	NA	NM	NM
Mean							**115.4x**	**23.5x**	**5.7%**	**7.1%**	**-1.0%**	**#NUM!**
Median							**16.3x**	**13.0x**	**4.2%**	**7.7%**	**2.4%**	**#NUM!**

Source: Bloomberg, Cowen and Company

Figure 75 Specialty Retail Free Cash Flow ($MM)

Specialty Retail Free Cash Flow ($MMs)							P/FCF	P/FCF	Yield	Yield	3-Year	4-Year
Company	Ticker	2019	2020E	2021E	2022E	2023E	2022E	2023E	2022E	2023E	CAGR	CAGR
Footwear/Sporting Goods												
Dicks's Sporting Goods	DKS	$487	$207	$806	$1,330	$741	6.1x	11.0x	16.4%	9.1%	43.6%	48.7%
Foot Locker	FL	$400	$425	$504	$446	$247	6.9x	12.5x	14.5%	8.0%	-2.2%	-4.6%
Academy Sports & Outdoors	ASO			$833	$627	$502	6.0x	7.5x	16.6%	13.3%	NA	NA
Hibbetts	HIBB	$41	$39	$163	$101	$26	8.0x	30.7x	12.4%	3.3%	22.4%	3.3%
Specialty												
Gap Inc.*	GPS	$817	$496	-$490	$359	-$108	12.9x	-43.0x	7.8%	-2.3%	NA	-13.8%
Lululemon	LULU	$395	$426	$423	$797	$567	56.7x	79.7x	1.8%	1.3%	8.5%	24.5%
Ulta Salon*	ULTA	$514	$721	$425	$803	$885	27.7x	25.2x	3.6%	4.0%	7.8%	24.1%
FIGS	FIGS			$21	$1	$60	1715.2x	17.0x	0.1%	5.9%	NA	NA
Urban Outfitters	URBN	$338	$67	$1	$196	-$6	12.0x	-392.7x	8.4%	-0.3%	-86.1%	-2.8%
Levi Strauss & Co.	LEVI	$232	$215	$394	$149	$591	41.2x	10.4x	2.4%	9.6%	14.7%	-13.1%
American Eagle*	AEO	$277	$198	$82	$396	$81	5.9x	28.9x	16.8%	3.5%	-28.6%	15.2%
Fashion Accessories												
Tapestry*	TPR	$687	$71	$855	$845	$814	9.9x	10.3x	10.1%	9.7%	5.4%	3.8%
Capri Holdings*	CPRI	$391	$666	$448	$857	$800	8.2x	8.7x	12.3%	11.4%	-21.9%	-2.4%
Ralph Lauren	RL	$592	$581	$12	$490	$445	13.8x	15.1x	7.3%	6.6%	-75.5%	-11.9%
Canada Goose*	GOOS	$96	$107	$213	$198	$186	9.5x	10.1x	10.5%	9.9%	28.7%	18.6%
Discounters												
TJX Companies	TJX	$2,706	$2,758	$1,514	$3,066	$2,595	29.5x	34.9x	3.4%	2.9%	-8.4%	11.7%
Ross Stores	ROST	$1,650	$1,599	$701	$1,480	$974	23.0x	34.9x	4.4%	2.9%	NA	3.1%
Burlington Stores	BURL	$426	$445	-$260	$524	-$64	18.9x	-155.6x	5.3%	-0.6%	NA	11.5%
Five Below	FIVE	$69	$12	$3	$23	$49	NA	175.0x	NA	NA	-68.3%	-30.8%
Ollie's	OLLI	$50	$77	NM	$82	$72	41.5x	47.0x	2.4%	2.1%	NA	1.8%
Broadlines												
Wal-Mart*	WMT	$13,860	$17,126	$18,712	$14,077	$10,835	28.5x	37.1x	3.5%	2.7%	0.8%	-6.3%
Costco*	COST	$2,542	$3,350	$3,919	$5,007	$5,343	46.1x	43.2x	2.2%	2.3%	11.8%	15.6%
Target*	TGT	$2,316	$3,082	$4,655	$6,050	$1,309	12.3x	57.0x	8.1%	1.8%	1.9%	8.3%
Department Stores												
Macy's*	M	$1,250	$549	-$874	$2,241	$477	2.7x	12.9x	36.5%	7.8%	NA	10.8%
Nordstrom*	JWN	$544	$494	-$478	$488	$470	6.9x	7.1x	14.5%	14.0%	NA	-7.6%
Kohl's*	KSS	$1,359	$928	$595	$1,073	$145	3.4x	25.3x	29.3%	4.0%	-16.4%	1.3%
Fast Fashion												
Inditex	ITX	€ 3,102	€ 4,548	€ 2,024	€ 5,251	€ 4,903	36.4x	15.0x	2.7%	6.7%	-5.2%	22.0%
H&M	HMB	SEK 7,950	SEK 10,829	SEK 33,339	SEK 14,001	SEK 16,050	5.7x	11.9x	17.5%	8.4%	41.6%	4.5%
Fast Retailing	9983	#N/A N/A		¥319,289	¥272,456	¥357,811	¥266,134	32.1x	32.9x	3.1%	3.0%	23.6%	25.5%
Luxury												
LVMH*	MC	€ 5,787	€ 5,549	€ 8,947	€ 14,444	€ 16,841	39.2x	20.8x	2.6%	4.8%	14.9%	25.1%
Kering	KER	€ 2,463	€ 2,573	€ 3,145	€ 3,663	€ 4,237	21.4x	15.9x	4.7%	6.3%	4.4%	7.3%
Hermes	RMS	€ 1,320	€ 1,244	€ 2,125	€ 2,960	€ 3,319	72.2x	46.2x	1.4%	2.2%	8.7%	15.6%
Moncler	MONC	€ 263	€ 271	€ 186	€ 513	€ 606	73.2x	22.5x	1.4%	4.4%	-20.7%	8.2%
Farfetch^	FTCH	-$157	-$114	-$243	-$154	-$2	NM	NM	NM	NM	23.6%	NA
Restoration Hardware**	RH	$250	$291	$399	$658	$506	10.4x	13.5x	9.6%	7.4%	-0.9%	12.5%
Lululemon	LULU	$395	$426	$423	$797	$567	56.7x	79.7x	1.8%	1.3%	8.5%	24.5%
Ecommerce Platforms												
Poshmark*	POSH		$57	$17	-$36	-$25	NM	NM	NM	NM	NA	NA
The RealReal^	REAL	-$70	-$136	-$168	-$136	-$89	NA	NM	NA	NA	NA	NA
Revolve^	RVLV	$17	$57	$92	$50	$72	38.1x	26.6x	2.6%	3.8%	NA	NA
Farfetch^	FTCH	-$104	-$114	-$243	-$154		NA	NM	NA	NA	NA	NA
Hardlines												
Best Buy	BBY	$1,438	$1,634	$2,645	$2,387	$861	6.6x	18.3x	15.1%	5.5%	22.1%	13.2%
Bed Bath & Beyond	BBBY	$371	$98	$168	-$252	-$922	NA	-0.3x	NA	NA	-29.8%	NA
Sally Beauty*	SBH	$217	$279	$282	$100	$175	12.7x	7.3x	7.8%	13.8%	-0.5%	NA
Ulta*	ULTA	$514	$721	$425	$803	$885	27.7x	25.2x	3.6%	4.0%	7.8%	24.1%
Golf												
Callaway Golf Co.	MODG	$83	$78	-$114	-$209	$113	NM	34.5x	NA	NA	NA	NA
Acushnet Holdings Corp.	GOLF	$134	$107	$185	$96	$213	34.3x	15.5x	2.9%	6.5%	12.2%	-7.4%
Mean							**68.0x**	**12.7x**	**8.5%**	**5.4%**	**-2.0%**	**8.3%**
Median							**16.3x**	**18.3x**	**6.3%**	**4.2%**	**4.9%**	**8.3%**

Source: Bloomberg, Cowen and Company

Figure 76 Companies Mentioned

Pricing as of 11/18/2022 Company Name	Symbol	RATING	Currency	Price	Analyst
ABB Ltd	**ABB**	Outperform	USD	30.72	Joseph Giordano, CFA
Air Transport Services Group	**ATSG**	Outperform	USD	28.18	Helane Becker
Caterpillar	**CAT**	Outperform	USD	231.43	Matt Elkott
Cognex Corp.	**CGNX**	Outperform	USD	47.74	Joseph Giordano, CFA
Cummins	**CMI**	Outperform	USD	250.31	Matt Elkott
Costco Wholesale	**COST**	Outperform	USD	523.67	Oliver Chen, CFA
Canadian Pacific Railway Limited	**CP**	Outperform	USD	78.51	Jason Seidl
GATX Corporation	**GATX**	Outperform	USD	109.03	Matt Elkott
Greenbrier Companies	**GBX**	Outperform	USD	37.16	Matt Elkott
GXO Logistics	**GXO**	Outperform	USD	42.15	Jason Seidl
Home Depot	**HD**	Outperform	USD	313.18	Max Rakhlenko, CFA
Nike	**NKE**	Outperform	USD	105.42	John Kernan, CFA
Silicon Laboratories	**SLAB**	Outperform	USD	140.63	Matthew D. Ramsay
Symbotic	**SYM**	Outperform	USD	9.39	Joseph Giordano, CFA
TFI International	**TFII**	Outperform	USD	104.8	Jason Seidl
Target	**TGT**	Outperform	USD	162.88	Oliver Chen, CFA
The TJX Companies	**TJX**	Outperform	USD	78.16	John Kernan, CFA
Trinity Industries	**TRN**	Outperform	USD	29.6	Matt Elkott
Wabtec Corp.	**WAB**	Outperform	USD	99.16	Matt Elkott
Walmart	**WMT**	Outperform	USD	150.23	Oliver Chen, CFA
Knight-Swift Transportation	**KNX**	Outperform	USD	54.73	Jason Seidl
Werner Enterprises	**WERN**	Outperform	USD	43.22	Jason Seidl
Schneider National	**SNDR**	Outperform	USD	25.15	Jason Seidl
PACCAR	**PCAR**	Market Perform	USD	103.87	Matt Elkott
Deere & Company	**DE**	Market Perform	USD	414.26	Matt Elkott
Canadian National Railway Company	**CNI**	Market Perform	USD	124.42	Jason Seidl
Daseke	**DSKE**	Outperform	USD	5.84	Jason Seidl
Old Dominion Freight Line	**ODFL**	Market Perform	USD	298.34	Jason Seidl
Saia	**SAIA**	Market Perform	USD	236.43	Jason Seidl
XPO Logistics	**XPO**	Outperform	USD	37.15	Jason Seidl
NVIDIA Corporation	**NVDA**	Outperform	USD	154.09	Matthew D. Ramsay
Advanced Micro Devices	**AMD**	Outperform	USD	73.57	Matthew D. Ramsay
Intel	**INTC**	Suspended	USD	29.87	Matthew D. Ramsay
Qualcomm	**QCOM**	Outperform	USD	123.85	Matthew D. Ramsay
Qorvo	**QRVO**	Market Perform	USD	98.92	Matthew D. Ramsay
Skyworks Solutions	**SWKS**	Outperform	USD	94.33	Matthew D. Ramsay
Silicon Laboratories	**SLAB**	Outperform	USD	140.63	Matthew D. Ramsay
Lattice Semiconductor	**LSCC**	Outperform	USD	67.15	Matthew D. Ramsay
Semtech Corp.	**SMTC**	Market Perform	USD	29.49	Matthew D. Ramsay
Ambarella	**AMBA**	Outperform	USD	76.35	Matthew D. Ramsay
Infineon	**IFX.GR**	Outperform	EUR	32.095	Matthew D. Ramsay
STMicroelectronics	**STM**	Outperform	USD	38.31	Matthew D. Ramsay
onsemi	**ON**	Outperform	USD	72.46	Matthew D. Ramsay
NXP Semiconductors	**NXPI**	Outperform	USD	171.94	Matthew D. Ramsay
Luminar Technologies	**LAZR**	Outperform	USD	7.87	Joshua Buchalter, CFA
Microchip Technology	**MCHP**	Market Perform	USD	74.17	Matthew D. Ramsay
Analog Devices	**ADI**	Outperform	USD	161.85	Joshua Buchalter, CFA
Texas Instruments	**TXN**	Market Perform	USD	175.18	Joshua Buchalter, CFA
Vishay Intertechnology	**VSH**	Market Perform	USD	22.83	Joshua Buchalter, CFA
Diodes Incorporated	**DIOD**	Outperform	USD	87.78	Matthew D. Ramsay
Monolithic Power Systems	**MPWR**	Outperform	USD	377.31	Matthew D. Ramsay
Arbe Robotics Ltd	**ARBE**	Outperform	USD	4.06	Joshua Buchalter, CFA
Taiwan Semiconductor Manufacturing Co.	**TSM**	Market Perform	USD	82.27	Krish Sankar
Applied Materials	**AMAT**	Outperform	USD	104.7	Krish Sankar
Lam Research	**LRCX**	Outperform	USD	456.7	Krish Sankar
ASML Holding NV	**ASML.NA**	Outperform	EUR	593.16	Krish Sankar
KLA Corporation	**KLAC**	Market Perform	USD	376.34	Krish Sankar
Micron Technology	**MU**	Outperform	USD	58.58	Krish Sankar
Apple	**AAPL**	Outperform	USD	151.29	Krish Sankar
HP	**HPQ**	Market Perform	USD	29.48	Krish Sankar
Dell	**DELL**	Market Perform	USD	42.04	Krish Sankar
Amphenol Corporation	**APH**	Market Perform	USD	79.71	Joseph Giordano, CFA
Fortive Corporation	**FTV**	Market Perform	USD	66.61	Joseph Giordano, CFA
ITT Corporation	**ITT**	Outperform	USD	84.29	Joseph Giordano, CFA
Pentair	**PNR**	Outperform	USD	45.03	Joseph Giordano, CFA
Parker-Hannifin Corp.	**PH**	Underperform	USD	305.63	Joseph Giordano, CFA
Rockwell Automation	**ROK**	Underperform	USD	264.74	Joseph Giordano, CFA
Air Canada	**AC.TO**	Outperform	CAD	18.61	Helane Becker
FedEx Corp.	**FDX**	Outperform	USD	174.72	Helane Becker
United Parcel Service	**UPS**	Market Perform	USD	178.97	Helane Becker
Hawaiian Holdings	**HA**	Market Perform	USD	14.18	Helane Becker
Sun Country Airlines Holdings	**SNCY**	Outperform	USD	20.64	Helane Becker
Air Transport Services Group	**ATSG**	Outperform	USD	28.18	Helane Becker
Atlas Air Worldwide Holdings	**AAWW**	Market Perform	USD	100.64	Helane Becker
Mesa Air Group	**MESA**	Market Perform	USD	1.31	Helane Becker
American Eagle Outfitters	**AEO**	Market Perform	USD	12.92	Jonna Kim, CFA
Farfetch Limited	**FTCH**	Market Perform	USD	8.11	John Blackledge
Lowe's Companies	**LOW**	Market Perform	USD	209.93	Max Rakhlenko, CFA
Amazon.com	**AMZN**	Outperform	USD	94.14	John Blackledge
Wayfair	**W**	Outperform	USD	33.24	John Blackledge

Source: Eikon, Cowen and Company

VALUATION METHODOLOGY AND RISKS

Valuation Methodology

Air Freight:

We use one-year forward PE multiples to value covered companies in the air freight and logistics industry. We support our valuation with EV/EBITDA and tangible book value analysis.

We make investment recommendations on certain early stage, pre-revenue companies based upon an assessment of their business model, technology, probability of market success, and the potential market opportunity, balanced by an assessment of applicable risks. Such companies may not be assigned a price target.

Airfreight & Logistics:

We use one-year forward PE multiples to value covered companies in the air freight and logistics industry. We support our valuation with EV/EBITDA and tangible book value analysis.

We make investment recommendations on certain early stage, pre-revenue companies based upon an assessment of their business model, technology, probability of market success, and the potential market opportunity, balanced by an assessment of applicable risks. Such companies may not be assigned a price target.

Diversified Industrials, Automation & Robotics:

We utilize multiple analysis and discounted cash flow (DCF) analysis to value companies under coverage. We employ both EV/EBITDA and P/E multiple analysis and look at historical valuation multiples (typically 5- and 10-year averages) as well as current and historical multiples for competitor or representative companies. We evaluate the subject company independently and in terms of its comp group. In certain instances, we may look at current/ recent transaction multiples to evaluate the subject company. When utilizing DCF analysis, we include a sensitivity table to both discount and terminal growth rates.

We make investment recommendations on certain early stage, pre-revenue companies based upon an assessment of their business model, technology, probability of market success, and the potential market opportunity, balanced by an assessment of applicable risks. Such companies may not be assigned a price target.

Machinery & Transportation OEM:

We generally use one-year forward PE multiples to value covered companies in the transportation OEM sector. We support our valuation with EV/EBITDA and Price-to-book analyses.

We make investment recommendations on certain early stage, pre-revenue companies based upon an assessment of their business model, technology, probability of market success, and the potential market opportunity, balanced by an assessment of applicable risks. Such companies may not be assigned a price target.

Rail:

We use one-year forward PE multiples to value covered companies in the railroad sector. We support our valuation with EV/EBITDA and tangible book value analysis.

We make investment recommendations on certain early stage, pre-revenue companies based upon an assessment of their business model, technology, probability of market success, and the potential market opportunity, balanced by an assessment of applicable risks. Such companies may not be assigned a price target.

Trucking:

We use one-year forward PE multiples to value covered companies in the trucking sector. We support our valuation with EV/EBITDA and tangible book value analysis.

We make investment recommendations on certain early stage, pre-revenue companies based upon an assessment of their business model, technology, probability of market success, and the potential market opportunity, balanced by an assessment of applicable risks. Such companies may not be assigned a price target.

Airlines:

We generally use a combination of Enterprise Value to EBITDAR and P/Es to the value the group.

We make investment recommendations on certain early stage, pre-revenue companies based upon an assessment of their business model, technology, probability of market success, and the potential market opportunity, balanced by an assessment of applicable risks. Such companies may not be assigned a price target.

Hardlines:

Our valuation methodology is primarily based on Price-to-Earnings (P/E), supplemented by, in some cases, Enterprise Value to EBITDA (EV/EBITDA) and Price-to-Free Cash Flow (P/FCF) ratios and DCF analysis. We may also use Enterprise Value to Revenue (EV/Revs) for companies operating at depressed levels of profitability. In some cases we use probability-weighed, scenario-based decision trees as a basis for devising our price targets. We incorporate the company's and its peers' historical and current valuation multiples, as well as our analysis of future growth rates, company-specific risks, return on invested capital, and other inputs from our research when devising our valuation multiples and the probabilities we assign to different scenarios when developing our price targets.

Retail & Consumer Brands:

Our valuation methodology is primarily based on Price-to-Earnings (P/E), supplemented by, in some cases, Enterprise Value to EBITDA (EV/EBITDA) and Price-to-Free Cash Flow (P/FCF) ratios and DCF analysis. We may also use Enterprise Value to Revenue (EV/Revs) for companies operating at depressed levels of profitability. In some cases we use probability-weighed, scenario-based decision trees as a basis for devising our price targets. We incorporate the company's and its peers' historical and current valuation multiples, as well as our analysis of future growth rates, company-specific risks, return on invested capital, and other inputs from our research when devising our valuation multiples and the probabilities we assign to different scenarios when developing our price targets.

We make investment recommendations on certain early stage, pre-revenue companies based upon an assessment of their business model, technology, probability of market success, and the potential market opportunity, balanced by an assessment of applicable risks. Such companies may not be assigned a price target.

Specialty Retail:

Our valuation methodology is primarily based on Price-to-Earnings (P/E), followed by Enterprise Value to EBITDA (EV/EBITDA), Price-to-Free Cash Flow (P/FCF) ratios, and DCF analysis. We may also use Enterprise Value to Revenue (EV/Revs) for companies operating at depressed levels of profitability. In some cases we use probability weighed, scenario-based decision trees as a basis for devising our price targets. We incorporate the company's and its peers' historical and current valuation multiples, as well as our analysis of future growth rates, company-specific risks, return on invested capital, and other inputs from our research when devising our valuation multiples and the probabilities we assign to different scenarios when developing our price targets.

We make investment recommendations on certain early stage, pre-revenue companies based upon an assessment of their business model, technology, probability of market success, and the potential market opportunity, balanced by an assessment of applicable risks. Such companies may not be assigned a price target.

E-Commerce:

Our valuation methodology is primarily based on Discounted Cash Flow analysis, comparable company multiples such as EV/FCF, EV/EBITDA, and P/E, and sum-of-the-parts analysis (for companies with ownership stakes in other equities or significant assets such as patents/

IP). However, this varies by company; for instance, we will often use EV/Revenue for high-growth companies that have recently entered the public equity markets.

We make investment recommendations on certain early stage, pre-revenue companies based upon an assessment of their business model, technology, probability of market success, and the potential market opportunity, balanced by an assessment of applicable risks. Such companies may not be assigned a price target.

Semiconductors:

Our valuation methodology is primarily based on forward P/E multiples plus cash followed by EV/EBITDA. In many cases, we use EV/sales as a third methodology.

We make investment recommendations on certain early stage, pre-revenue companies based upon an assessment of their business model, technology, probability of market success, and the potential market opportunity, balanced by an assessment of applicable risks. Such companies may not be assigned a price target.

Investment Risks

Primary Air Freight Industry Risks:

- Risk of economic downturns and their potential impact on the integrated parcel business.
- Rising fuel prices could significantly increase operating costs.
- Competitive threat posed by other modes of freight transportation such as rail and trucking.
- Risk of doing business abroad including currency exchange, political, and legal risks.
- Risk of terrorism and the costs associated with more stringent security requirements.

Primary Air Freight and Logistics Industry Risks:

- Risk of economic downturns and their potential impact on the integrated parcel business.
- Rising fuel prices could significantly increase operating costs.
- Competitive threat posed by other modes of freight transportation such as rail and trucking.
- Risk of doing business abroad including currency exchange, political, and legal risks.
- Risk of terrorism and the costs associated with more stringent security requirements.

Diversified Industrials, Automation & Robotics:

A general decline in the industrial production index, coupled with a global decrease in automation spending as a percentage of total capex could negatively impact the sector and the implied industry growth rate as well as leading to additional project delays.

Sustained pressure in emerging markets (especially countries with lower labor wages) could cause delays in automation implementation in several sectors, including general industrial, automotive, logistics, medical, and aerospace as factory upgrades are delayed.

Significant, lasting changes in the prices of key commodities, such as oil and natural gas could have material impact on upstream, midstream, and downstream applications. For example, a sharp increase in domestic natural gas projects could make LNG export facilities in the US less attractive and cause delays or cancellations of planned domestic chemical facilities. Sharp declines in oil and gas prices could lead to reduced production activity and therefore reduce demand for midstream logistics and downstream processing applications.

Machinery & Transportation OEM Risks:

- The transportation OEM industry is highly cyclical; the timing of the cyclicality may be difficult to predict; and down cycles could weigh on the top and bottom lines of companies in the sector.
- The industry is highly dependent on the North American and global economies. Economic downturns could pose a threat to the companies' earnings power.
- Fluctuations in the price of steel and other materials used in the manufacture of equipment could be unfavorable at times.
- Currency fluctuations could negatively impact production costs and demand for finished products.
- Potentially unfavorable shifts in freight among transportation modes, such as between rail and trucking, could impact demand for certain types of transportation equipment.
- Relatively high capital expenditure requirements.
- Relatively high fixed cost structure.
- Regulatory risk.
- Litigation risk.

Primary Rail Investment Risks -

- Risk of economic downturns and their impact on rail traffic and pricing.
- Regulatory risk posing a threat to the railroads' ability to achieve sufficient returns on their investments.
- The possibility of high-speed passenger rail encroachment.
- Litigation risk stemming from accidents and fatalities.
- Competitive threat posed by other modes of freight transportation such as trucking.
- High capital spending required to build and maintain railroad networks and to replace cars and locomotives.
- Risk of severe weather disrupting railroad networks.
- Rising fuel costs and the lag effect of fuel surcharge recovery.

Primary Trucking Investment Risks -

- Risk of economic downturns and their impact on tonnage and pricing.
- Litigation risk stemming from accidents and fatalities.
- Competitive threat posed by other modes of freight transportation such as the railroad sector.
- Rising fuel prices could significantly increase truckers' operating costs.
- Environmental concerns and regulations associated with air pollution.
- Driver availability and stricter driver screening requirements.
- Risk of severe weather disrupting trucking operations.

Primary Airline Investment Risks:

- Economic and Geopolitical Risk. Airlines are affected by worldwide economies, especially if they have international operations.
- Fuel Risk. Fuel represents ~30% of expenses and the companies have limited visibility into price changes.
- Liquidity. Airlines are capital intensive and there are times when the markets are capital constrained, which affects their ability to finance aircraft purchases.
- Credit card processing fees. Credit card companies often require airlines to maintain capital reserves related to future air travel.
- Seasonality. The airlines generally use cash in 1Q and 4Q and generate cash in 2Q and 3Q.
- Fare Risk. Fares may not rise as fast as expenses putting pressure on margins.
- Government Regulation. The industry is highly regulated and taxed.
- Terrorist Attacks and the outbreak of diseases. The unpredictability of terrorist attacks and disease outbreaks gives the airlines little margin of error.
- Labor Risk Some airlines are having issues attracting qualified pilots and mechanics which could limit their growth.
- Insurance Costs. Hull insurance varies from year to year, but is generally affected by the number of accidents in the previous year.
- Environmental Costs. Airlines are subject to various laws and government regulations concerning environmental matters and employee safety and health around the world

Hardlines:

Risks to the companies in our sector include risks and uncertainties associated with the global economic and housing environment and related consumer spending, as well as competition within the industry. These factors can create variability in sales and margins. Increases in the prices of raw materials, rent, freight, labor, tariffs, or manufacturers' inability to produce goods on time or to specifications may negatively impact results. Execution flaws and the departure of certain key executives may negatively affect performance and financial results. Legal, regulatory, political, currency, and economic risks, as well as challenges to maintain favorable brand recognition, loyalty, and reputation for quality, may affect the ability to conduct business in both domestic and international markets.

Retail & Consumer Brands:

Risks to the companies in our sector include risks and uncertainties associated with the global economic environment and consumer spending, as well as competition within consumer and fashion products industries and fluctuating consumer demand trends, which can create variability in sales and margins. Increases in the prices of raw materials, rent, freight, labor, tariffs, or manufacturers' inability to produce goods on time or to specifications may negatively impact results. Execution flaws and the departure of certain key executives may negatively affect performance and financial results. Legal, regulatory, political, currency, and economic risks, as well as challenges to maintain favorable brand recognition, loyalty, and reputation for quality, may affect the ability to conduct business in both domestic and international markets.

Specialty Retail:

Risks to the companies in our sector include risks and uncertainties associated with the global economic environment and consumer spending, as well as general competition within the consumer and fashion products industries and fluctuating consumer demand trends, which can create variability in sales and margins. Increases in the prices of raw materials, rent, freight, labor, tariffs, or manufacturers' inability to produce goods on time or to specifications may negatively impact results. Execution flaws and the departure of certain

key executives may negatively affect performance and financial results. Legal, regulatory, political, currency, and economic risks, as well as challenges to maintain favorable brand recognition, loyalty, and reputation for quality, may affect the ability to conduct business in both domestic and international markets.

E-Commerce:

The industry in which our companies operate is fiercely competitive and technological change is rapid. All of our companies face the risk that they are unable to keep pace with new innovations or that new innovations impact competitive positioning. Our companies are international operators and are therefore exposed to currency fluctuations and other factors associated with operating in a foreign territory. Finally, our names sit within traditional commerce and retail space and are exposed to the same seasonality and macro trends as the rest of the industry, including competition from offline retailers.

Semiconductors:

The semiconductor industry is cyclical and has strong correlation to global GDP. If global growth slows, consumer demand and IT spending could impact our forecasts. Additionally, pricing pressure is severe in certain parts of the market, particular those that are consumer focused.

ADDENDUM

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Jason Seidl, the author of this research report, served as President of The North East Association of Rail Shippers (NEARS), a rail transportation industry group, for a two-year term from September 27, 2017 through September 2019. Jason is currently the Chairman of the NEARS Executive Committee.

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The recommendation contained in this report was produced at November 20, 2022, 20:58 ET. and disseminated at November 21, 2022, 05:28 ET.

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Cowen and Company, LLC. New York 646 562 1010 **Boston** 617 946 3700 **San Francisco** 415 646 7200 **Chicago** 312 577 2240 **Cleveland** 440 331 3531 **Atlanta** 866 544 7009 **Stamford** 646 616 3000 **Washington, D.C.** 202 868 5300 **London** (affiliate) 44 207 071 7500

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POINTS OF CONTACT

Author Profiles

Jason H. Seidl
New York
646 562 1404
jason.seidl@cowen.com

Jason H. Seidl is a senior analyst focused on rail, trucking & logistics and has over 20 years of transportation industry experience.

Chris Krueger
Washington, DC
202 868 5307
chris.krueger@cowen.com

Chris Krueger is a strategist with Cowen Washington Research Group. He is a graduate of the University of Vermont and King's College London.

Helane Becker
New York
646 562 1399
helane.becker@cowen.com

Helane Becker is a senior research analyst covering airlines & air-related industries for the past 30+ years. She has an MBA from NYU.

John Blackledge
New York
646 562 1359
john.blackledge@cowen.com

John Blackledge is a senior analyst covering the Internet sector. He joined Cowen in 2012 as the head of Internet research.

Oliver Chen, CFA
New York
646 562 1424
oliver.chen@cowen.com

Oliver Chen is an *II*-ranked analyst covering retailing/specialty, broadlines, department stores, & luxury goods. He has an MBA from Wharton.

Matt Elkott
New York
646 562 1409
matthew.elkott@cowen.com

Matt Elkott covers transportation OEMS and has been part of the freight team since 2009. He previously covered other industrial sectors.

Joseph Giordano, CFA
New York
646 562 1405
joseph.giordano@cowen.com

Joe Giordano is a senior analyst covering the diversified industrials, automation & robotics sectors. He is a CFA charterholder and a CPA.

John Kernan, CFA
New York
646 562 1324
john.kernan@cowen.com

John Kernan is a managing director focused on consumer. He graduated from the University of Pennsylvania and the University of North Carolina.

Max Rakhlenko, CFA
New York
646 562 1423
max.rakhlenko@cowen.com

Max Rakhlenko is a director on the retail & luxury team. He joined Cowen in 2016.

Matthew D. Ramsay
San Francisco
415 646 7373
matt.ramsay@cowen.com

Matt Ramsay is a managing director and senior research analyst covering the semiconductor sector.

Reaching Cowen

Main U.S. Locations

New York
599 Lexington Avenue
New York, NY 10022
646 562 1010
800 221 5616

Boston
Two International Place
Boston, MA 02110
617 946 3700
800 343 7068

Cleveland
20006 Detroit Road
Suite 100
Rocky River, OH 44116
440 331 3531

San Francisco
One Maritime Plaza, 9th Floor
San Francisco, CA 94111
415 646 7200
800 858 9316

Atlanta
3424 Peachtree Road NE
Suite 2200
Atlanta, GA 30326
866 544 7009

Chicago
181 West Madison Street
Suite 3135
Chicago, IL 60602
312 577 2240

Stamford
262 Harbor Drive
Stamford, CT 06902
646 616 3000

Washington, D.C.
2900 K Street, NW
Suite 520
Washington, DC 20007
202 868 5300

International Location

Cowen International Limited

London
1 Snowden Street - 11th Floor
London EC2A 2DQ
United Kingdom
44 20 7071 7500