
CCC INTELLIGENT SOLUTIONS
2023
CRASH COURSE
ignite
EXPERIENCE

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WELCOME TO **CRASH COURSE**

ABOUT CRASH COURSE

Leaders from across the multi-trillion-dollar property and casualty (P&C) insurance economy, including the automotive claims and collision repair industries, have turned to our annual Crash Course report for nearly 30 years for in-depth coverage and comprehensive data on everything from shifts in driving behavior and advances in vehicle technology to the macroeconomic business and social shifts driving change.

A LEGACY OF LEADING-EDGE DATA

Crash Course draws insights based on decades of experience, including data from across 260-million claims-related transactions, 50-billion miles of driving data, and millions of auto physical damage and auto bodily injury and personal injury protection (PIP) /medical payments (MedPay) casualty claims — data and analysis only CCC can provide given our unique position across the marketplace.

NEW IN 2023

We've expanded our coverage to include a deeper look at the casualty and subrogation markets.

The industry is evolving, and Crash Course is evolving too. Welcome to Crash Course 2023.

> "THE INDUSTRY IS EVOLVING, AND **CRASH COURSE IS EVOLVING,** TOO.

EXECUTIVE **SUMMARY**

THE ERA OF EXPERIENCE: THE STAKES HAVE NEVER BEEN HIGHER

The pandemic changed many things, including which companies people choose to do business with — and that includes their insurance carriers and auto repair providers.

Consumers have grown to expect the same simple, seamless and positive interactions they experience in every other aspect of their lives. If those expectations are not met, they will quickly move on.

As a result, the industry is undergoing a customer experience overhaul focused on loyalty and retention to drive profitable growth. Raising the bar in service and keeping customers happy is no longer a nice to have, but a must-have.

This underscores the important role that technology plays (and must continue to play) in delivering improved communication and more intelligent use of data and analytics that — when combined with empathy at the moments that matter most — create truly desirable customer-centric experiences.

In Crash Course 2023, we'll explore how the P&C insurance economy is adapting to the **Era of Experience** in three distinct parts:

01 **People:** This section will explore changes to how and where people live and drive and how technology like AI is changing their experience with vehicle ownership, insurance claims, and vehicle repair experiences.

02 **Performance:** This section will examine the impact of these changes and new technologies on the P&C insurance and collision repair industries.

03 **Powering Forward:** This section will provide perspective on what's to come in 2023 and beyond.

"In a world where products and services are becoming **more and more commoditized, customer experience is the only true differentiator.**"

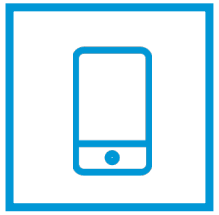
Annette Franz
Founder and Chief Experience Officer
CX Journey Inc.

THE ERA OF **EXPERIENCE**

TAG-TEAM PHILOSOPHY

The physical and digital worlds are becoming increasingly intertwined, and consumers are forging deeper and more meaningful connections with businesses through a growing number of channels that range from mobile devices and web virtual assistants to social media and in-person engagement.

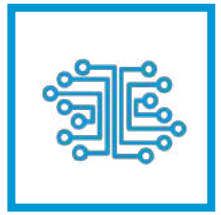
As businesses attempt to strike a delicate balance between automation and human touch, they are turning to Artificial Intelligence (AI) technologies to augment — not replace — human processes to facilitate richer, more personalized consumer experiences.



DIGITAL DONE RIGHT

Customer satisfaction and repeat business have become so dependent on positive digital experiences that organizations can no longer compete without it.

Providing an exceptional product or service is table-stakes, but today so is providing high-quality curated experiences that meet customers' needs in real-time.



INTELLIGENCE-GUIDED INTERACTIONS

AI's impact is especially pronounced when the digital exchange connects consumers to the realities of their physical world — the car they drive, the insurance policy they pay for, and the unexpected collision that throws everything off course.

As more vehicles come standard-equipped with Advanced Driver Assistance Systems (ADAS) and connectivity features, AI is helping customers to communicate more efficiently with collision repairers and insurers, helping to counter longer claim resolution process time that has grown with vehicle complexity and capacity issues.

PEOPLE:
ON THE MOVE

This section explores changes to how and where people live and drive, and how technology like AI is changing their experience with vehicle ownership, insurance claims, and repair.

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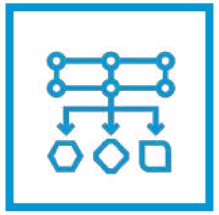
PEOPLE: ON THE MOVE

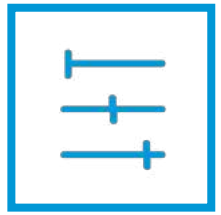
DEMOGRAPHICS & DRIVING BEHAVIOR TRENDS

Technology is rapidly transforming consumer behavior with real-world implications. While consumers' digital adoption over the last several years has led to more remote work, for example, it has also led to an increase in distracted driving.



ECOSYSTEM IMPERATIVE

The next phase of the P&C insurance economy's digital transformation is dependent on how the industry addresses ecosystem challenges, such as experienced labor shortages, vehicle complexity, and consumer demand. These challenges and more are creating new layers of complexity the industry must navigate to move forward.



MASS CUSTOMIZATION

Consumers now expect businesses to provide an always-on user experience that's also highly personalized to meet their needs. These expectations, in turn, create the need for service platforms to deliver "mass customization," which all but necessitate AI technology to identify and deliver those experiences at scale.

U.S. POPULATION GROWTH REMAINS TEPID

Population growth between CY2020-CY2021 is at its lowest annual rate since the Census Bureau began tracking in 1900, with the 2020 census data showing the U.S. in its second-lowest decade of growth in its history.

The U.S. population's annual rate of growth fell to only 0.12% by CY2020-CY2021 from 0.99% for CY2000-CY2001 and 0.4% for CY2021-CY2022.

Eighteen U.S. states lost population between CY2021-CY2022, including NY (-0.9%); IL (-0.8%); LA (-0.8%) and CA (-0.3%). The largest gains were in FL (+1.9%); ID (+1.8%); SC (+1.7%); and TX (+1.6%).[1]

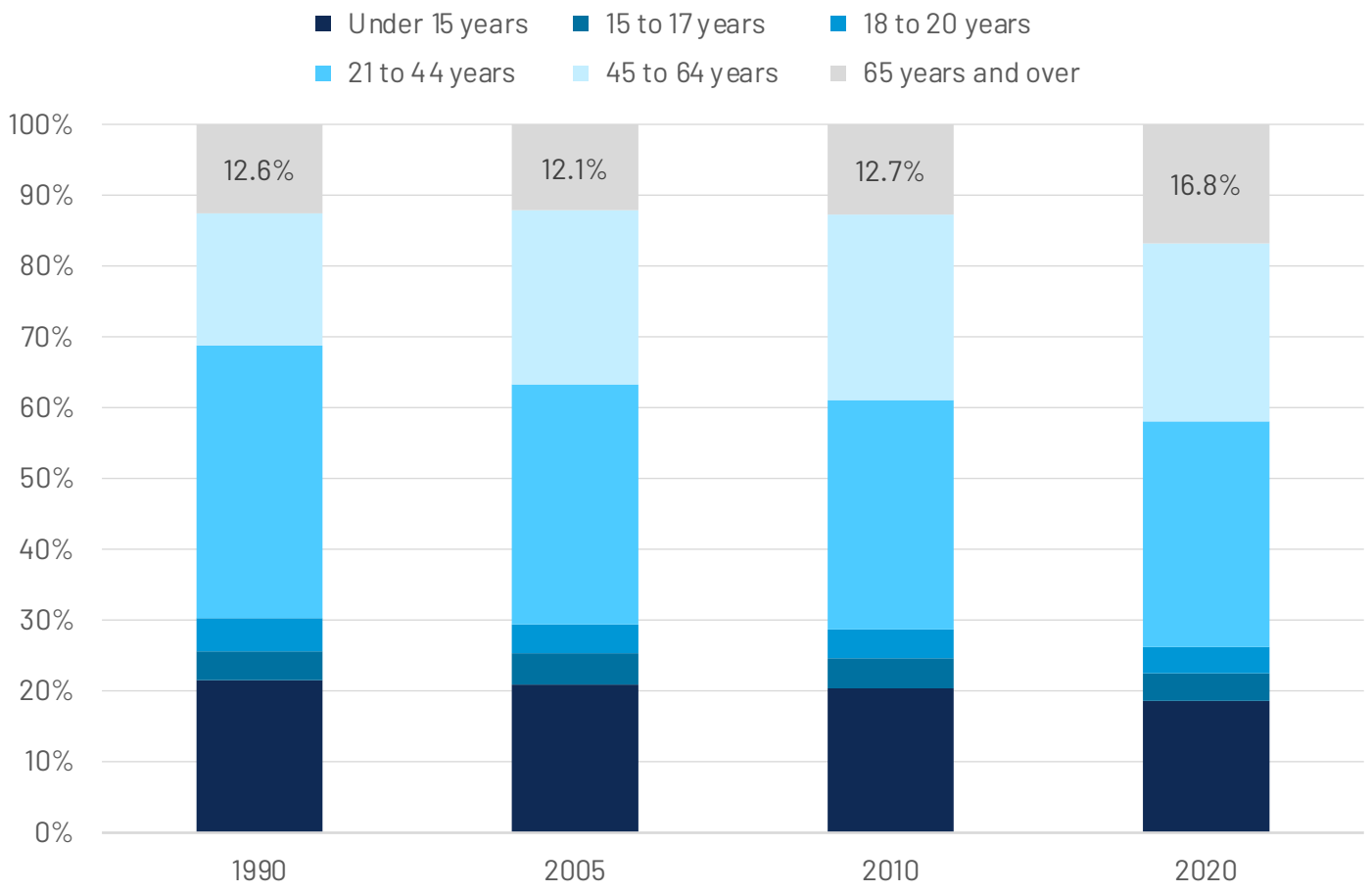
Key factors driving lower population growth? Lower birth rates, more deaths, and less net immigration.[2]

The U.S. is also an aging population — its median age was 38.8 years in CY2021 versus 35.4 in CY2000 and 32.9 in CY1990.[3]

Slower population growth further challenges the labor markets.

Share of Population by Age, 1990, 2005, 2010, and 2020

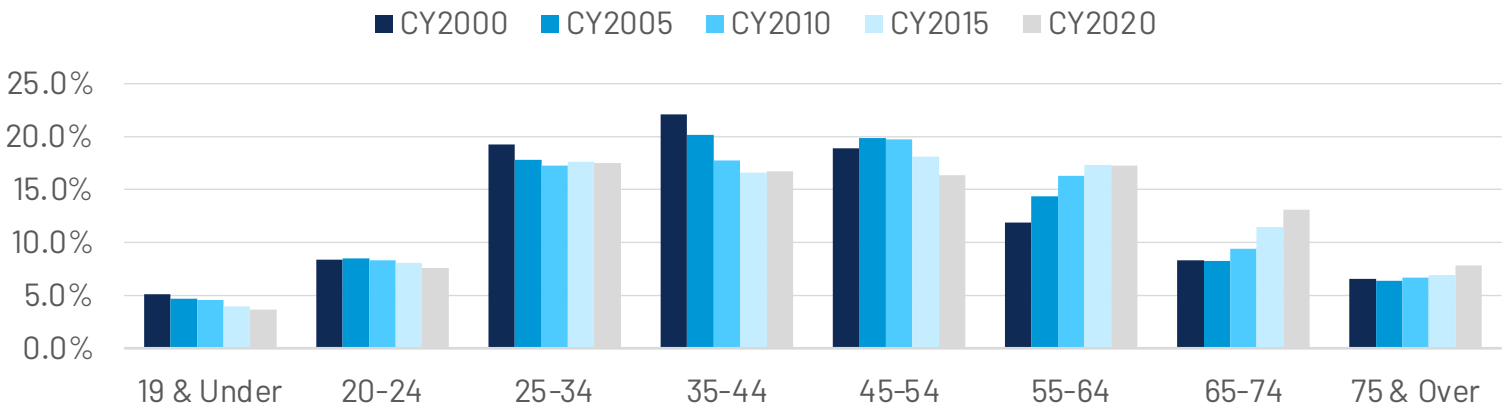
SOURCE: U.S. CENSUS BUREAU



AGING POPULATION MEANS MORE OLDER DRIVERS

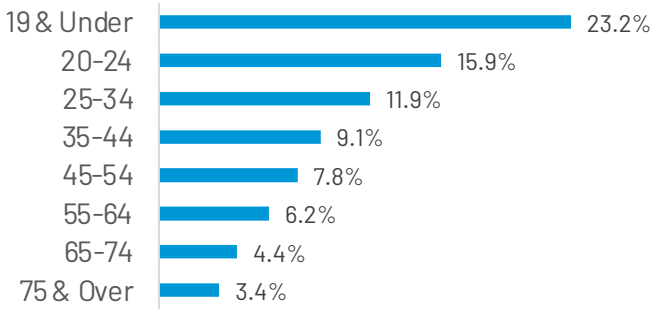
Licensed Drivers by Age Group 1995-2020

SOURCE: U.S. DOT FHWA HIGHWAY STATISTICS



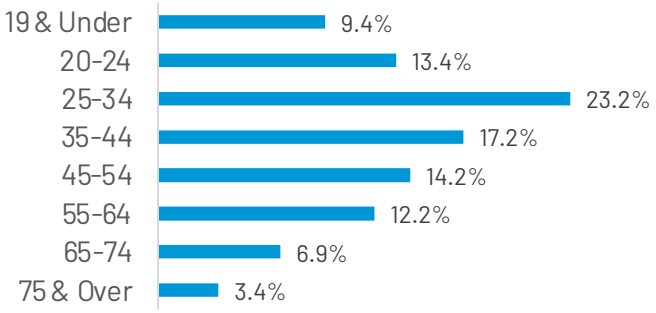
Share of Drivers per Age Group with Accident(s) CY2020

SOURCE: NATIONAL SAFETY COUNCIL



Distribution of Overall Accident Count by Driver Age CY2020

SOURCE: NATIONAL SAFETY COUNCIL



As the population ages, it's not surprising to see an increase in the number of older licensed drivers.(4)

Good news? Older drivers have lower accident rates, thus accounting for a lower share of overall accident counts.(5)

Bad news? When an older driver sustains injuries in an accident, claim complexity increases due to greater propensity for pre-existing conditions, which can also complicate treatment.

MIGRATION AWAY FROM URBAN AREAS CONTINUES

The U.S. has seen steady migration of population out of urban centers and to states in the Southeast and Southwest.

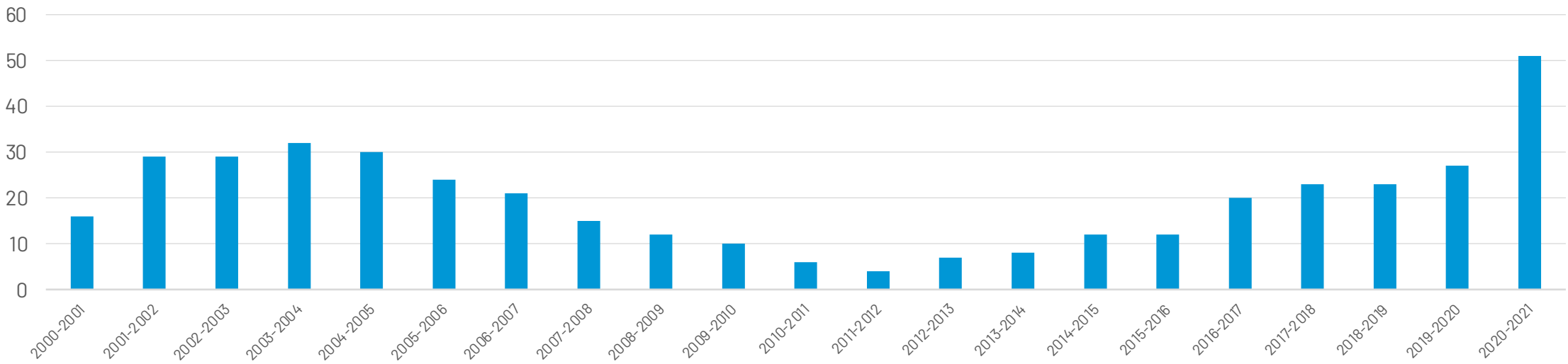
Overall population has shifted away from the largest metropolitan areas, including their suburbs. A Brookings' study shows that between CY2019-2021, 43 of the 56 major metro area suburbs either declined in growth or increased population losses, and 31 experienced their slowest annual growth since at least 2010.[6]

According to the National Association of Realtors (NAR), buyers who purchased homes in the year ending Jun'22 moved a median of 50 miles from their previous residences — the most on record since 2005.[7]

The NAR study also showed 48% of home purchases were in small towns and rural areas — a record going back to 2003.[8]

Number of Cities with Population Losses, 2000-2021, Among 88 U.S. Cities with Populations Over 250K

SOURCE: WILLIAM H. FREY, BROOKINGS.EDU



"The pandemic didn't necessarily change the direction of internal migration but **accelerated some trends already in place.**"

SOURCE: PLACER.AI. DOMESTIC MIGRATION TRENDS, JUNE 2022.
COPYRIGHT 2022 PLACER LABS, INC.

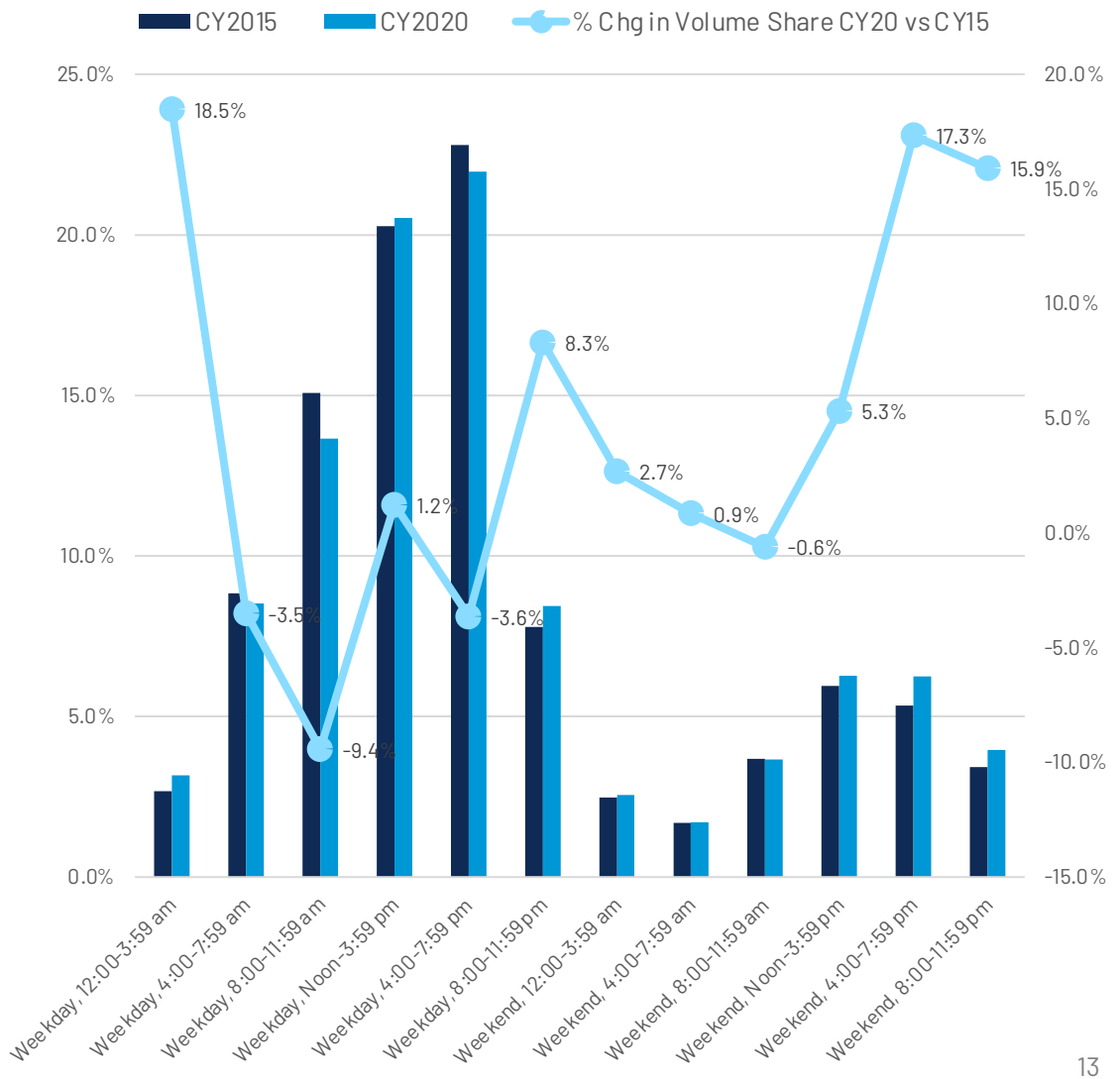
CHANGES IN COMMUTING AND TRAFFIC PATTERNS MEAN ACCIDENTS ARE OCCURRING AT DIFFERENT TIMES OF THE DAY AND WEEK

Traffic congestion is returning, but not at the same pre-pandemic days and times.[9]

- Across the top 10 U.S. cities by population, vehicle miles traveled (VMT) metro-wide is 4% above pre-pandemic levels on average, whereas VMT downtown is 27% below pre-pandemic levels.
- Vehicle hours of delay in 10 of the largest U.S. city centers is approximately 40% below April 2019 levels on average during peak morning hours, but only 22% lower during midday hours.
- Traffic is building later in the day than it used to and is coming back faster during non-peak hours.
- Perhaps not surprisingly, as traffic volume builds in non-peak hours, there has been a decrease in the overall share of motor vehicle crashes that occur during typical morning and afternoon rush hours.[10]

Motor Vehicle Crashes by Time of Day and Day of Week CY2020 Versus CY2015

SOURCE: NATIONAL SAFETY COUNCIL



TRAFFIC CONGESTION IS STARTING TO BUILD AGAIN

According to the *2022 INRIX Global Traffic Scorecard*, traffic delays exceeded pre-pandemic levels in 39% of U.S. urban areas (116 out of 295).[11]

Among the top 25 most congested cities in the U.S., some of the largest increases in vehicle hours of delay were in Miami and Las Vegas, with Nashville making the top 25 list for the first time.[12]

INRIX data also reveals most smaller, less-congested cities have seen traffic congestion return to pre-pandemic levels .[13]

Most Congested Cities in the U.S.

SOURCE: INRIX

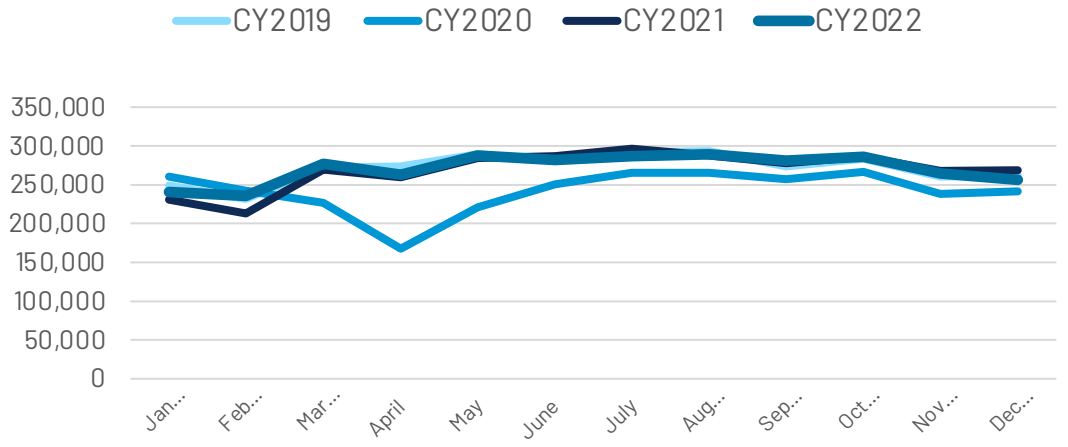
Urban Area	2022 Rank	2018 Rank	2022 Change vs Pre-pandemic In Total Number of Hours Lost in Congestion During Peak Commute Periods Compared to Off-peak Conditions	2022 Change vs Pre-pandemic in Speed at Which Driver Can Expect to Travel One Mile into Central Business District During A.M. Peak Hours
Chicago, IL	1	3	7%	-27%
Boston, MA	2	1	-10%	-27%
New York City, NY	3	4	-16%	-15%
Philadelphia, PA	4	9	-20%	-15%
Miami, FL	5	12	+30%	-21%
Los Angeles, CA	6	5	-8%	-17%
San Francisco, CA	7	8	0%	-14%
Washington, DC	8	2	-33%	-21%
Houston, TX	9	13	-9%	-16%
Atlanta, GA	10	11	-10%	-16%

U.S. MILES DRIVEN CONTINUE TO RECOVER, WITH TRUCK MILES EXPERIENCING FASTEST GROWTH

- Overall vehicle miles traveled in the U.S. are trending higher than pre-pandemic levels.
- Continued growth in e-commerce means truck miles driven also continue to rise. The U.S. Census Bureau estimates e-commerce sales grew between 7% and 11% each quarter in 2022 versus the same quarter in 2021.(14)
- Consumer preference continues to shift with more drivers choosing light trucks over cars. In CY 2013, just under 50% of all new vehicle sales were for light trucks. By 2022, that number jumped to nearly 80%.
- Not surprisingly, as e-commerce and light trucks' share of registered vehicles has grown, truck interstate miles have recovered much faster, and now exceed pre-pandemic levels.(15)
- When heavier vehicles are driving more relative miles than their lighter private passenger auto (PPA) counterparts, the heavier vehicles' accidents (which should be at a higher rate because of more miles driven) are likely to be with their lighter counterparts, which increases the impact severity (Delta-v) for the lighter PPA counterparts.

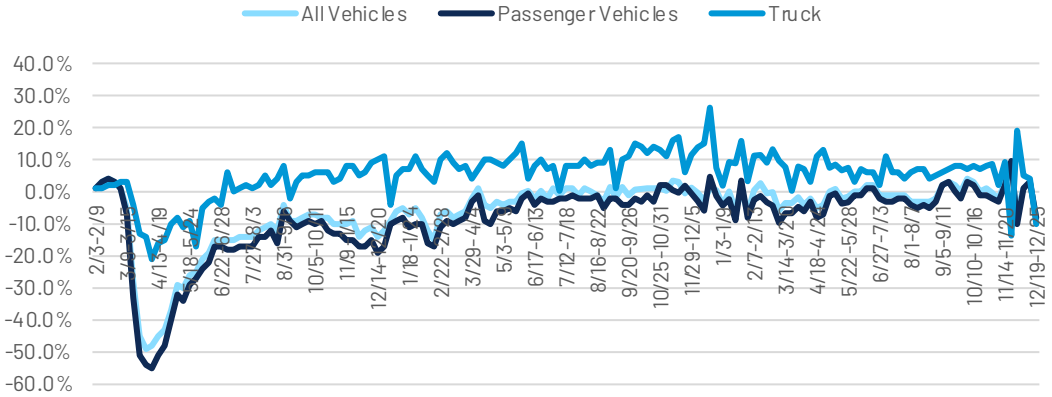
Vehicle Miles of Travel CY2019 – CY2022 (in Millions of Vehicle Miles)

SOURCE: U.S. DOT OHPI



Weekly Traffic Volume Interstate Travel by Week Percent Change from Same Week in CY 2019

SOURCE: U.S. DOT OHPI



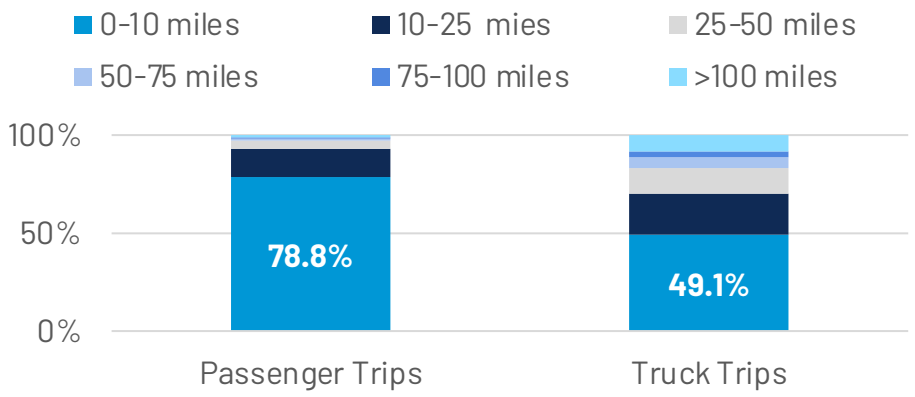
HEAVIER TRUCKS ACCOUNT FOR GROWING SHARE OF MILES DRIVEN IN U.S.

In CY 2021, light-duty vehicles accounted for 87.4% of miles driven, followed by 9.4% for freight trucks, and 3.2% for commercial light trucks. Freight trucks and commercial light trucks are expected to see their share of miles driven grow by 2050.[16]

A comparison of overall trips by distance for passenger vehicles versus trucks reveals the majority for both are 0-10 miles; although truck trips overall skew to longer distances.[17]

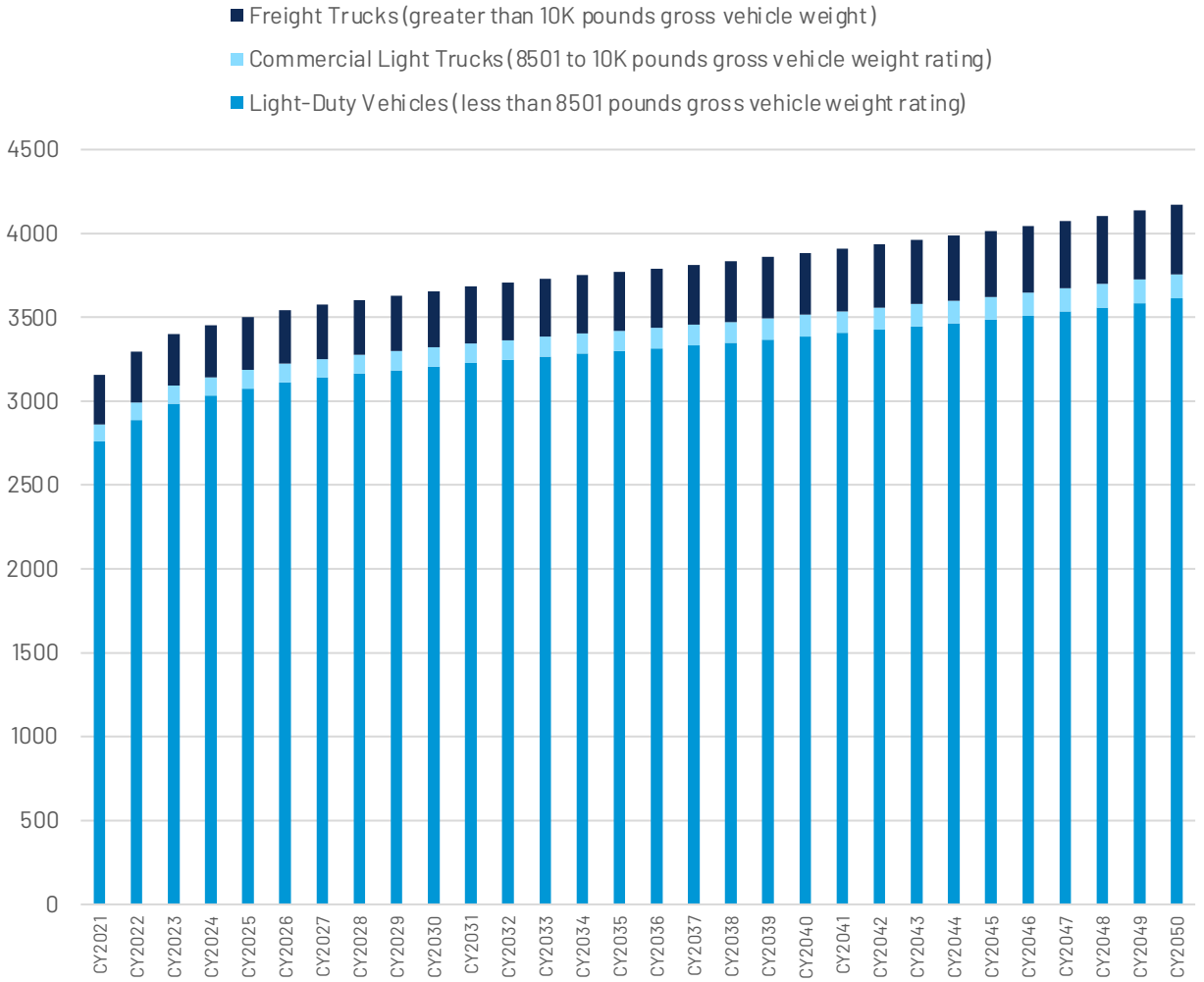
Distribution of Trips

SOURCE: 2020 U.S. NATIONAL HOUSEHOLD TRAVEL SURVEY



Forecast Miles Traveled (Billions of Miles) by Vehicle Size and Type CY2021 to CY2050

SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION



AMERICANS ARE DRIVING HEAVIER AND MORE POWERFUL VEHICLES

The U.S. Environmental Protection Agency (EPA) reports the average weight of passenger vehicles on the road in the U.S. increased from about 3,200 pounds for MY1981 vehicles to nearly 4,300 pounds for MY2021. Consumer preference for larger SUVs and pickups has contributed to this increase.[18]

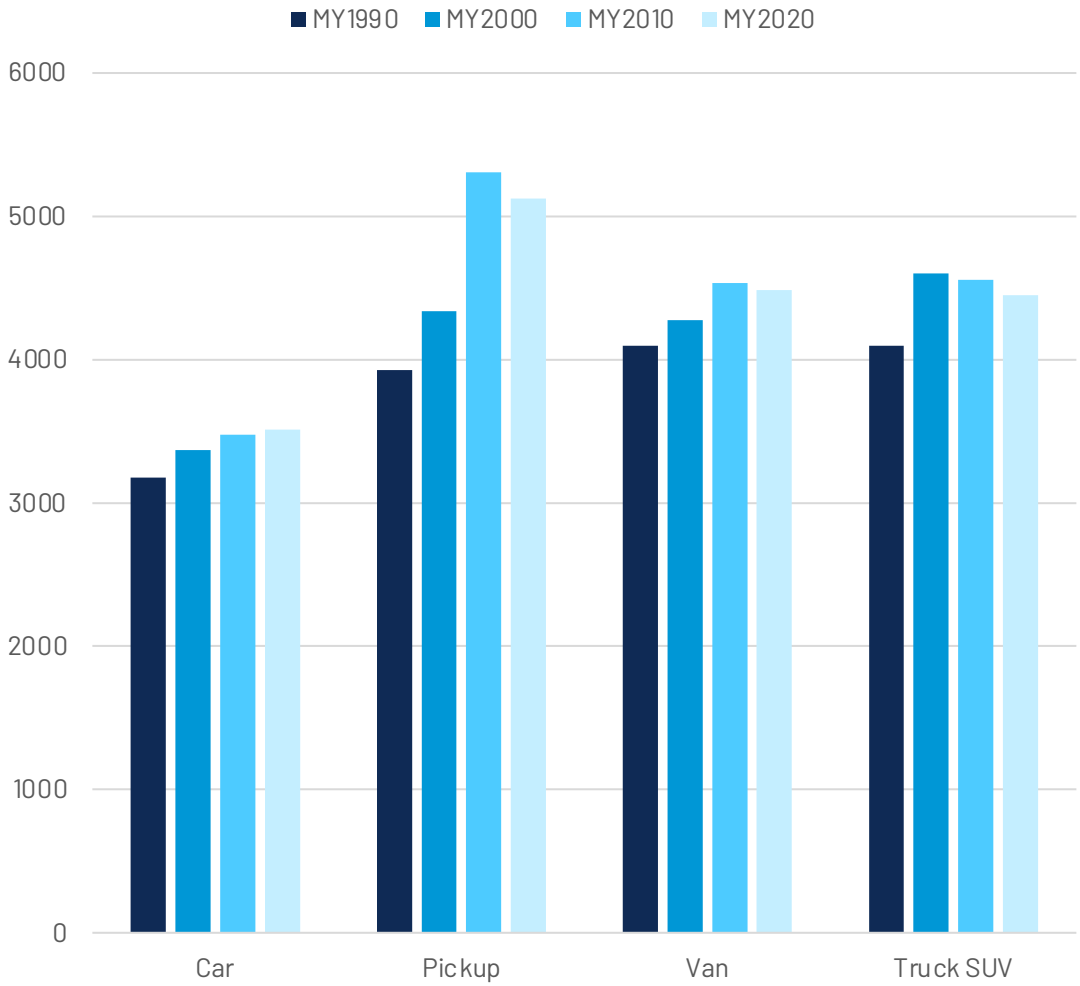
SUVs and trucks increased in average weight by 7% and 32% respectively between 1990 and 2021.[19]

The average vehicle saw an increase of nearly 85% in horsepower (hp) between MY1975 and MY2021, with pickups experiencing a gain of nearly 140%. In fact, the EPA estimates vehicles with more than 300 hp make up more than half of new vehicle production, and 20% of MY 2022 vehicles reach 400 hp or higher.[20]

Heavier vehicles with more horsepower are a potentially lethal combination. While a heavier vehicle has a lower Delta-v when it crashes into a lighter vehicle/object, a lighter vehicle has a higher Delta-v when it crashes into a heavier vehicle/object.

Production-Weighted Loaded Vehicle Weight of New Domestic and Import Vehicles by Model Year (in Pounds)

SOURCE: OAK RIDGE NATIONAL LABORATORY, TRANSPORTATION ENERGY DATA BOOK: EDITION 40.



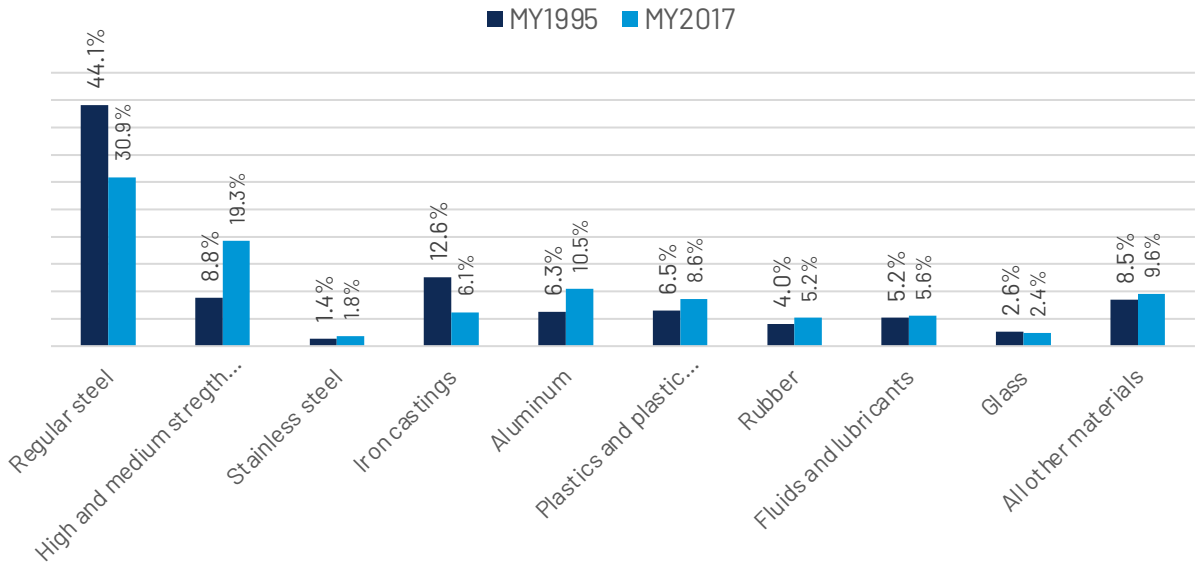
VEHICLES HAVE BECOME INCREASINGLY COMPLEX

The materials used to manufacture vehicles have shifted as automakers look to counter the growing weight of larger vehicles and meet stricter fuel economy standards.

The automobile industry has been moving at a steady pace to integrate electronics into cars that augment safety and autonomy, support infotainment and navigation, and provide system monitoring, onboard computers, and more. The average vehicle today has between 1,400 and 1,500 semiconductor chips, and electric vehicles have nearly double that amount.[21]

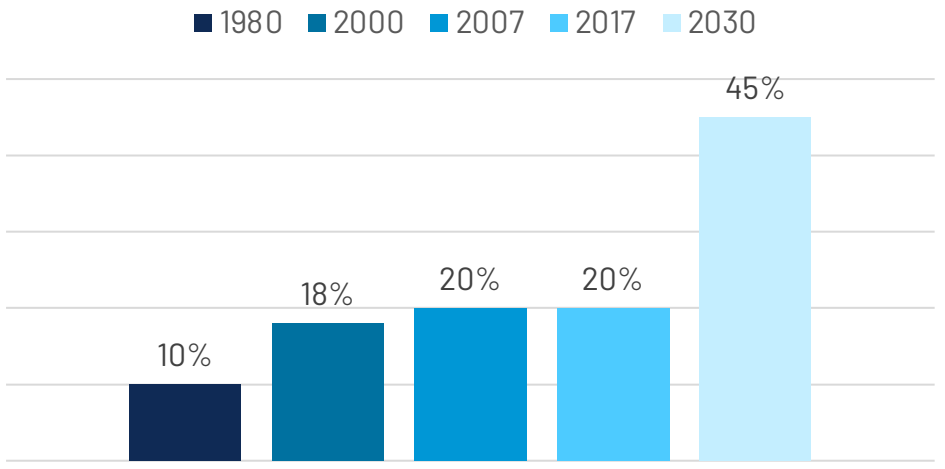
Average Material Consumption for Vehicles Built in North America MY1995 and MY2017

SOURCE: OAK RIDGE NATIONAL LABORATORY, TRANSPORTATION ENERGY DATA BOOK: EDITION 40.



Electronics Systems Powered by Semiconductor-Based Chips Share of the Cost of a New Vehicle

SOURCE: CAR AND DRIVER (WWW.CARANDDRIVER.COM/FEATURES/A32034437 /COMPUTER-CHIPS-IN-CARS)



AMERICANS ARE DRIVING FASTER AND WITH MORE DISTRACTIONS

The Insurance Institute for Highway Safety (IIHS) Nov'22 survey on the propensity of drivers to engage in distracting behaviors revealed 65% did so within the last 30 days. While distracted driving appears to be concentrated among drivers younger than 50 years old, no age group or demographic studied abstains.[22]

People who drive most frequently engage in distracting behaviors more than those who drive less frequently.[23]

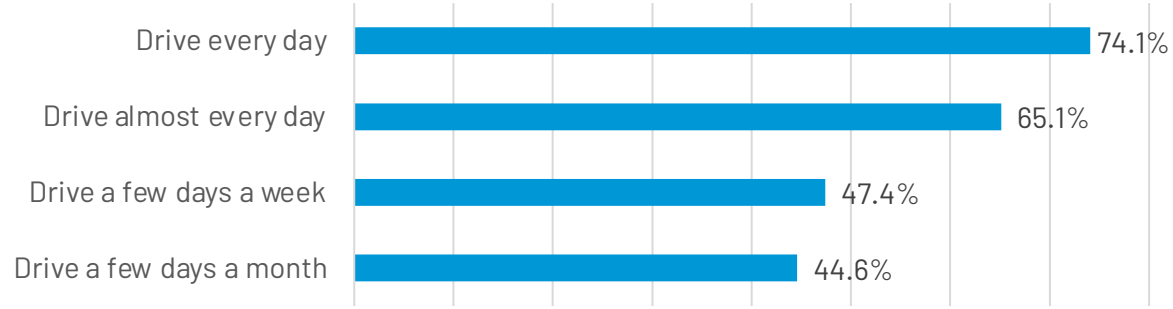
Even ADAS may not help. Motorists with partial vehicle autonomy (L2 ADAS) drive nearly 5K miles more per year than drivers without the feature.[24]

The AAA Foundation for Traffic Safety's *2021 Culture Index* showed an increase in unsafe driving behaviors between 2020 and 2021 after three years of steady declines.[25]

February 2022 research from Cambridge Mobile Telematics revealed speeding levels were still higher than pre-pandemic levels, with drivers 10 mph over the speed limit 50% of the time. Their data also revealed evening and late-night distracted driving spiked during the early part of the pandemic and has remained elevated above pre-pandemic levels.[26]

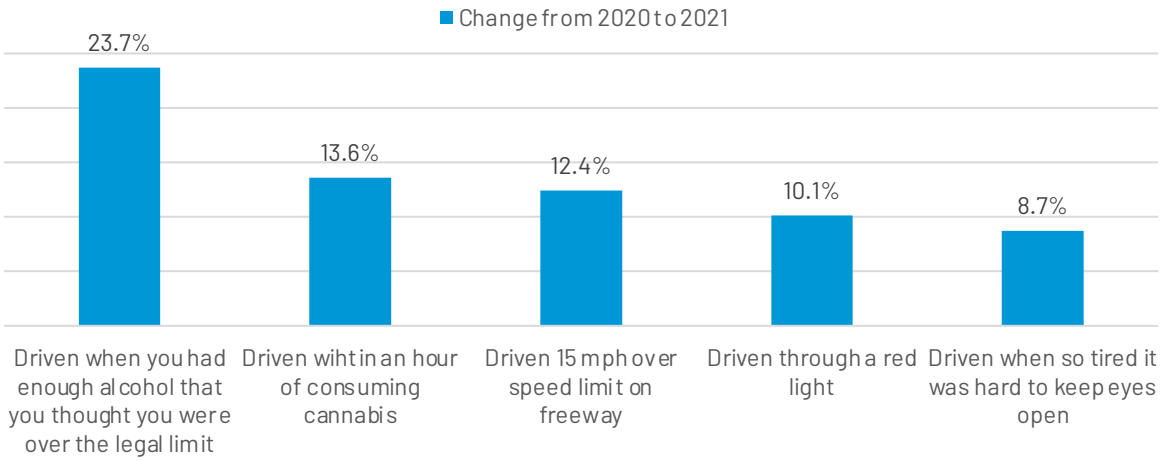
Percentage of Study Sample Who Reported Doing at Least One Distraction (Non-Driving Related Task) Most or Every Time They Drove in Past 30 Days by Driving Frequency

SOURCE: IIHS PREVALENCE OF DISTRACTED DRIVING BY DRIVER CHARACTERISTICS IN THE U.S., NOVEMBER 2022



Dangerous Driving Behaviors Are on the Rise

SOURCE: AAA FOUNDATION FOR TRAFFIC SAFETY'S 2021 TRAFFIC SAFETY CULTURE INDEX



RISKIER DRIVING LEADS TO MORE MOTOR VEHICLE FATALITIES

During the first nine months of CY2022, the U.S. experienced an estimated 31,785 motor vehicle fatalities, down slightly from its peak of 31,850 during the same period in CY2021.(27)

28% of fatal crashes, 13% of injury crashes, and 10% of property damage-only crashes in CY2020 were related to speeding, and speeding-related fatalities increased 17% between CY2019 and CY2020.(28)

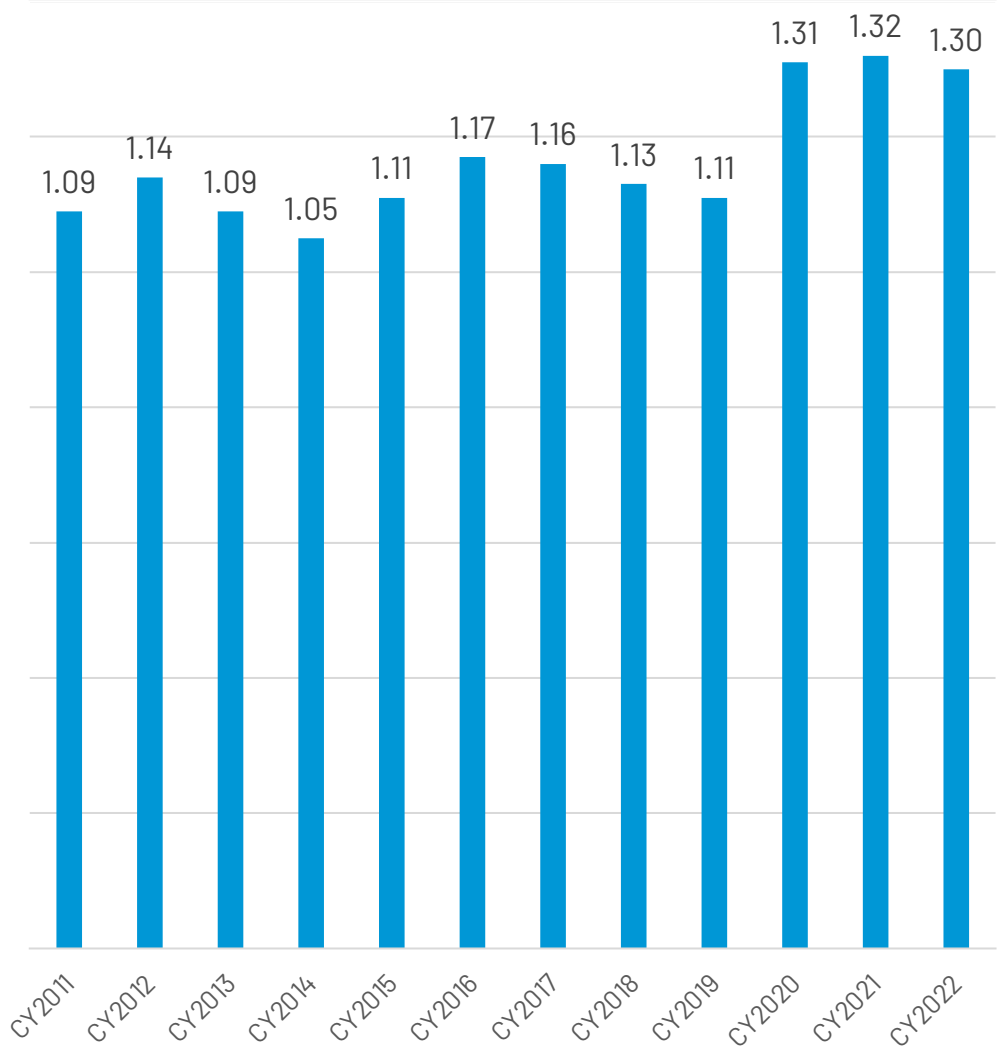
Traffic fatalities on urban roads and streets increased 34% between CY2010 and CY2019, and urban roadways account for a disproportionate number of speeding-related fatalities (54% in CY2019). Those most at risk were the speeders themselves, followed by pedestrians and bicyclists.(29)

23% of speeders involved in fatal crashes were driving during nighttime weekend hours, where overall share of motor vehicle accident counts has grown.(30)

Governors Highway Safety Association (GHSA) data shows a 62% increase in pedestrians killed by motor vehicles between CY2009 and CY2020.(31)

NHTSA U.S. Motor Vehicle Fatality Rate per 100 Million Vehicle Miles Traveled (Jan-Sep)

SOURCE: NHTSA

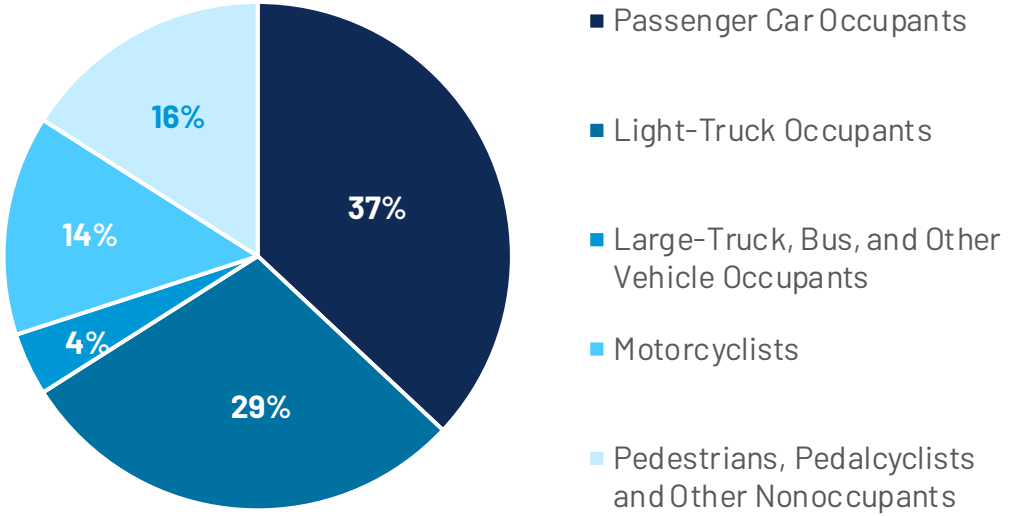


MOTOR VEHICLE FATALITIES INCREASE OVERALL, ESPECIALLY FOR NON-OCCUPANTS

Even pre-pandemic, the composition of fatalities continued to shift toward more pedestrians, bicyclists, and other non-occupants. [32] Fortunately, significant advances in vehicle safety — both in terms of crash worthiness and crash avoidance — have meant fewer fatalities for vehicle occupants in a crash, but those same protections are not in place for people outside the vehicle.

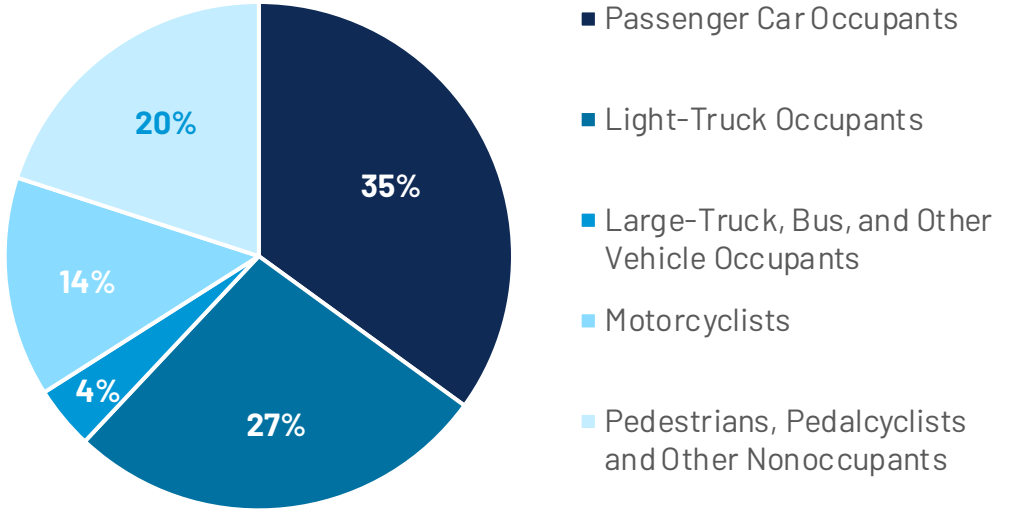
CY2011

SOURCE: USDOT NHTSA OVERVIEW OF MOTOR VEHICLE CRASHES IN 2020, DOT HS 813 266, MARCH 2022.



CY2020

SOURCE: USDOT NHTSA OVERVIEW OF MOTOR VEHICLE CRASHES IN 2020, DOT HS 813 266, MARCH 2022.



MORE EMPLOYEES WORKING REMOTELY

Pre-pandemic, an estimated 5% of all workdays were done remotely. WFH Research shows that number jumped to 30% as of December 2022.[33]

As of December 2022, approximately 13% of full-time employees are fully remote, 58% are full-time on-site, and 29% are in a hybrid arrangement averaging 2-3 days per week in the office. [34]

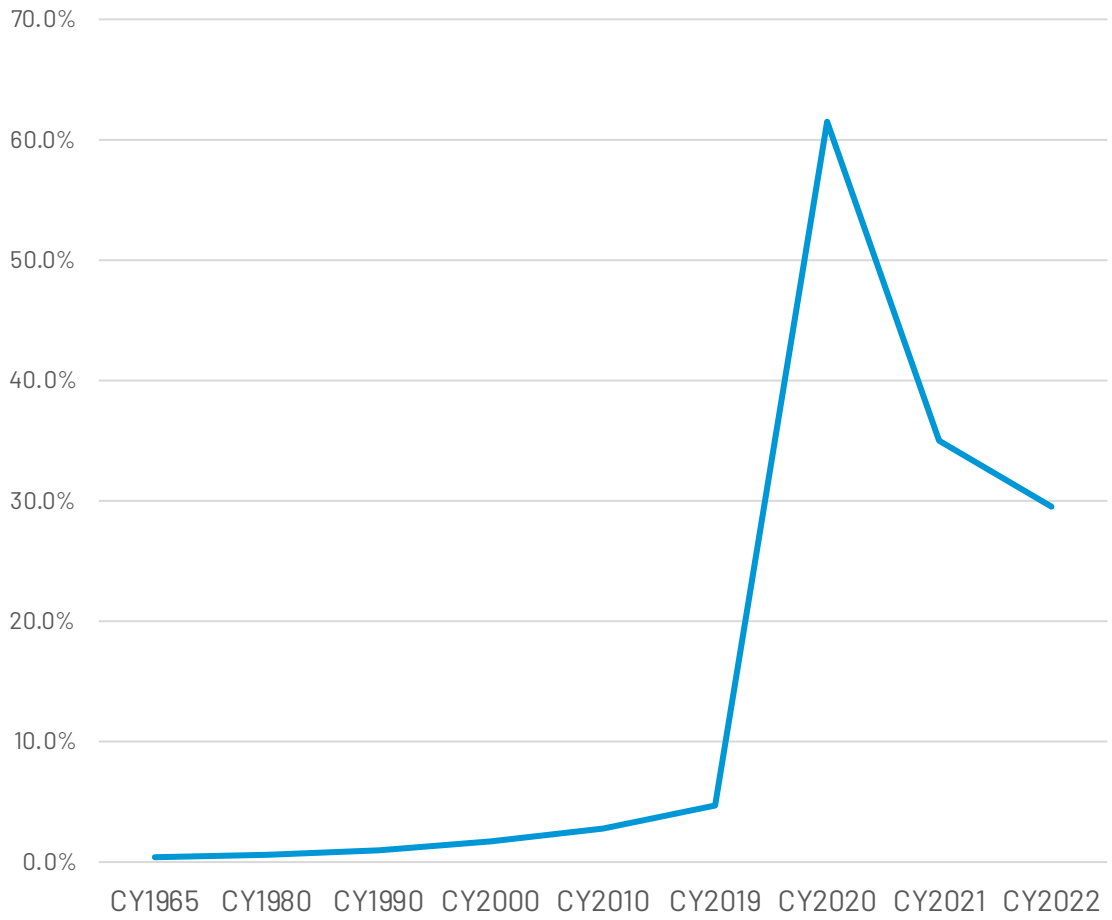
Remote work doubled every 15 years, pre-pandemic. The increase in remote work during the pandemic was equal to 30 years of pre-pandemic growth.[35]

Kastle Systems' 10-city average office occupancy data suggests offices remain below 50 percent occupied through 2022, but finally crossed the 50 percent mark in late January 2023.[36]

Technology has made it easier for teams to work together without physically being together.

Historical Work From Home Share

SOURCE: WFHRESEARCH.COM



1965-1975 uses data from the American Household Time Use Survey
1980-2019 uses data from American Community Survey
May 2020-August 2022 uses data from the Survey of Working Arrangements and Attitudes

"No other episode in modern history involves such a **pronounced and widespread shift in working arrangements** in such a compressed time frame."

SOURCE: CEVAT GIRAY AKSOY, JOSE MARIA BARRERO, NICHOLAS BLOOM, STEVEN J. DAVIS, MATHIAS DOLLS, AND PABLO ZARATE. "WORKING FROM HOME AROUND THE WORLD." PREPARED FOR THE BROOKINGS PAPERS ON ECONOMIC ACTIVITY, AUGUST 23, 2022.

FULLY REMOTE WORK MAY HAVE PEAKED

Analysis from a review of more than 60 million paid job listings on LinkedIn since Jan'21 reveals employers' willingness to create remote work job postings may be fading. In Mar'22, remote work listings peaked at more than 20% of all paid job postings. This was a huge jump from less than 10% in January 2021, but that spike has given way to an abrupt decline. In November 2022, barely 14% of paid job postings on LinkedIn invited remote applicants.(37)

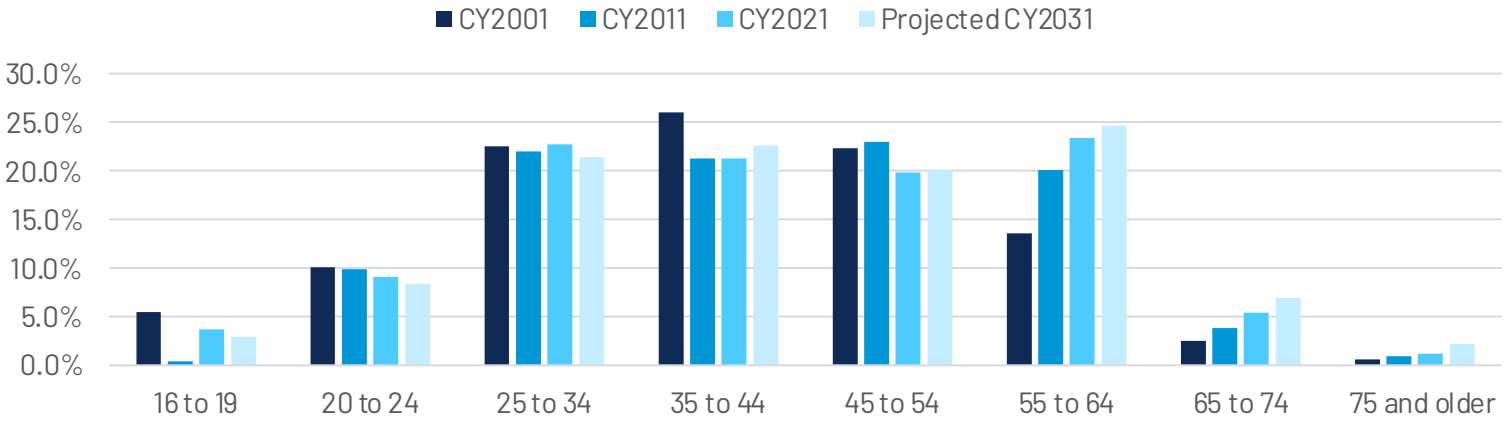
HubbleHQ, a company that provides co-working and office management solutions, tracks post-pandemic work strategies for many of the most well-known companies globally. As of Dec'22, only two of the 40+ companies tracked are listed as "office-first," five are listed as "remote-first," and the remainder are "hybrid," with many companies requiring employees to be in the office at least three days per week.(38)

A Q4'22 survey conducted by ResumeBuilder.com of 1,000 business leaders revealed that 9 in 10 companies will require employees to return to the office in 2023.(39)

OVERALL U.S. LABOR PARTICIPATION RATE REMAINS AT HISTORIC LOWS

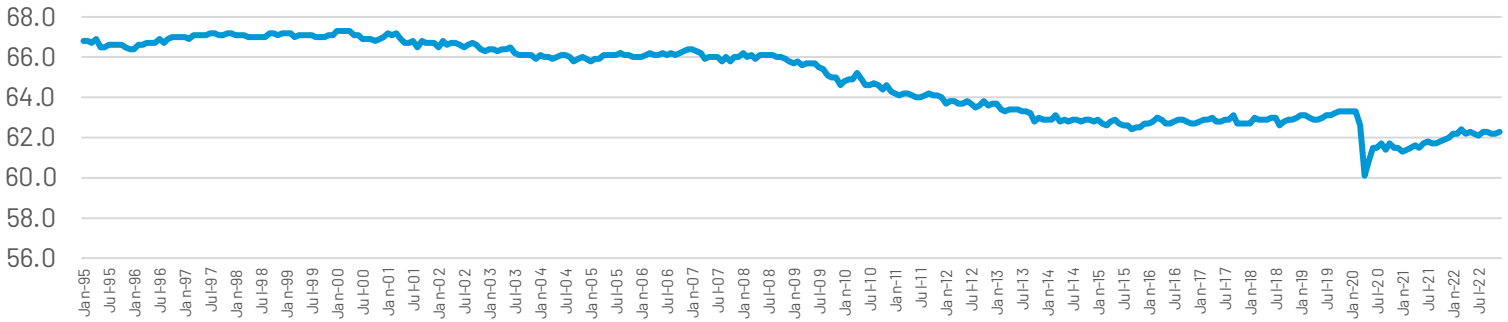
Civilian Labor Force by Age, 2001, 2011, 2021, and Projected 2031

SOURCE: U.S. CENSUS BUREAU



Labor Force Participation Rate, Percent, Monthly, Seasonally Adjusted

SOURCE: FEDERAL RESERVE ECONOMIC DATA



Aging population and other demographic factors have contributed to the change in labor participation rates in the U.S.

One example is the increase in the share of workers aged 56 years and older. This age group's labor participation rate was lower compared to other age groups, which means the share increase had a negative contribution to the overall aggregate participation rate.[40]

Growth in older workers' share of the civilian labor force also suggests that challenges within the labor markets will remain for some time. According to the Organization for Economic Co-Operation and Development (OECD), as of Sep'22 the jobless rate in major developed economies was 4.4%, its lowest since the early 1980s.[41]

U.S. JOBS MARKET REMAINS TIGHT HEADING INTO 2023

The U.S. unemployment rate edged down to 3.5% in Dec'22 and has remained in a narrow range of 3.5% to 3.7% since Mar'22. The last time the U.S. reached a 3.5% unemployment rate was 53 years ago.[42]

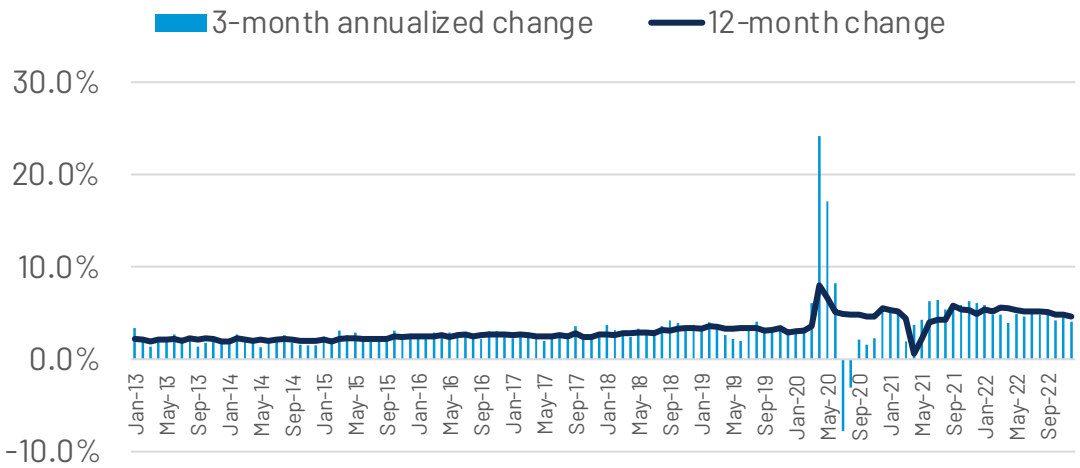
U.S. employers added 4.5 million jobs in CY2022, the second-best year for job creation in records dating back to CY1940. A net gain of 6.7 million jobs were added in CY2021, when the labor market rebounded from pandemic-induced shutdowns.

Wage growth has been strong coming out of the pandemic but began cooling at year-end 2022.[43]

U.S. workers benefited from a resilient jobs market over the last two years, raising fears of a so-called "wage-price spiral," where employees demand greater pay hikes in response to climbing prices, but those wage increases then fuel further inflation. Recent slowdown in wage increases suggests this scenario is less likely, easing pressure on the Fed to keep hiking interest rates.[44]

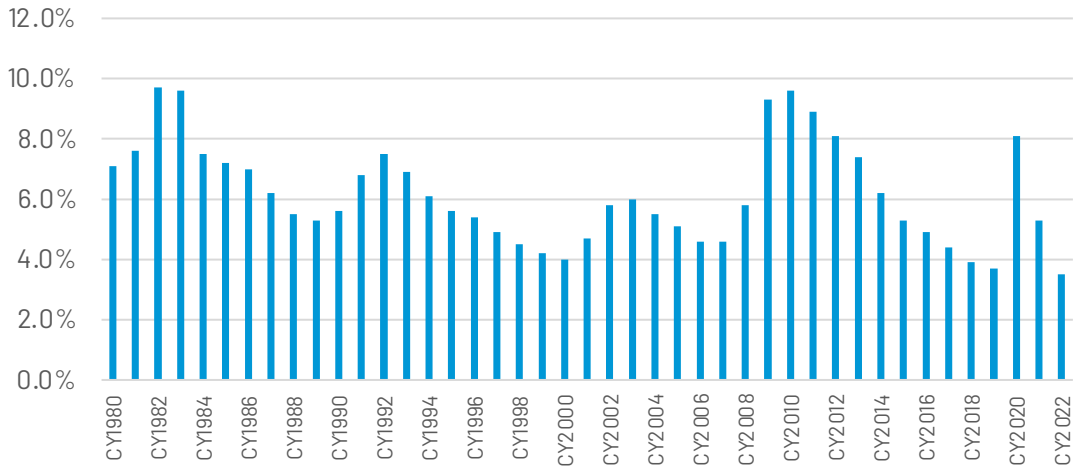
Average Hourly Earnings Jan '13-Dec' 22 [Nonfarm Private Sector (Excludes Government), Seasonally Adjusted]

SOURCE: U.S. BUREAU OF LABOR



Unemployed Percent of U.S. Civilian Noninstitutional Population CY1980-CY2022

SOURCE: U.S. BUREAU OF LABOR



COLLISION REPAIR INDUSTRY FACES SIGNIFICANT TECHNICIAN SHORTAGE

In 2022, annual demand for new entrant technicians was over 35,000, but there were only 4,500 graduates from post-secondary collision programs.(45)

Many of the open positions will replace retiring baby boomers. As of 2019, the average age of collision repair technicians was 41, up 17% from 1995.(46)

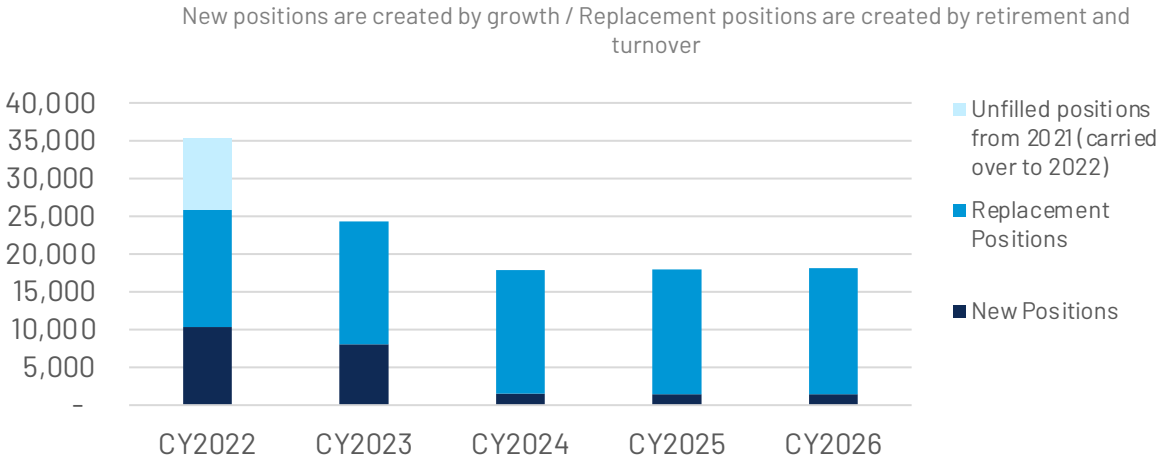
The 2022 FenderBender Industry Survey revealed two-thirds of collision repair shop owners participating in the survey were age 50 and older, and 31 percent had been in the collision repair industry for 40+ years.(47)

The same survey from FenderBender showed that 34% of shop owner respondents said they believe a shortage of qualified technicians is the single biggest challenge that collision repair shop operators face today, while 22% claimed it was low labor rates.

Data from the Bureau of Labor Statistics Occupational Outlook Handbook projects only 3% growth in the number of automotive body and glass repairers between 2021 and 2031 versus 5% across all occupations. (48)

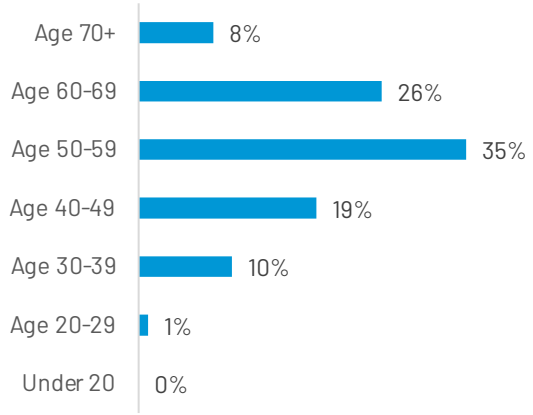
Demand for Collision New Entrant Technicians

SOURCE: TECHFORCE FOUNDATION



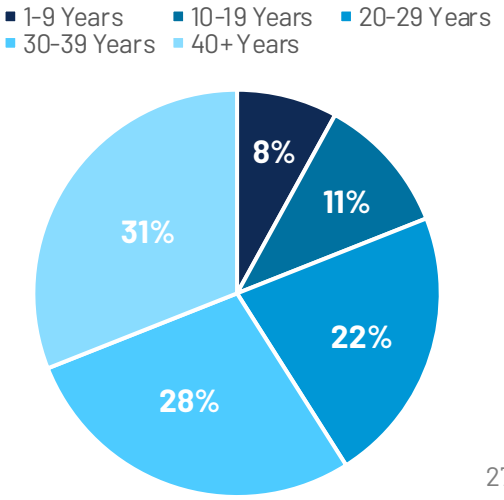
Shop Participant Age

SOURCE: FENDER BENDER INDUSTRY SURVEY 2022



Years in the Collision Repair Industry

SOURCE: FENDER BENDER INDUSTRY SURVEY 2022



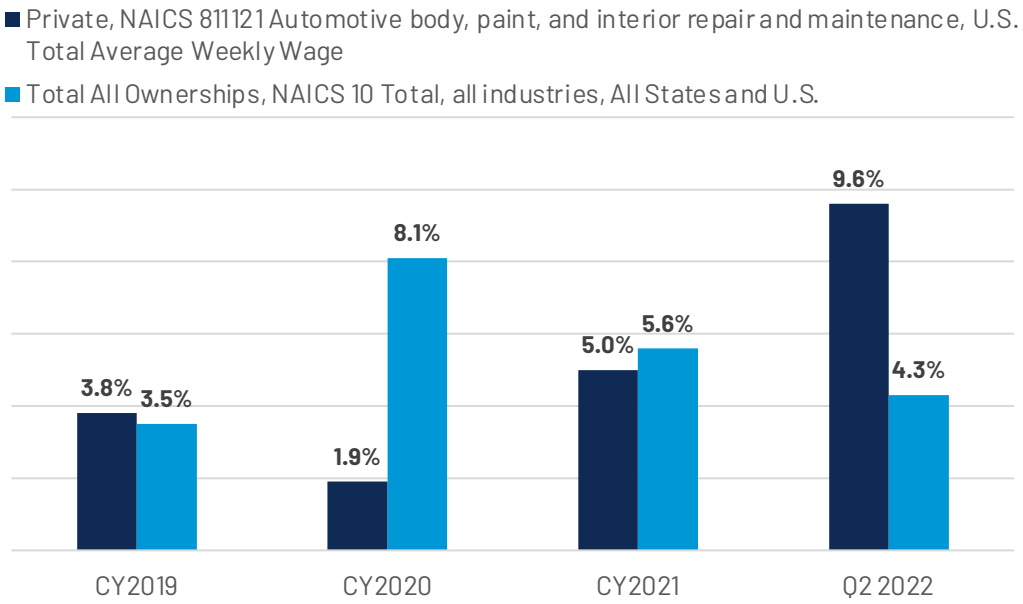
COLLISION REPAIRERS FACE HIGHER EMPLOYEE WAGES

Data suggests the technician shortage is not a short-term issue for repairers, but rather one that will be a drag on industry capacity for years to come. As shops compete for a smaller number of technicians, and as repairs continue to become more complex requiring new skillsets, many shops have indicated they cannot repair as many vehicles at the same time as they did before the pandemic.

The technician shortage is also leading collision repairers to raise wages at a much faster pace than in previous years. Increases in average weekly wages for all employees within a shop outpaced wage increases across all industries in CY2022 after trailing between CY2018-CY2021.[49]

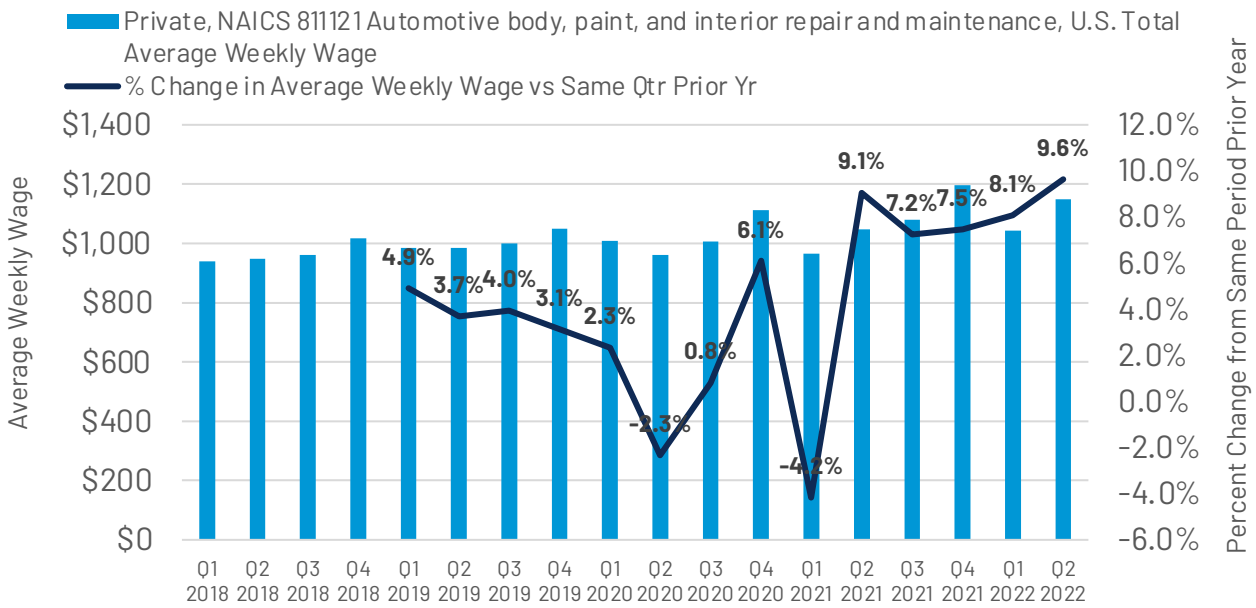
Percent Change in Average Weekly Wage CY2018-CY2022

SOURCE: U.S. BUREAU OF LABOR STATISTICS: QUARTERLY CENSUS OF EMPLOYMENT AND WAGES



Private, NAICS 811121 Automotive Body, Paint, and Interior Repair and Maintenance, U.S. Total Average Weekly Wage

SOURCE: U.S. BUREAU OF LABOR STATISTICS: QUARTERLY CENSUS OF EMPLOYMENT AND WAGES



P&C INSURERS STRUGGLE TO RECRUIT CERTAIN SKILLSETS

According to 2022 The Jacobson Group and Ward Insurance Labor Market Study, 82% of Personal Lines P&C companies are expecting to increase staff during the next 12 months.(50)

Unfortunately, insurers are finding the recruiting environment is the most difficult in the study's history *(6.2 average on a scale of 1-10, with 10 being "most difficult").*(51)

Top areas that are most in need include: technology staff, underwriting, analytics, and claims.(52) Research presented during Aon's 2022 P&C Performance Outlook webinar showed that claims has the highest employee turnover rate in the industry right now.(53)

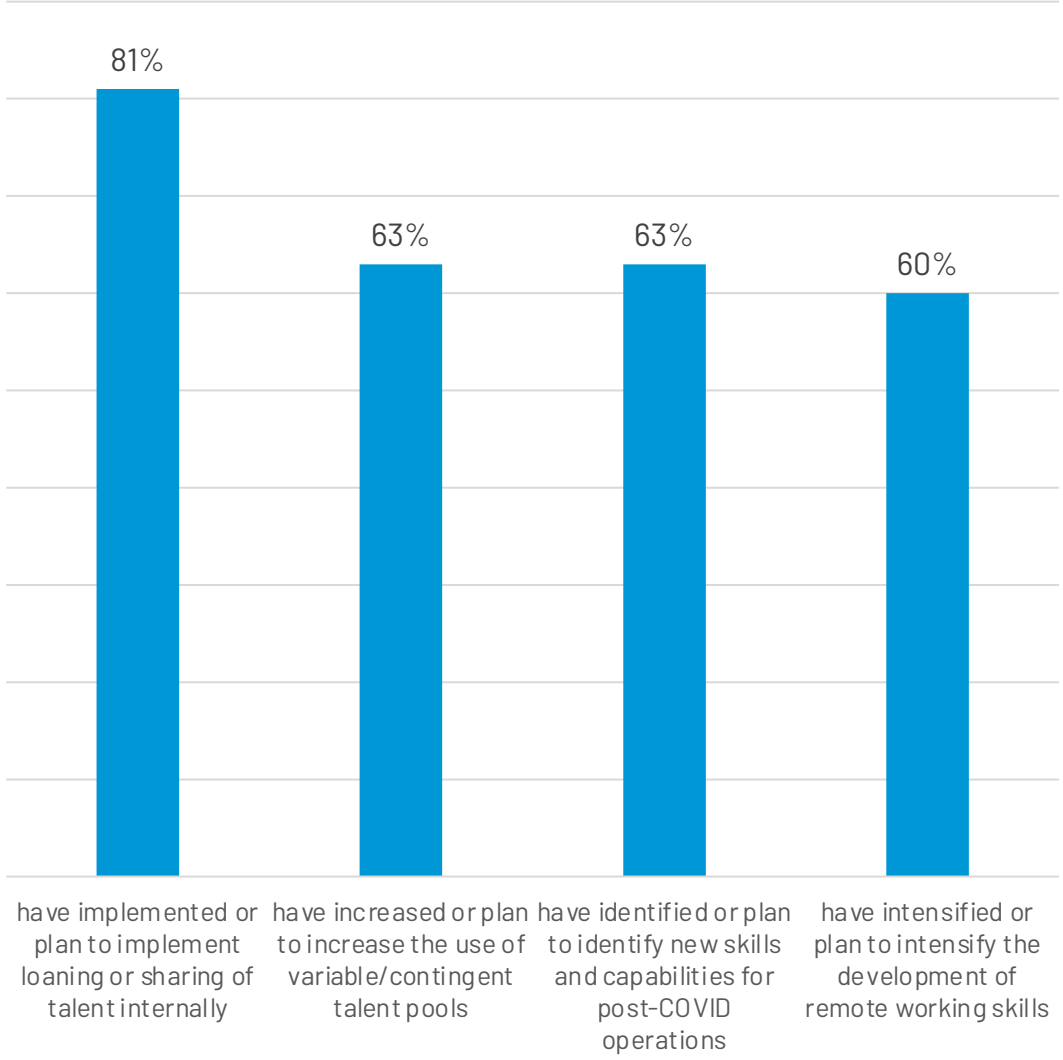
The median age of insurance industry employees is 45 compared to 42.2 for the overall workforce, and 25% of the insurance workforce is 55 or older, versus 30% for the overall civilian workforce population.(54)

Survey results from a Sep'21 Boston Consulting Group study on the insurance workforce revealed that 48% fear their jobs will be automated versus 40% across all industries. And while 71% of insurance employees said they are willing to reskill, 62% of insurance workers spend a few weeks or more on training per year, the third-lowest of all industries.(55)

Insurance companies have implemented workforce development strategies that embrace digital transformation in order to adapt and meet evolving customer needs.(56)

What Are Insurers Doing to Create a More Fluid Workforce and Accelerate Skill Development?

SOURCE: MERCER'S INNOVATION-DRIVEN TECH WORKPLACES RESEARCH



"America needs to start thinking about 'talent' differently, not as a problem that can be solved but as **a supply chain that needs to be sustained."**

SOURCE: ADRIAN WOOLDRIDGE. "AMERICA IS FACING A GREAT TALENT RECESSION." BLOOMBERG, FEBRUARY 3, 2022.

HEALTHCARE INDUSTRY FACES STAFFING SHORTAGES

The Department of Health and Human Services expects the number of individuals aged 65 and older to grow from 54M in 2019 to more than 80M by 2040 — a key factor driving projected healthcare staff shortages.[57]

Research from McKinsey reveals 29% of nurses responding to their survey said they were likely to leave their current role in direct patient care, with many saying they planned to leave the workforce entirely. The U.S. may be looking at a shortage of 200K to 450K nurses available for direct patient care by 2025.[58]

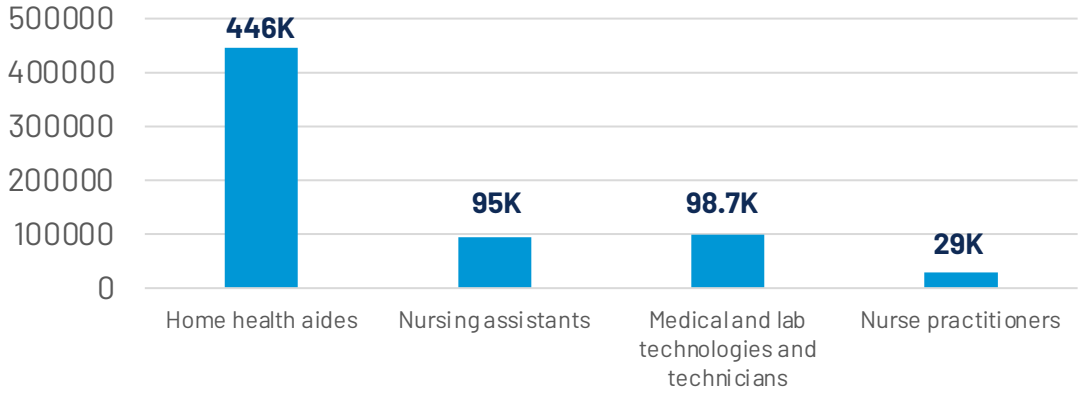
As of February 2022, more than one-third of surveyed hospital leaders expected demand in several specialties to exceed provider capacity over the next six months. Almost all respondents said that staffing challenges will affect capacity for elective care.[59]

The National Hospital Flash Report showed hospital operating margins were negative in 2022 through September (-0.1%). Revenues fell as hospital expenses rose, and total labor expenses were up 10% year-to-date.[60]

Staffing and profitability challenges faced by medical providers could potentially affect the quality and availability of medical care for auto casualty claimants.

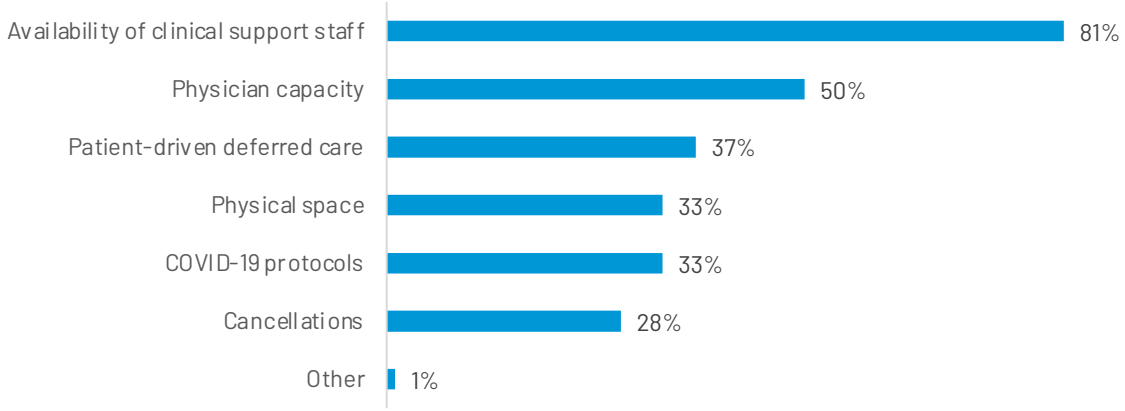
Projected U.S. Medical Staffing Shortages by 2025

SOURCE: MERCER 2021 STUDY OF THE U.S. HEALTHCARE LABOR MARKET



Barriers to Increasing Outpatient Clinic Volume in Upcoming Months, % of Respondents

SOURCE: MCKINSEY MARCH 2022 SURVEY



CHANGES IN HOW WE WORK DRIVEN IN PART BY TECHNOLOGY

The insurance industry has accelerated its adoption of technologies like machine learning, digitization, AI, and insurtech solutions that can help provide support to the remaining personnel who may be less experienced than those retiring. But while technologies can help automate and improve certain processes, the need to provide high-touch personalized customer service during a claim is more important than ever.

Many carriers are experiencing staffing challenges as they look to fill open jobs left by retirees or find that new employees are needed as they expand. Yet, with the flexibility of many jobs to support a hybrid model, insurers can recruit from an expanded talent pool. In a Deloitte mid-year survey, 51% of insurer respondents said they are now hiring employees irrespective of their location, and 58% are augmenting their teams with gig workers.(61)

In the collision repair industry, most of the work is on-site and hands-on; however, with vehicles including more technology like ADAS, automatic emergency braking (AEB), connected mobile devices, and more, repairers are having to spend more time reviewing vehicle data like diagnostic trouble codes (DTCs) and repair procedures-work that could potentially be done from a remote setting aided by technology like AI, but also requires new skillsets.

Moving forward, all industries will look to technology to help focus peoples' time where it matters. Technology like AI can help automate highly repetitive, low-skill tasks, and free up time for people to spend on more important tasks.

INSURANCE COMPANIES INCREASE AI TECHNOLOGY ADOPTION

There was significant growth in AI adoption across auto claims in 2022, according to CCC's annual AI Adoption Report, which found the application of advanced AI for claims processing increased 60 percent year-over-year.

In addition, CCC found that more than 14 million unique claims have been processed through 2022 using a CCC advanced AI solution, growing 3x since before the pandemic.

The data also shows a deepening penetration of multiple different AI solutions being applied per claim, with CCC reporting the number of claims using four or more of its AI applications grew 2x year-over-year.

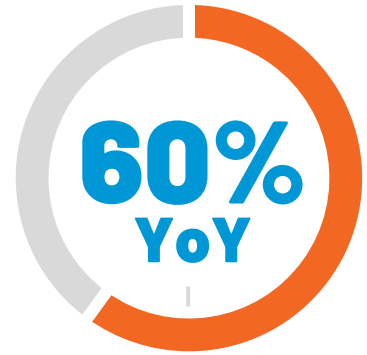
View the complete report findings **here**.

P&C INSURANCE INDUSTRY **AI ADOPTION 2022**

14M

Unique claims processed using a CCC advanced AI solution through 2022

3X Growth in unique claims processed since before the pandemic in 2019



Increase in the application of advanced AI for claims processing

Growth in the number of claims using four or more of CCC's AI applications

2X YoY

Today more than **100 insurers** are actively using CCC's AI-powered capabilities.

PERSPECTIVE: P&C DIGITAL TRANSFORMATION

THE END OF THE BEGINNING

JASON VERLEN

VICE PRESIDENT OF PRODUCT MARKETING, CCC

The journey to digitally transform the Property & Casualty insurance ecosystem started in earnest 7 to 10 years ago. At the time, there was widespread skepticism. Now it's 2023 and the evidence is clear:

The doubters were wrong. Where do we go from here?

PERSPECTIVE

P&C DIGITAL TRANSFORMATION

Over the last 7-10 years, we have seen mass adoption of the following transformative technologies across the industry:

- Automated accident detection from telematics data
- Mobile consumer experience to document accident damage
- AI damage detection and visualization through deep learning
- Total versus repair AI prediction upfront, based on photos
- Mobile-based estimate receipt
- Shop selection and repair booking
- Repair versus replace prediction
- Labor hours calculation
- AI generating partial and now complete estimates
- AI and rules analyzing estimates written by 3rd parties that flag possible omissions and changes
- Integration of diagnostics into shop workflows
- Fraud identification
- Subrogation opportunity detection
- Natural language processing that enables replies to consumer queries without human intervention
- Delta-v calculation to identify possible injuries and their severity
- Digital payments

That's quite a list — one that's indicative of an industry driving for change in an environment that demands it.

But these innovations have not just been deployed into systems and workflows — they're on a rapid ascent when it comes to actual usage. Here's an example:

According to CCC data, 27% of repairable vehicles today are being processed via consumer-driven mobile AI. Remove the direct repair program (DRP)-assigned vehicles from the total, and the percentage is now close to 50%.

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PERSPECTIVE P&C DIGITAL TRANSFORMATION

Adoption is not concentrated within a small number of select carriers but is instead broad-based across the industry. In fact, more than 150 carriers now enable policyholders to send collision damage photos, and roughly 100 carriers apply AI to determine next steps for repair.

Benefits from this process have been measurable. According to a CCC survey, 84% of consumers prefer this new digital process because it's user-friendly and it's cutting their claims cycle time, from crash to keys, by as much as one-third.

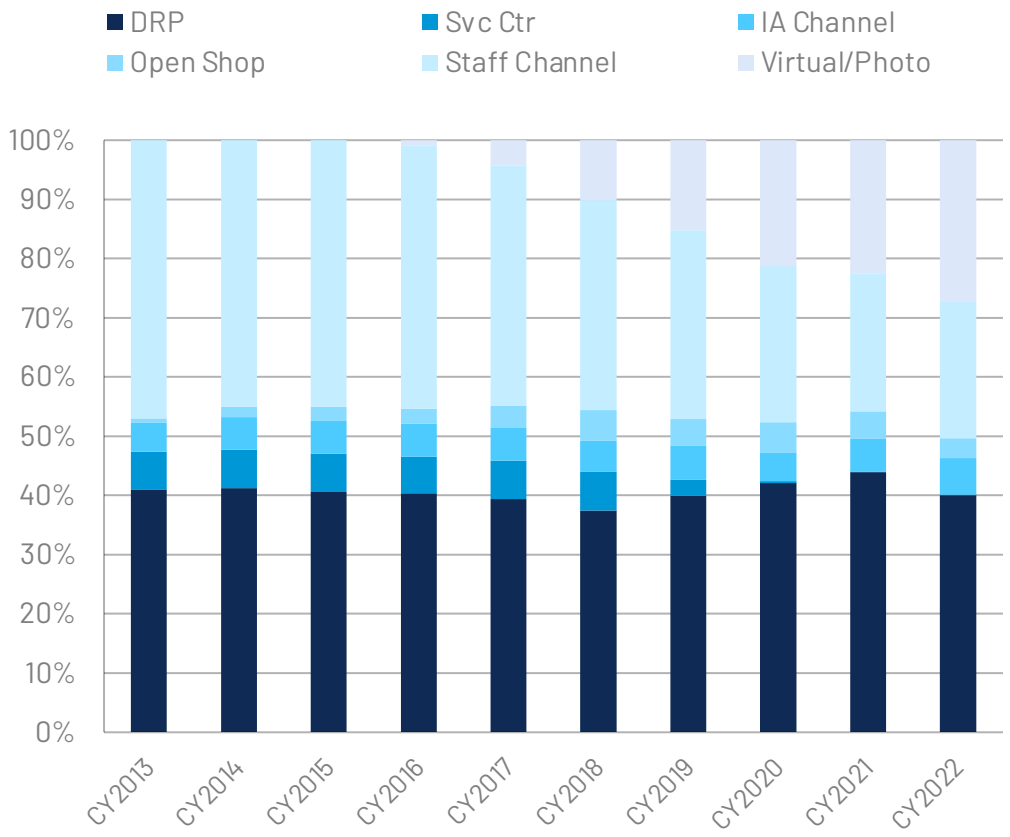
Given everything that's been accomplished, it's time for the big question: Is this the end or have we "arrived"?

Is this transformation more or less accomplished and now it's time to move on? Or is it, in fact, more appropriate to look at what has been accomplished and see it as a launch pad for something even bigger. Put another way, is this the "end of the beginning" rather than "the end?"

There is strong evidence that we're merely at the "end of the beginning," and it's highly likely that the pace of digital transformation in this space will now accelerate and become more all-encompassing.

Share per Method of Inspection CY2013-CY2022

SOURCE: CCC NATIONAL INDUSTRY REPAIRABLE APPRAISAL VOLUME



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PERSPECTIVE P&C DIGITAL TRANSFORMATION

The most compelling evidence is market demand, which suggests this ecosystem is up against a daunting set of challenges, among them: Consumers expect a digital experience for all interactions in their lives. Then there are the increasing costs to repair vehicles driven by a host of factors including inflation, increasing vehicle complexity, and a shortage of experienced labor to do both estimates and repairs.

This combination of challenges can only be addressed by increasing adoption of advanced technology.

Of course, needing more technology doesn't always mean the technology actually exists, but in recent years there have been a number of breakthroughs making their way into corporate systems.

One example is Adversarial AI networks within Generative AI, which not only make predictions like AI has done for nearly 70 years, but also create entirely new things, like new content, translations, answers to questions, sentiment analysis, summaries, and even videos.

This is indeed a step change that we can use to our advantage. So, if acceleration is needed and we have technology that could achieve it, what path might it take?

To keep things simple, transformation will go deeper in areas where progress has already been made and will also go broader across the industry in terms of new users and use cases.

An example of deeper would be straight-through estimate processing. Instead of using AI to generate partial estimates that are then completed by humans, it is now possible — for some accidents — to create the entire estimate via automation and integrate that estimate through the entire process. This has the potential to improve speed, reduce costs, and provide more personalized, 1-to-1 consumer experiences, because human efforts that were previously focused on estimate creation can now be redirected toward customer service to achieve differentiation.

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PERSPECTIVE P&C DIGITAL TRANSFORMATION

But ensuring broader technology adoption also requires enabling new users — and use cases — to actually use it. In keeping with our estimate creation example, AI technology could be used by a carrier's staff appraisers to create more consistent estimates faster, improving productivity and reducing errors in the process.

Similarly, repair facilities could use the technology with the vehicle right in front of them to generate estimates and repair plans, and they could do so with superior integration of adjacent capabilities, such as determining what types of scans are needed at what stages in the process.

And now that photos are becoming more ubiquitous in the process, we can calculate Delta-v upfront much faster than before to triage casualty workflows more efficiently. There are many areas where this technology will similarly spread.

To reiterate: market-based challenges in this space are considerable and not solvable via conventional means. This creates a prerequisite for more advanced and focused use of technology to meet market needs. What has been accomplished thus far is impressive but should be viewed as the "end of the beginning."

> "
>
> More is needed,
> and more is coming.

PEOPLE: ON THE MOVE — SUMMARY

As our human population, demographics, and day-to-day behaviors continue to grow and change, it's important to remember that evolution doesn't happen overnight, giving businesses time to innovate, adapt, and identify technologies needed to address these transformations.

Understanding how each of these trends may impact customer expectations, demands, and business interactions is critical. Could a customer's status as a remote or on-site worker impact how they feel about potential delays in bringing their vehicle in for repair? As an employer, are there tasks that could be better automated to focus employees' time on work that drives better customer experience? How might technology be used to encourage better driving behaviors?

In the next two parts of Crash Course 2023, we'll explore more trends that challenge our industry's performance, and how we can continue to deliver on experiences.

Changes to how, when, where and what we drive have driven up auto claim complexity. But the need to provide high-touch personalized customer service during a claim is more important than ever. Tools like AI and digitization must enhance the experience, not simply take the place of an empathetic, knowledgeable person.

KEY **TAKEAWAY**

Digital transformation for the P&C insurance economy is dependent on how the industry addresses challenges like labor shortages, vehicle complexity, and consumer demand.

AI technology can help automate repetitive, low-skill tasks, guide repair technicians, and provide seamless policyholder experiences.

CRASH COURSE 2023

PERFORMANCE: INDUSTRY IMPACT

This section examines the impact of changes in population, demographics, consumer behaviors, and new technologies on the P&C insurance and collision repair industries.

ignite EXPERIENCE

PERFORMANCE: AUTO PHYSICAL DAMAGE

SUSANNA GOTSCH

SENIOR DIRECTOR, INDUSTRY ANALYST, CCC

Over the last three years, we have seen significant changes to how people work, live, drive, and experience the world. Some of these changes were in place before the pandemic, while others developed in response to it.

THE POST-PANDEMIC WORLD TAKES SHAPE

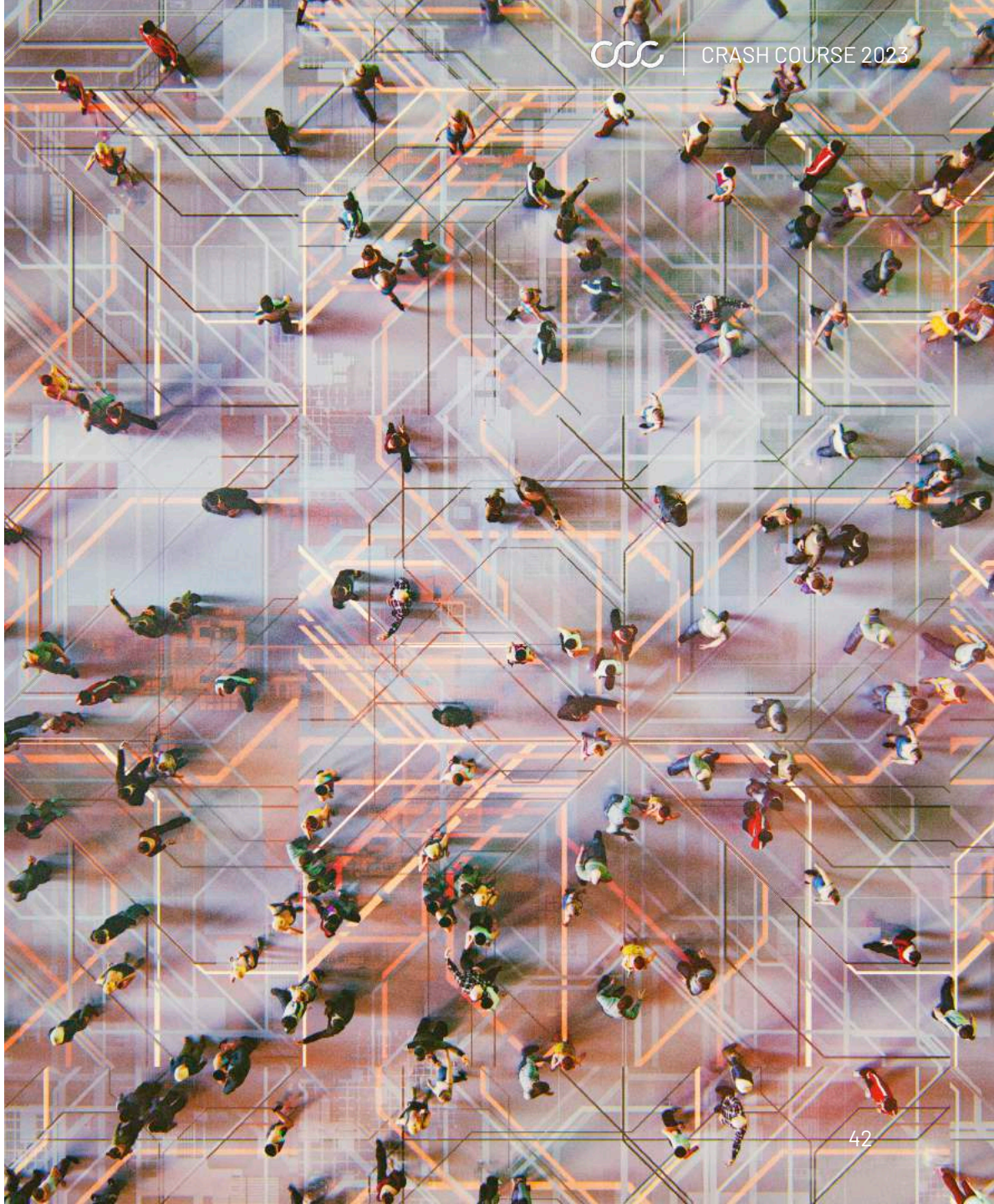
The pandemic sharply accelerated changes in digitization and AI, for example, but also reduced traffic congestion that led to riskier driving, thus reversing gains in motor vehicle fatalities.

In 2023, factors like tight labor markets and increases in road congestion and driver distraction suggest the following trends:

01 Automotive accident and claim counts will continue to climb to pre-pandemic levels.

02 More speeding and more distracted driving mean that accident severity will remain elevated from pre-pandemic levels.

03 Technology like AI can help automate highly repetitive, low-skill tasks, and free up time for people to spend on more important tasks.



PERFORMANCE: INDUSTRY IMPACT – AUTO PHYSICAL DAMAGE

THE NEW NORMAL?

When it comes to cars on the road, post-pandemic drivers are driving faster and more distracted than ever. The result is accidents with greater severity.

CAPACITY CHALLENGES

Longer cycle times to produce estimates and repair vehicles, higher labor costs, increased focus on enabling digital/AI to maximize employee efficiency and customer engagement — these are just some of the challenges impeding the industry's ambition to advance.

MORE VEHICLE COMPLEXITY

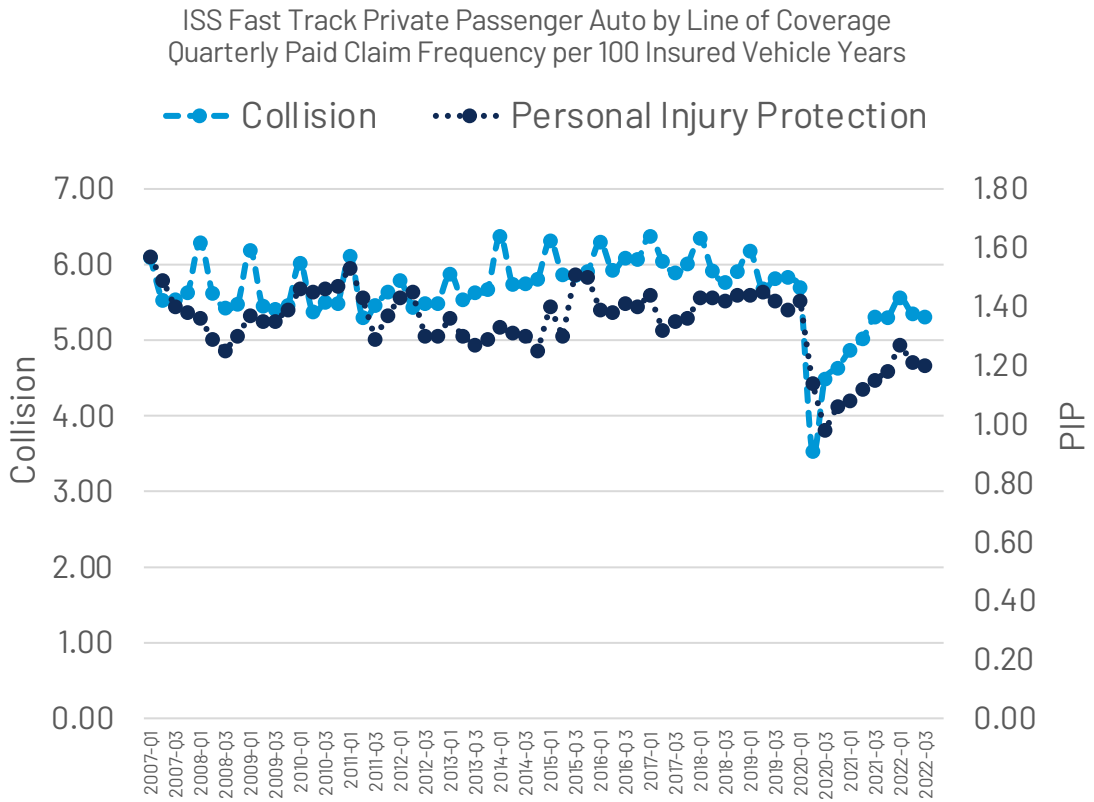
Vehicles today come equipped with more technology and that means more complexity for everyone involved in resolving an accident claim — from the carrier to the repair facility and more.

CLAIM AND ACCIDENT COUNTS CONTINUED RECOVERY IN 2022

Auto claim frequency continues to rebound from significant declines during 2020. Recovery is being led within the 1st party collision and PIP coverages that saw claim frequency per 100 insured vehicle ramp up faster since Q2 2022, before slowing in the most recent quarters.(62)

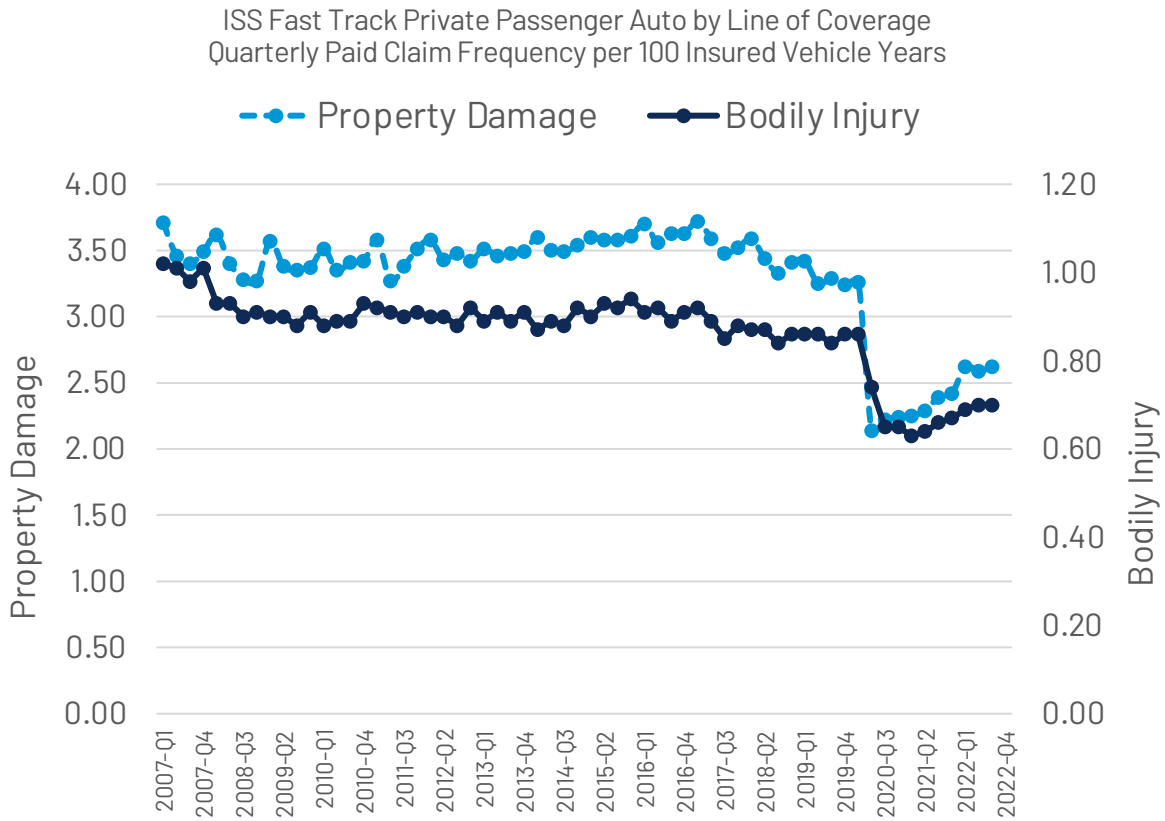
Collision and Personal Injury Protection (PIP)

SOURCE: ISS FAST TRACK



Property Damage Liability – Bodily Injury (BI)

SOURCE: ISS FAST TRACK



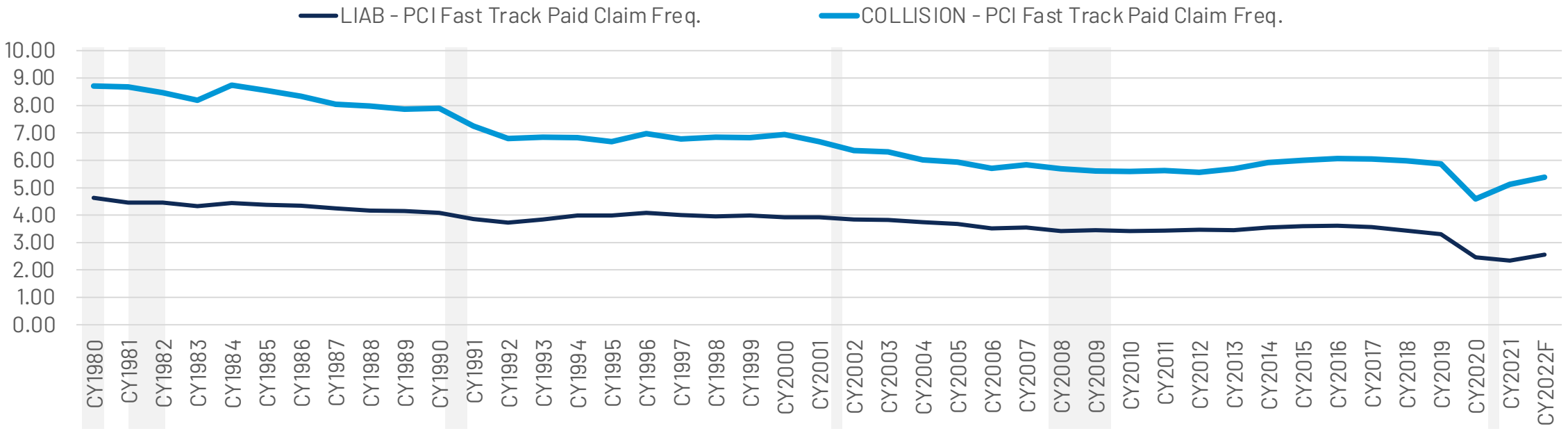
UNEMPLOYMENT NUMBERS ARE LOWER THAN IN PRIOR RECESSIONS

The potential for a recession in 2023 does not necessarily mean a reversal in auto claim frequency, as U.S. unemployment numbers were substantially higher during previous recessions.

Slow population growth and low labor force participation rates suggest that even with a recession, unemployment rates in 2023 will remain below historic levels.This means congestion related to commuting will see little relief, helping to keep auto claim frequency stable.

Private Passenger Auto Claim Frequency During Recessionary Periods (Claims Per 100 Insured Vehicles)

SOURCE: ISS FAST TRACK

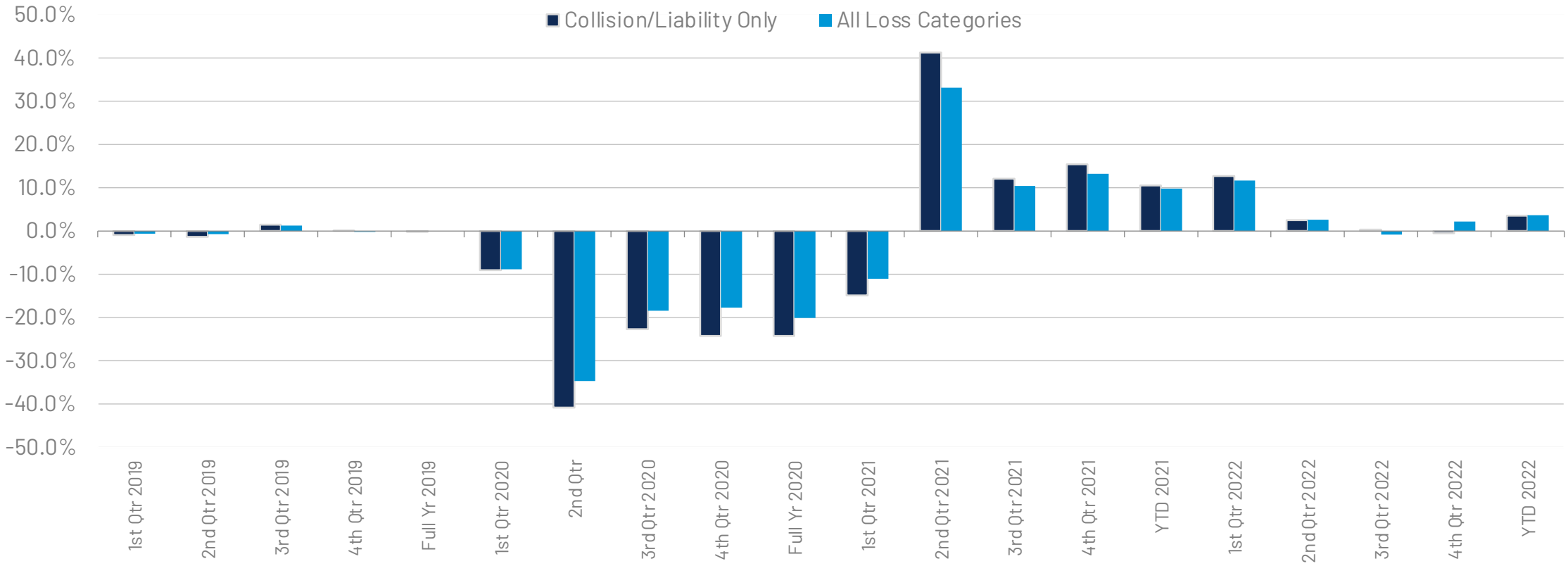


Note: Shaded areas indicate U.S. recessions. Source: FastTrack and SwissRe

A SLOW BUT STEADY RETURN IN CLAIM COUNTS

According to CCC data, claim counts have continued to climb. Industry-wide, claim counts increased 3.7% in 2022 versus 2021, while overall non-comprehensive claim counts increased 3.6%. Compared to 2019, overall claim counts were still down -7.6% in 2022, while overall non-comprehensive claim remained down -11.4%.

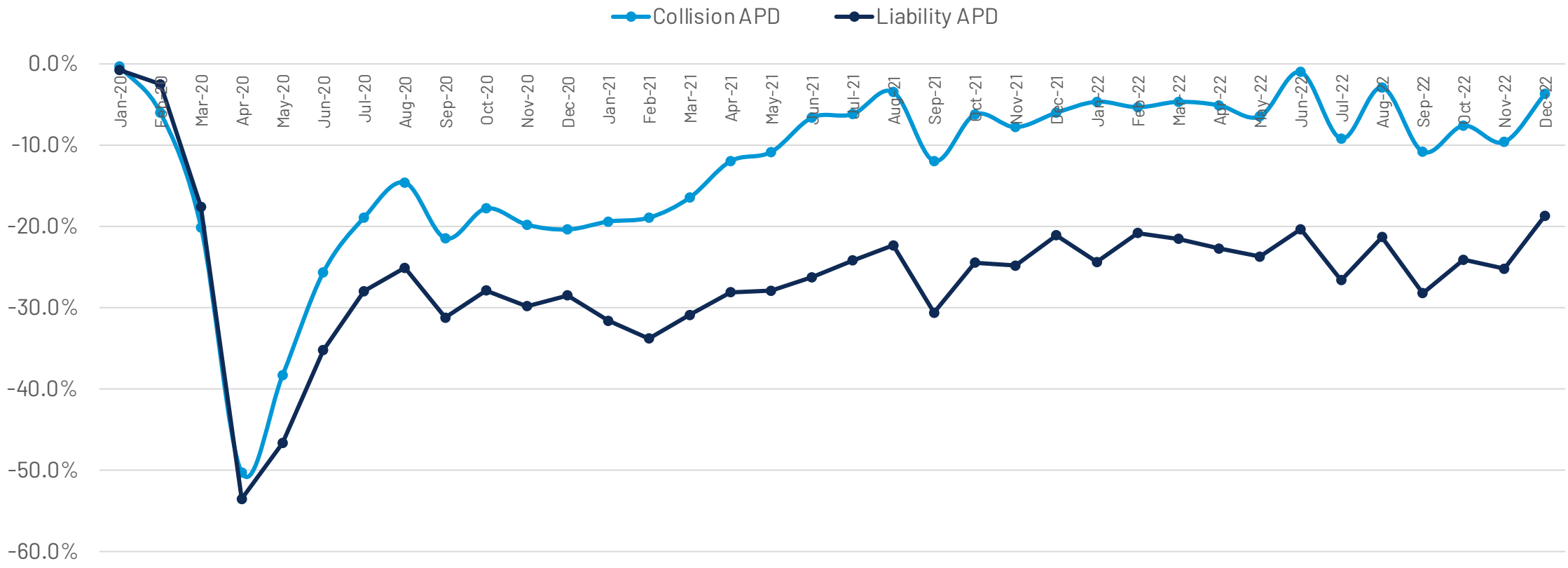
Overall CCC National Industry Claim Counts Change From Same Period Prior Year (Includes Repairable Appraisals & Total Loss Valuations)



LIABILITY CLAIMS ARE SLOWER THAN COLLISION TO RECOVER

CCC's national industry claims data shows that liability claim counts are recovering slower than claim counts for losses with collision loss coverage when compared to 2019's pre-pandemic numbers.

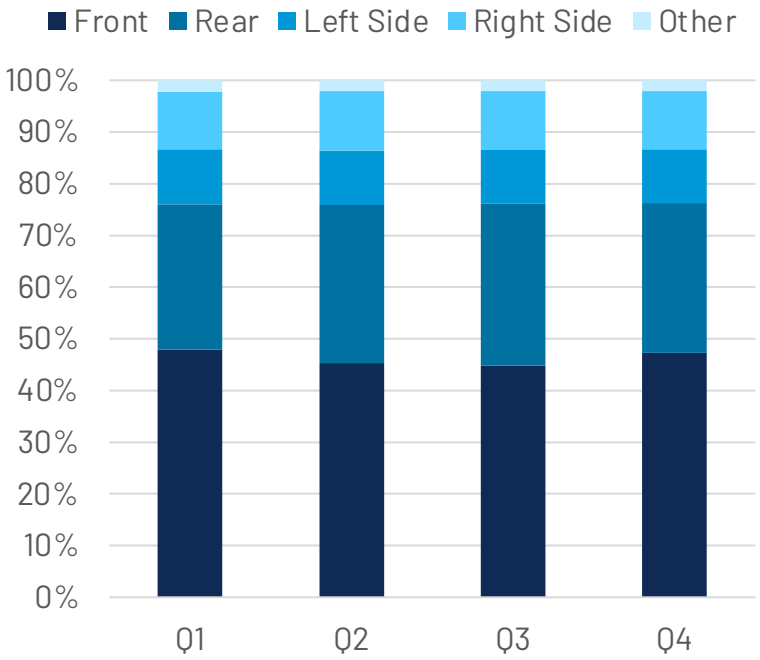
CCC National Industry Percent Change in Overall Appraisal Count from Same Month 2019 (Pre-Pandemic)



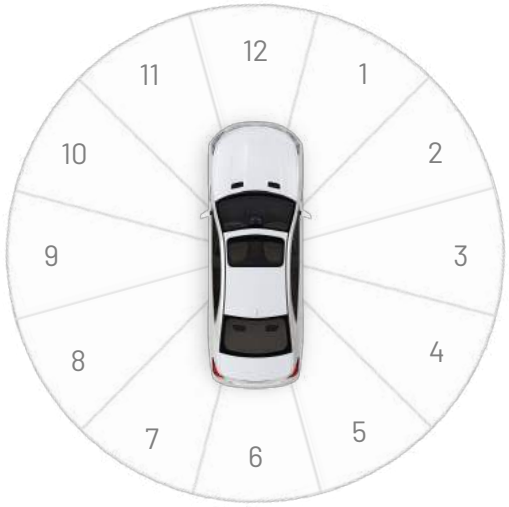
SLOWER RECOVERY IN LIABILITY LOSSES UNDERSCORES HOW TRAFFIC PATTERNS AND CONGESTION LEVELS MAY HAVE CHANGED, PERMANENTLY

Analysis of historical claims volume share by primary impact and loss category reveals that the majority of collision losses are front impacts, while the majority of liability losses are rear-impacts.

Collision Losses — CCC National Industry CY2016-CY2019 Combined Share of Volume per Primary Impact



Primary Impact Point

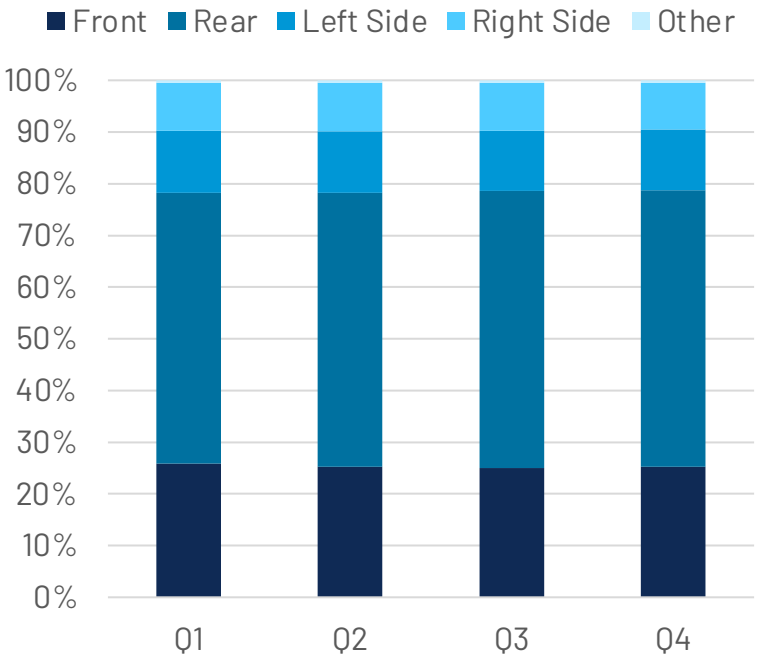


Front 11, 12, 1 **Left Side** 8, 9, 10

Right Side 2, 3, 4

All Other: All Over, Front & Rear, Hail, Hood, Deck Lid, Left & Right Side, Rollover, Roof, Undercarriage

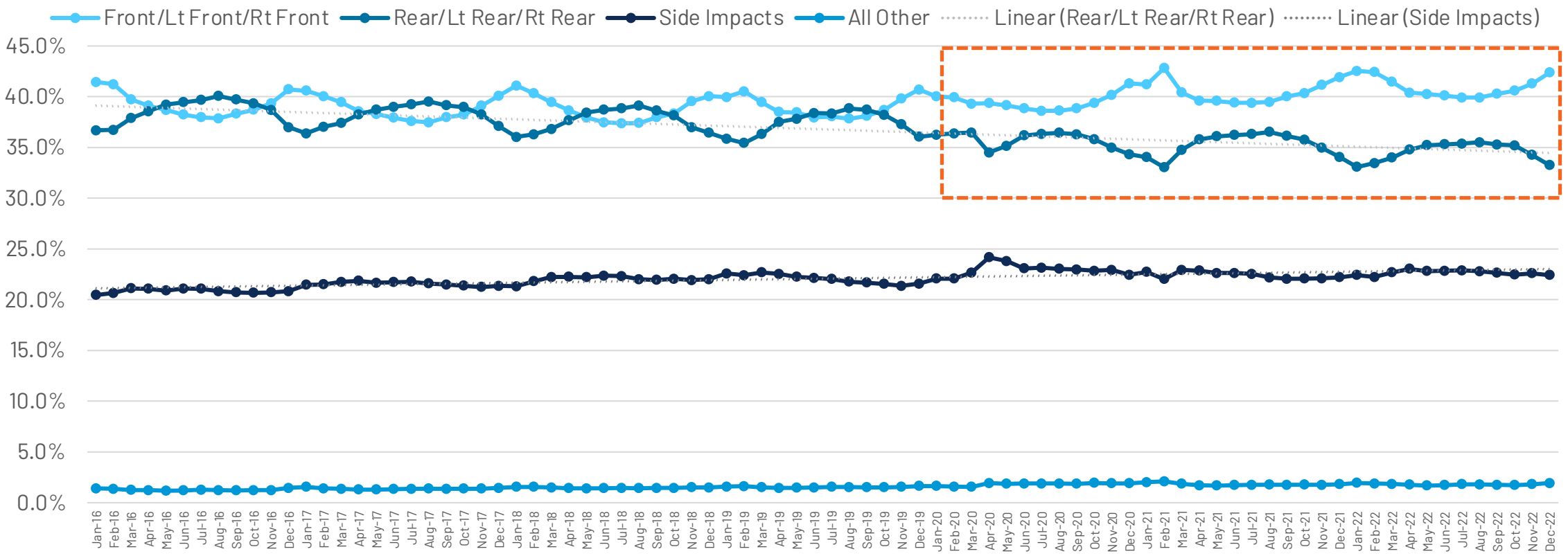
Liability Losses — CCC National Industry CY2016-CY2019 Combined Share of Volume per Primary Impact



FRONT IMPACTS' SHARE OF CLAIM VOLUME CHANGED IN 2020

Front impacts' share of volume was historically higher in the winter months, while rear impacts' share rose in the summer months, underscoring the impact of weather and seasonal driving trends. This pattern diverged in the beginning of April 2020, with front impacts' share of volume remaining higher across all months.

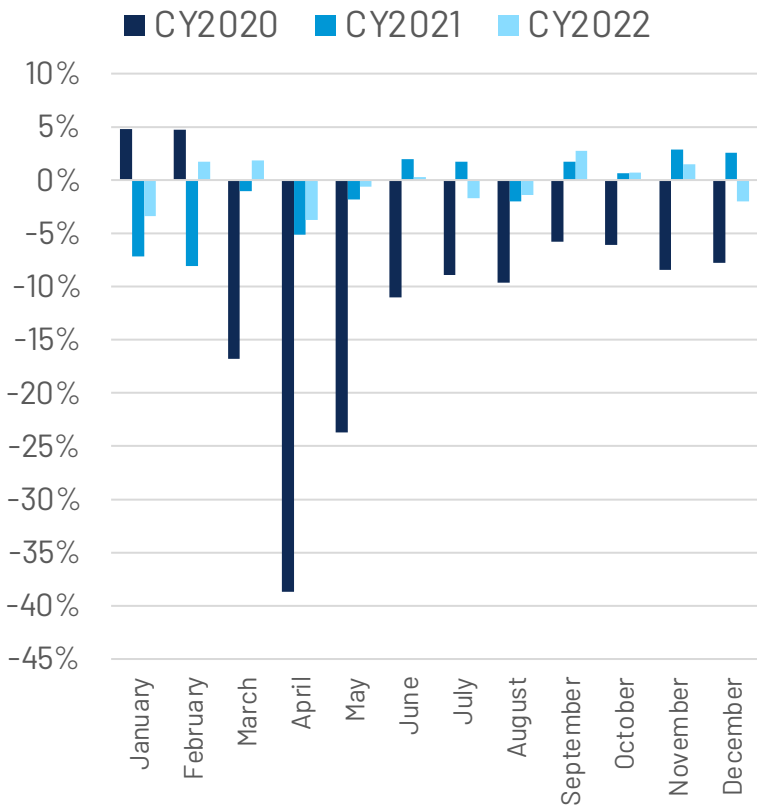
Primary Impact Share of Overall CCC National Industry Appraisal Volume for Collision and Liability Losses by Year & Quarter



CHANGES IN POPULATION GROWTH, HYBRID WORK, AND ECONOMIC RECOVERY MEAN MILES DRIVEN RECOVERY VARIES BY GEOGRAPHY

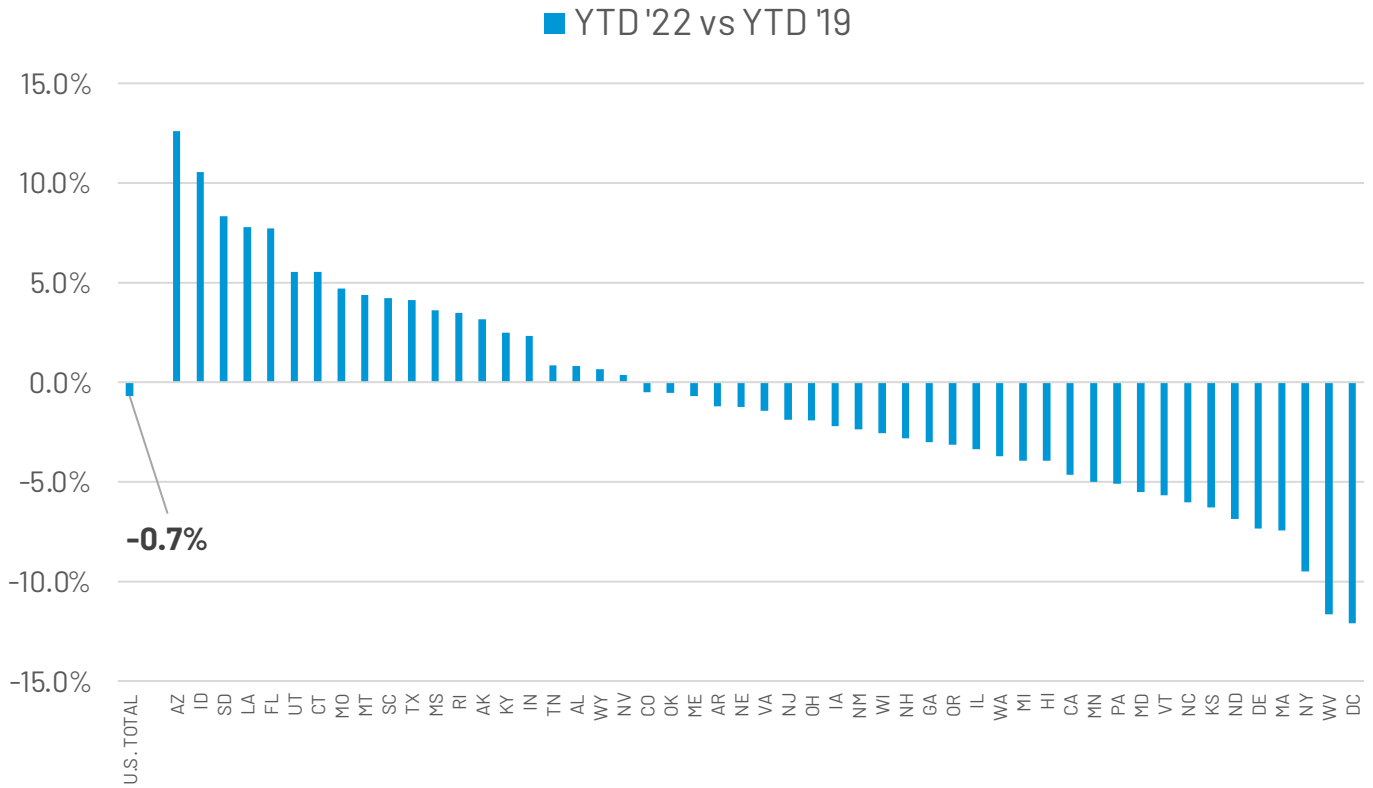
Vehicle Miles of Travel (In Millions of Vehicle Miles) – Percent Difference Versus Same Month in CY2019

SOURCE: U.S. DOT OHPI



Percent Change in Miles Driven by State Versus Prior Period (YTD Through December)

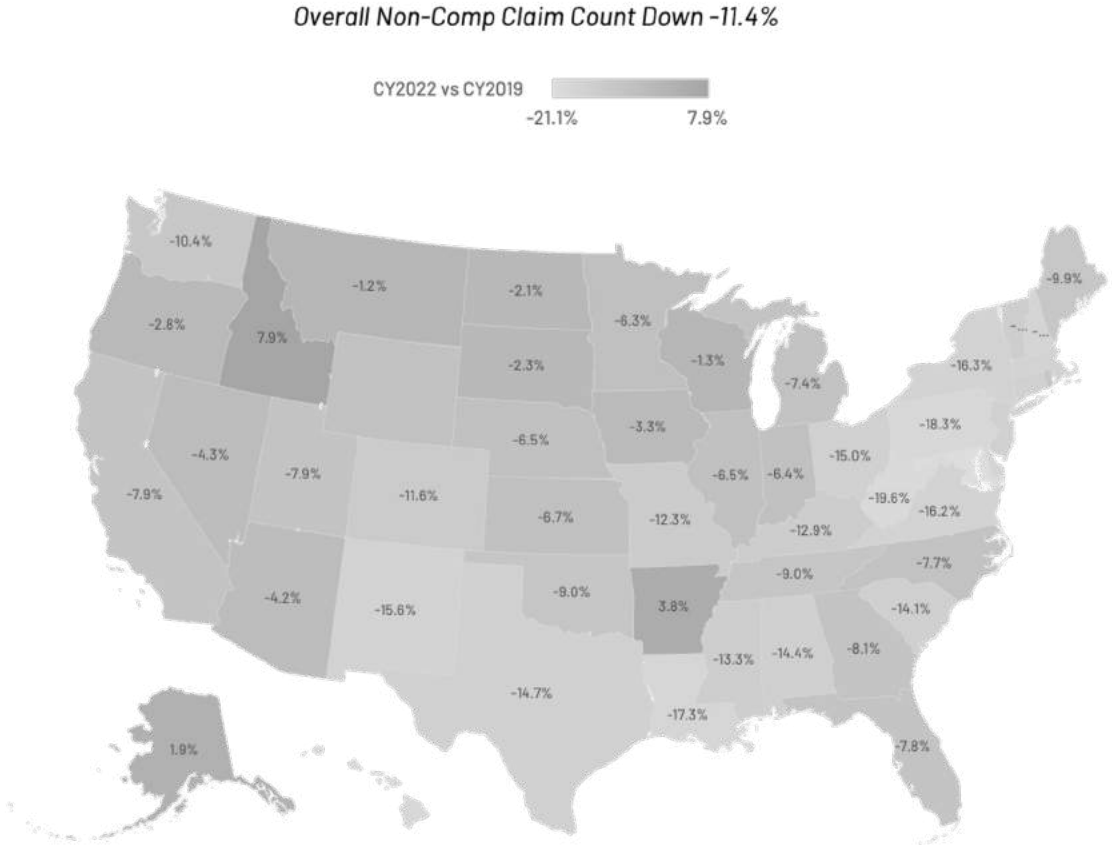
SOURCE: U.S. DOT OHPI



CLAIM COUNT RECOVERY CONTINUES TO VARY BY GEOGRAPHY

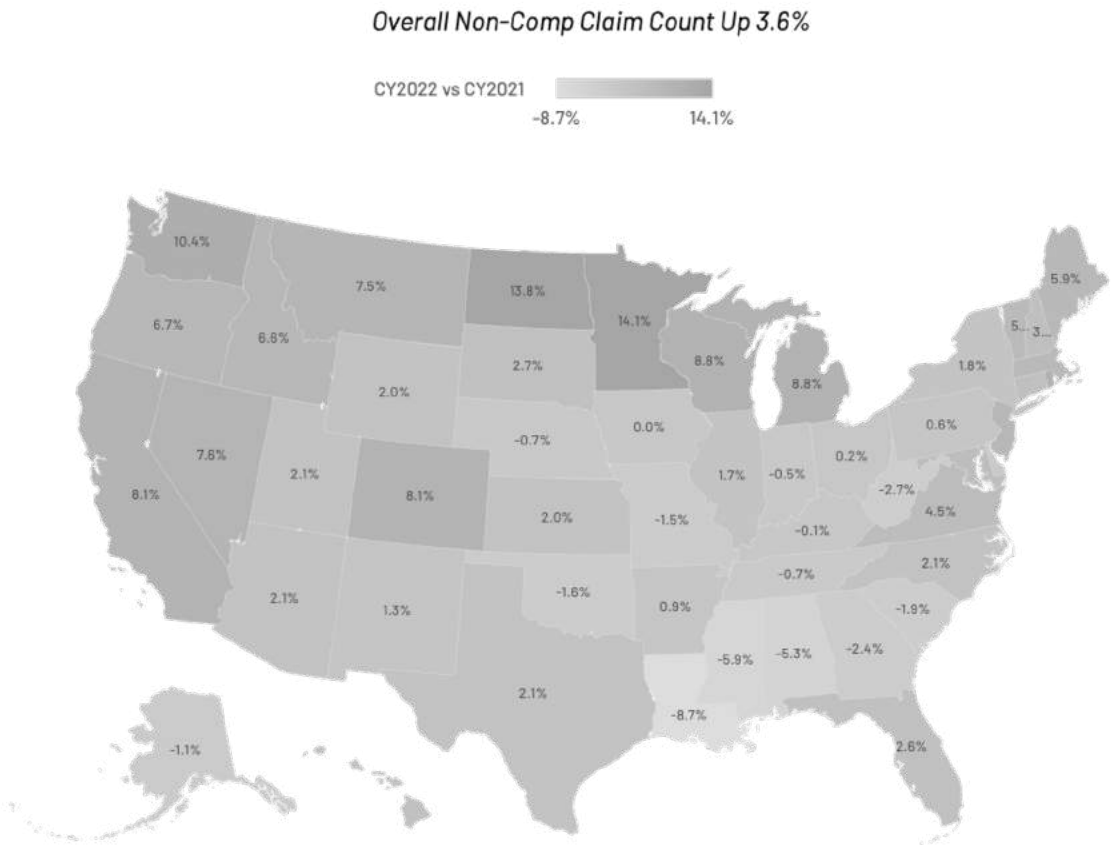
CY2022 Versus CY2019

SOURCE: CCC NATIONAL INDUSTRY CLAIM COUNTS



CY2022 Versus CY2021

SOURCE: CCC NATIONAL INDUSTRY CLAIM COUNTS



LOWER GAS PRICES AND OVERALL GAS CONSUMPTION FALLS WITH RISE IN REMOTE WORK AND GREATER FUEL EFFICIENCY

The average U.S. retail price for regular-grade gasoline (i.e., the price that consumers pay at the pump) averaged $3.96 per gallon (gal) in 2022.(63)

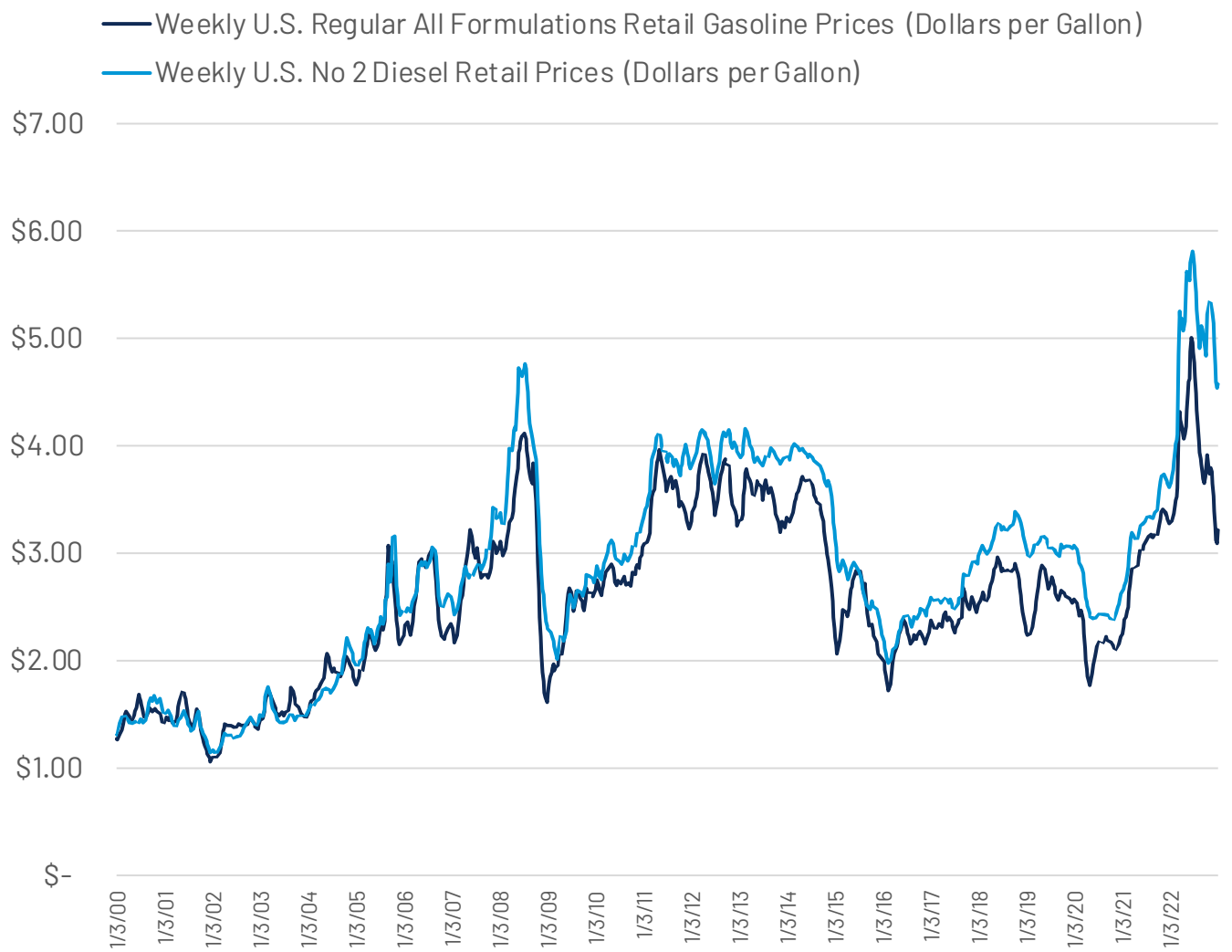
The average U.S. retail gasoline price began 2022 at $3.28/gal. The average price surpassed $4.00/gal on March 7 and peaked at $5.01/gal in June.

The U.S. Energy Information Administration (EIA) forecasts gasoline prices will average $3.32/gal in 2023 and $3.09/gal in 2024, while diesel prices will average $4.23/gal in 2023 then fall to $3.70/gal in 2024.

EIA also anticipates gas consumption will fall in 2023 after rising in 2022 but will remain less than consumption levels in 2019 through the end of 2024, which is primarily due to increased vehicle fleet fuel economy.

Gas and Diesel Prices Have Begun to Fall

SOURCE: U.S. EIA



OFFICE OCCUPANCY LEVELS CONTINUE TO SLOWLY BUILD

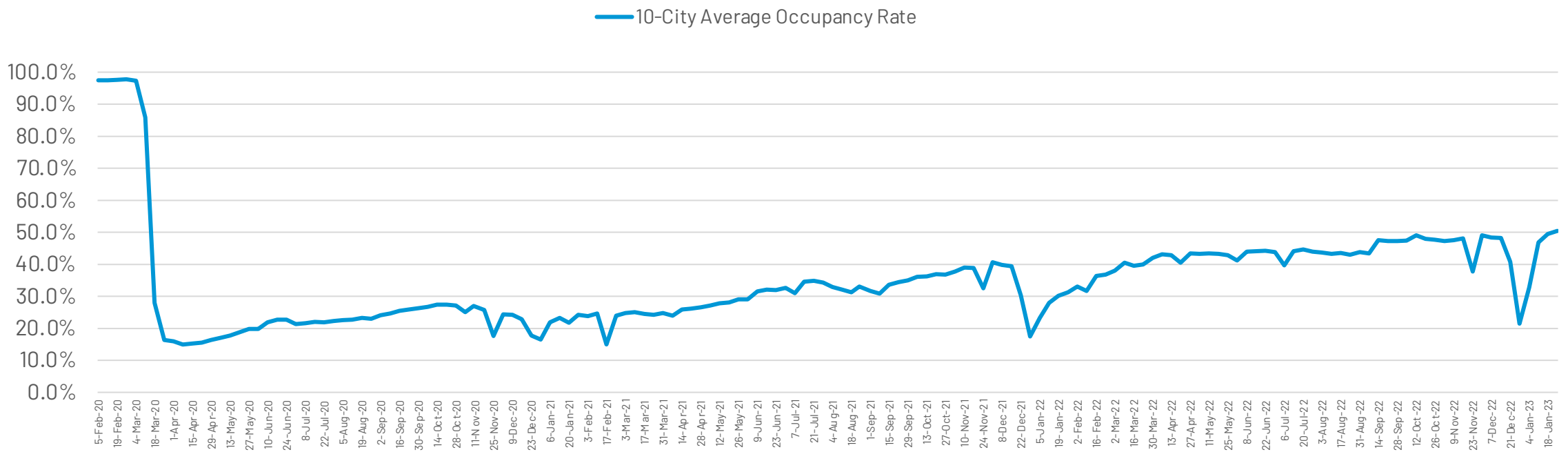
Office occupancy levels are climbing slowly, and stabilization in share of hybrid work suggests traffic congestion levels will also continue to build slowly.

More companies have begun to require employees to return to the office in 2023, but WFH Research and others suggest 55% of full-time workers are working on-site. Among the remaining full-time workers, 15% are fully remote and 30% are in hybrid arrangement.

This suggests that congestion levels, while building, may permanently be different in terms of when they occur and their severity.

Average Office Occupancy by Calendar Week CY 2020 – CY 2023

SOURCE: KASTLE SYSTEMS



CHANGES TO WHEN AND HOW PEOPLE DRIVE HAVE RESULTED IN DIFFERENT TYPES OF VEHICLE CLAIMS

Less congestion and greater driver distraction continue to drive changes in accident and claim characteristics.

How these claim characteristics differ tells us that traffic patterns are potentially permanently changed from pre-pandemic.

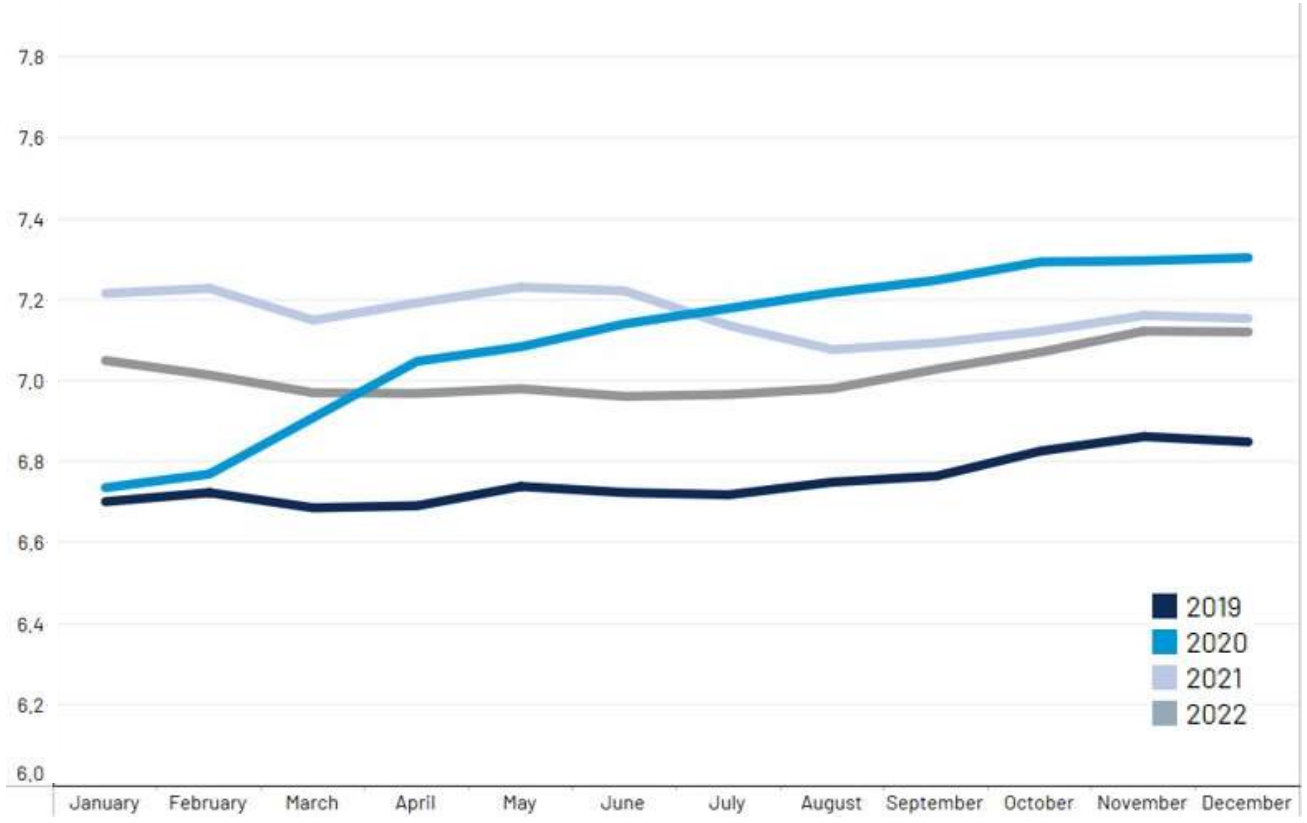
1st party collision losses continue to see claim counts recover faster than 3rd party liability losses.

Among collision and liability losses, front impacts' share of losses remains elevated.

And the average Delta-v (change in velocity between pre-collision and post-collision trajectories of a vehicle) decreased from post-pandemic peaks in 2022 while remaining above 2019 baseline.

Average Delta-v by Claim Create Date | Collision and Liability Claims

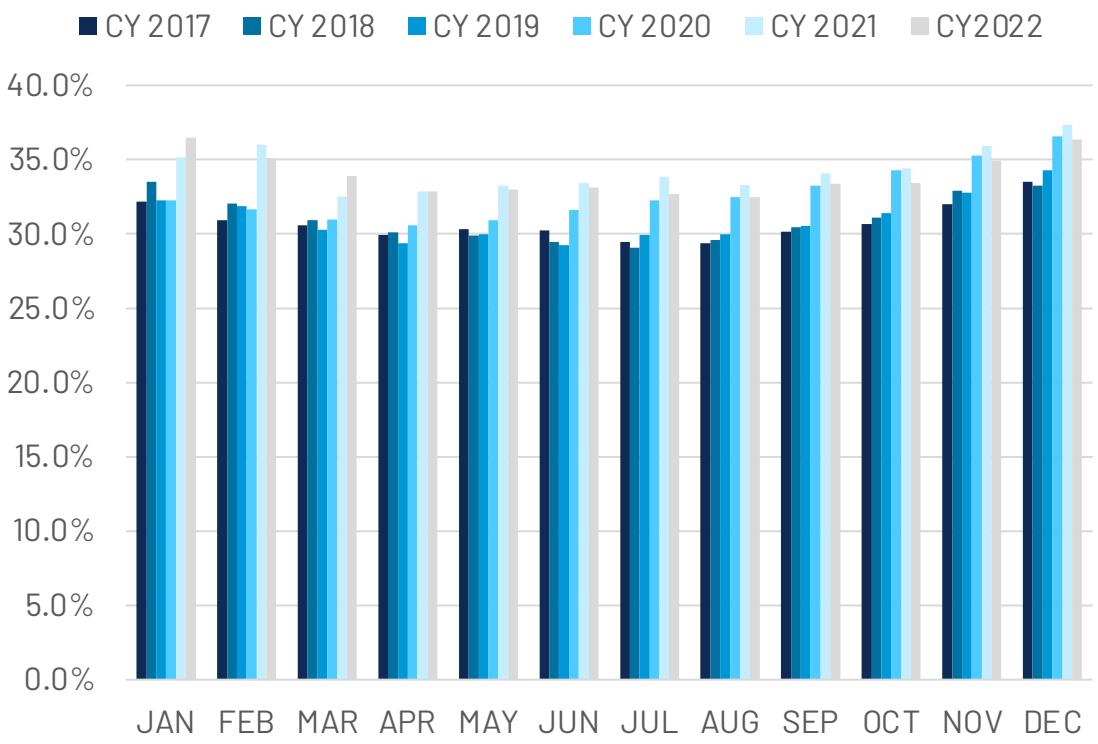
SOURCE: CCC



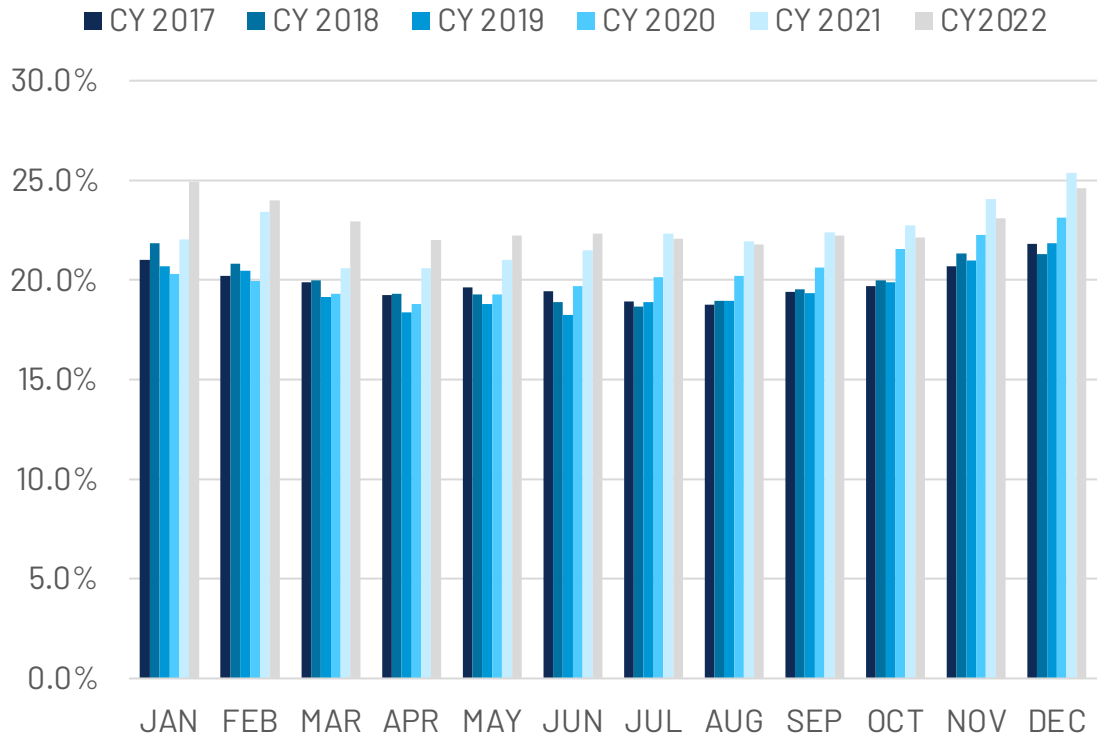
HIGHER NON-DRIVEABLE PERCENTAGE SUGGESTS ACCIDENT SEVERITY IS STILL HIGHER THAN PRE-PANDEMIC

And, as shown in these two charts and in the two on the following page, the non-driveable percentage of losses and the percentage of losses with air bag replacement(s) are still higher than they were in 2019 and 2020.

CCC National Industry Non-Driveable Percent of Claims (Non-Comprehensive Losses – All Vehicle Conditions)



CCC National Industry Non-Driveable Percent of Claims (Non-Comprehensive Losses – Repairable Appraisals)



THE RESULT IS INCREASED LEVELS OF DAMAGE SUSTAINED IN VEHICLE ACCIDENTS FOR BOTH VEHICLES AND PEOPLE

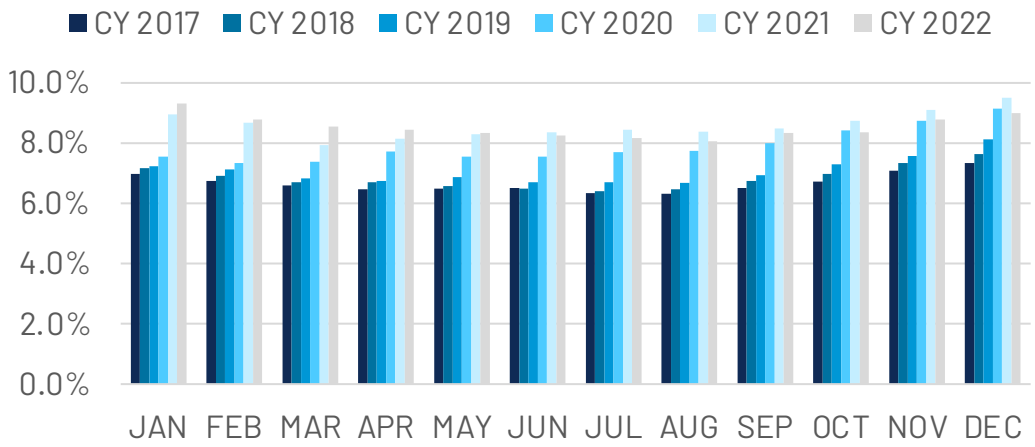
Why do these things matter? The professional disciplines of accident reconstruction and injury causation have clearly established axioms. All other factors being equal, the following are true:

01 Increasing the severity of an impact, in terms of impact force, increases the amount of damage to a vehicle.

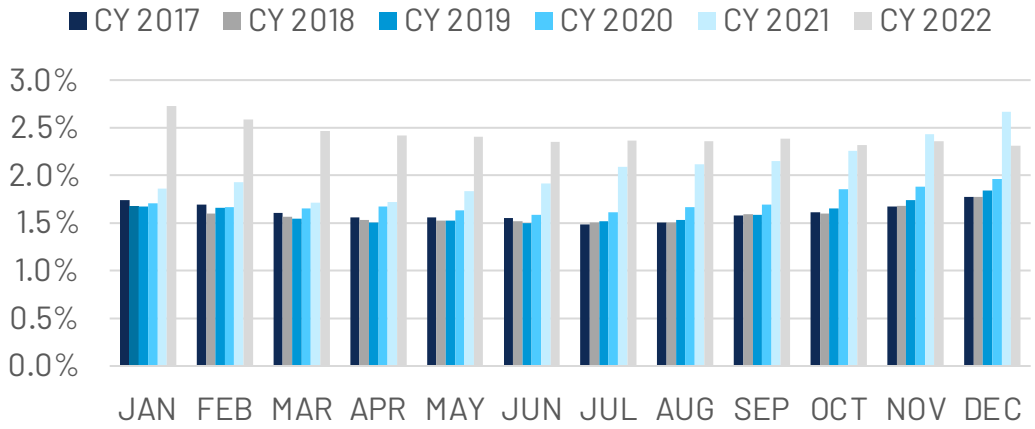
02 Increasing the severity of an impact, also in terms of impact force, increases the risk of injury to the vehicle's occupants.

In the next section of Crash Course, we'll explore the changes that have occurred within the vehicle fleet itself, and the impacts on auto physical damage claims and repairs.

CCC National Industry Percent of Claims with Airbag(s) Deployed (Non-Comprehensive Losses – All Vehicle Conditions)



CCC National Industry Percent of Claims with Airbag(s) Deployed (Non-Comprehensive Losses – Repairable Appraisals)



INDUSTRY IMPACT OF VEHICLE COMPLEXITY IS CONSIDERABLE

Vehicle complexity has increased, and electronic share of overall vehicle content has soared, driving up the number of semiconductor chips used in vehicles substantially. The vehicle itself has essentially become a poster child for accelerated adoption of technology.

Today's vehicles are increasingly ultra-connected, high-tech, and structurally sophisticated. Greater vehicle complexity from lightweight materials and more electronics like sensors and cameras have also ramped up repair complexity and the overall number of vehicle components. The transition from an internal combustion engine (ICE) fleet to a battery-powered electric vehicle (EV) fleet will lead to even more changes in vehicle design, as manufacturers look for ways to incorporate the battery into the vehicle and transition away from mechanical components to electronic.

The results?

- Repairs now include more parts and labor hours and need for operations like scanning and calibration.
- New material types lead to higher cost vehicle parts.
- Parts account for a higher share of overall repair costs, compressing margins for collision repairers.
- Labor is comprised of more replace versus repair and operations require different skill sets at higher costs.
- Detecting all vehicle damage upfront has become more challenging and led to growth in supplements.
- The industry is experiencing longer repair cycle times and increasing repair costs.
- High demand and supply constraints for semiconductor chips have disrupted vehicle production and driven up vehicle prices.

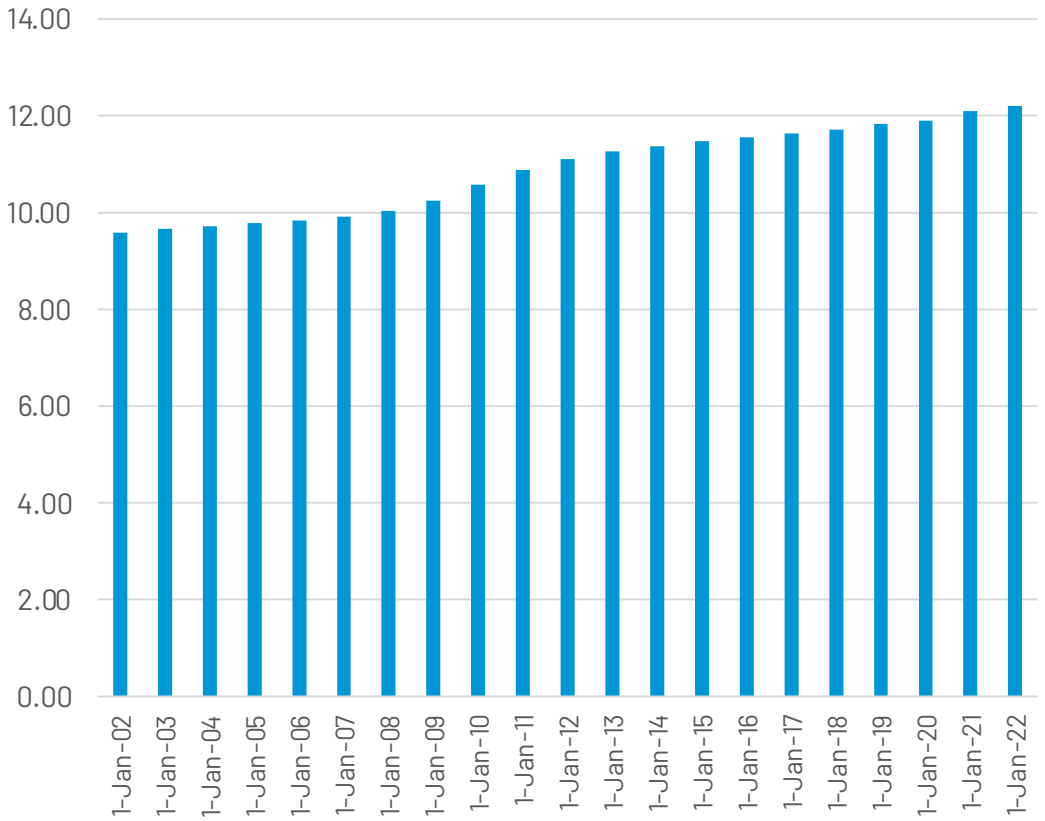
The vehicle itself has come to **embody accelerated adoption of technology**.

U.S. FLEET VEHICLES ARE GROWING MORE COMPLEX

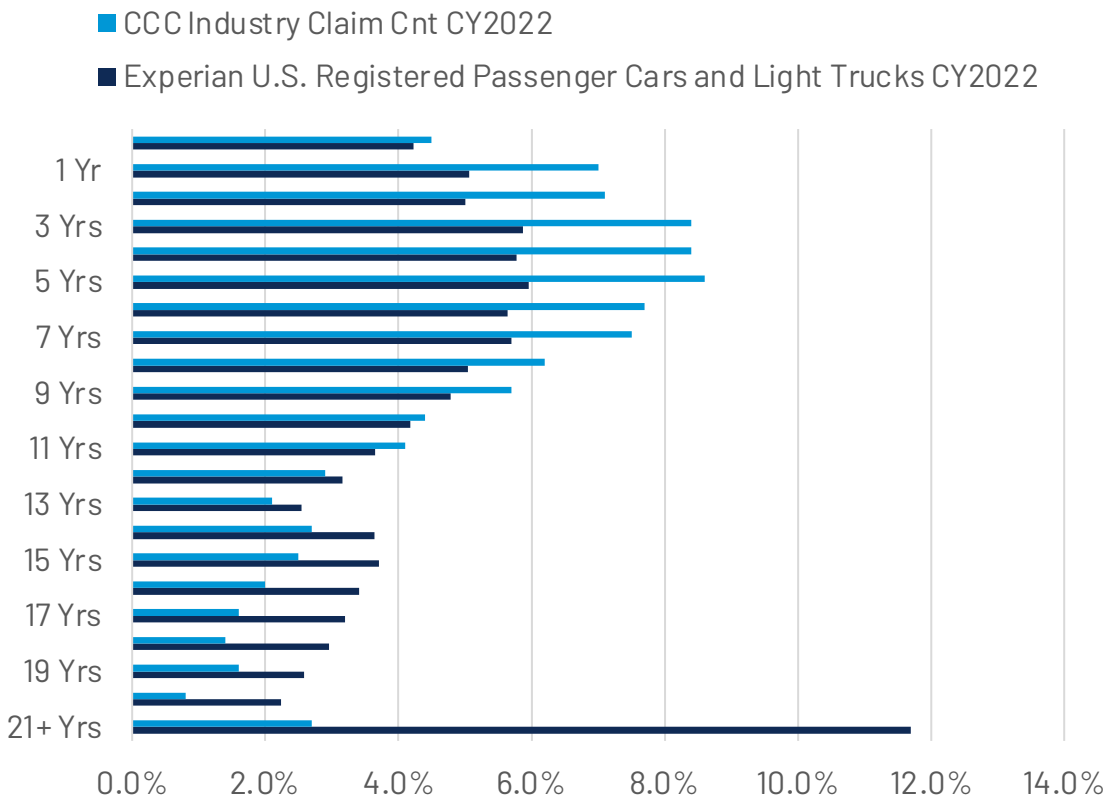
Despite an average vehicle age of 12.2 years, the U.S. vehicle fleet is comprised of more complex vehicles than ever before. And the vehicle claim mix skew towards an even younger vehicle fleet.

Average Age of Vehicles in Operation in the U.S. CY2002-CY2022

SOURCE: IHS AUTOMOTIVE



CY 2022 Share of U.S. Registered Vehicle Counts and CCC Overall Claim Count by Vehicle Age

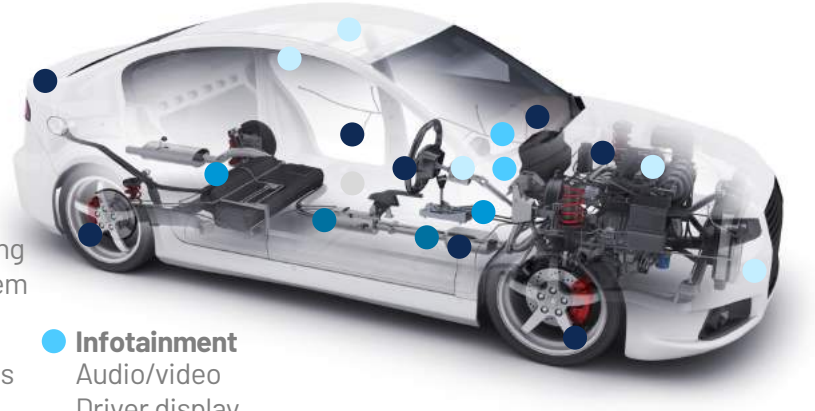


VEHICLES HAVE BECOME SMARTPHONES ON WHEELS

Numerous new vehicle technologies were introduced over the last 10+ years that have translated to greater complexity, more electronic content, and need for more tech like sensors, radar, lidar, cameras, and semiconductor chips.

A Computer on Wheels

The average car is packed with 1,400 semiconductors that control everything from airbags to the engine. Modern cars simply cannot run without chips



Safety
Airbag controls
Collision—avoidance
Parking—assist
Power locks
Braking—assist
Tire pressure monitoring
Traction—control system

Comfort
Window/mirror controls
Seat controls
Climate control

Infotainment
Audio/video
Driver display
Navigation

Powertrain
Engine control
Fuel injection system
Hybrid-electric control
Transmission control

Electrical
Starter
Lighting system
Vehicle diagnostics

Connectivity
CAN (controller area network)
Broadband, WiFi, Bluetooth
Over-the-air software updates

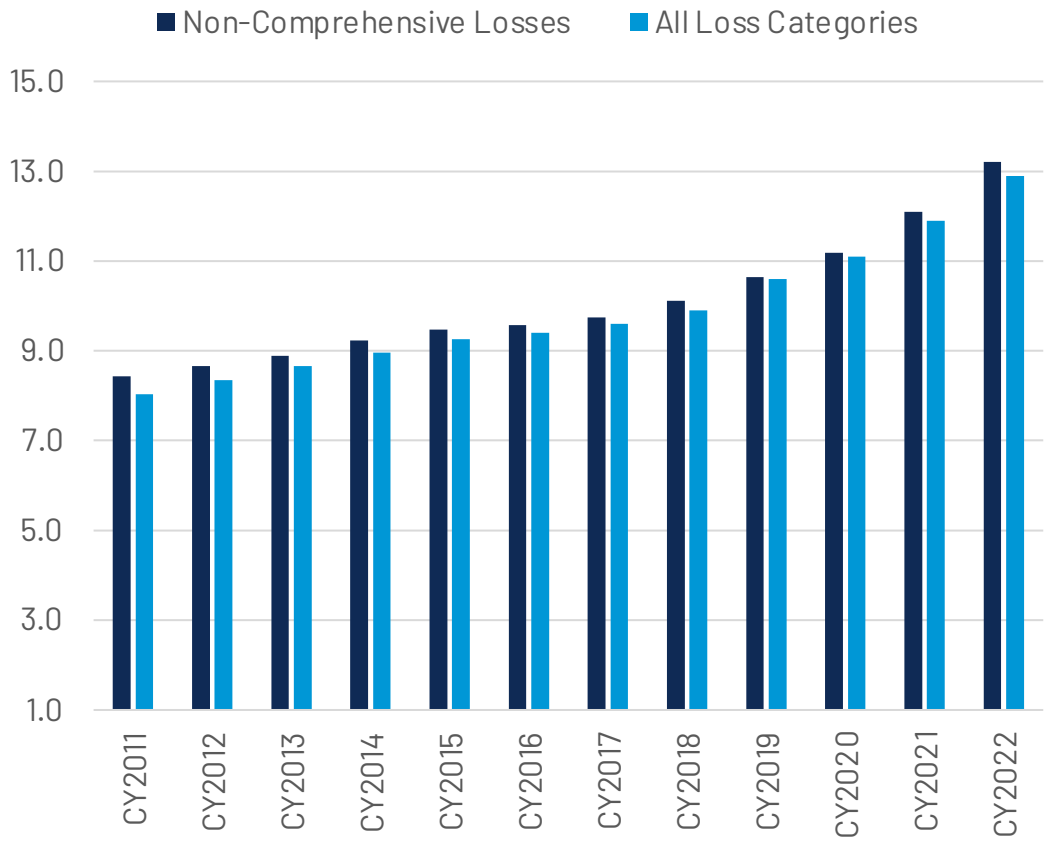
Computers in modern cars monitor **many different systems**

- Night vision
- Windshield wiper control
- Parental controls
- Engine control
- Airbag deployment
- Adaptive front lighting
- Adaptive cruise control
- Automatic braking
- Electric power steering
- Electronic throttle control
- Electronic valve timing
- Idle stop/start
- Cylinder deactivation
- Active vibration control
- OBDII
- Remote keyless entry
- Blindspot detection
- Lane departure warning
- Transmission control
- Seat position control
- Active yaw control
- Parking system
- Antilock braking
- Tire pressure monitoring
- Regenerative braking
- Hill-hold control
- Active suspension
- Active exhaust noise suppression
- Security system
- Navigation system
- Digital turn signals
- Electronic toll collection
- Lane correction
- Battery management
- Entertainment system
- DSRC
- Cabin environment controls
- Voice/data communications
- Active cabin noise suppression
- Interior lighting
- Auto-dimming mirror
- Event data recorder
- Accident recorder
- Driver alertness monitoring
- Head-up display

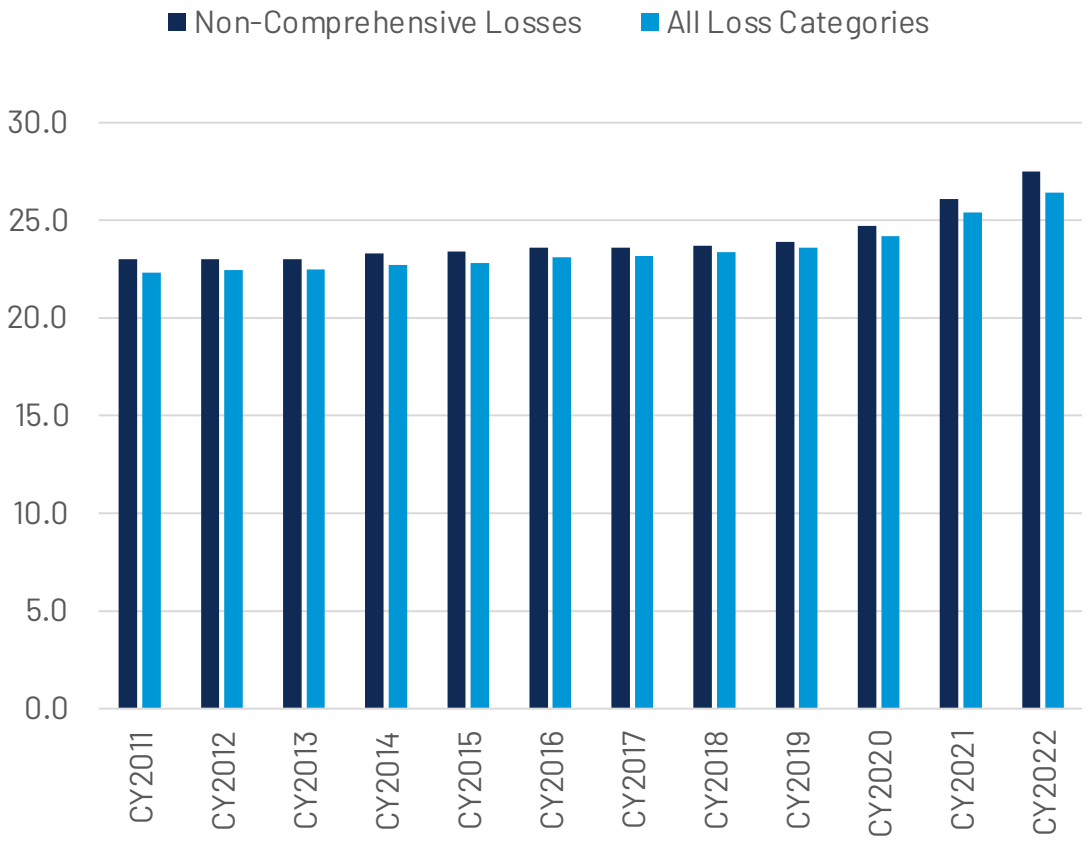
MORE "SMART" VEHICLES MEANS MORE COMPLEX REPAIRS

Not surprisingly, when a "smart" vehicle is in an accident, there are more part replacements and labor hours necessary to repair it than ever before.

CCC National Industry Repairable Appraisals – Average Number of Parts Replaced per Claim



CCC National Industry Repairable Appraisals – Average Number of Labor Hours per Claim

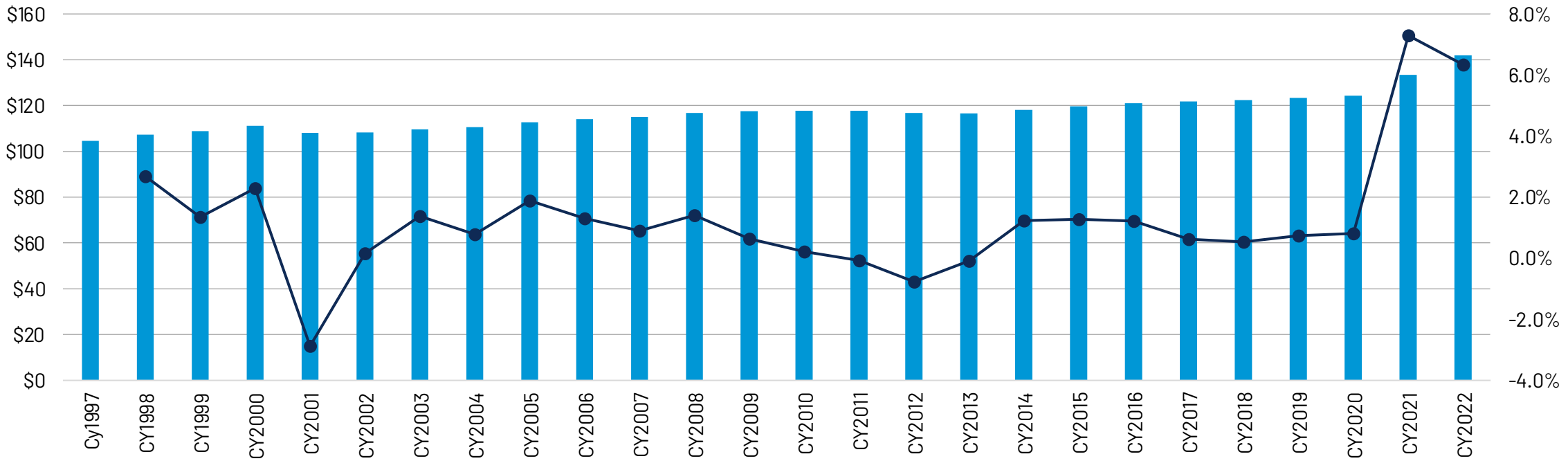


REPLACEMENT PART COSTS HAVE SOARED

As manufacturers continue using new material types to reduce the weight of and strengthen parts, the average cost of parts has grown, accounting for a larger share of the overall repair. And tariffs introduced during the Trump administration drove up prices of components like auto glass even further.

In 2021 and 2022, the average cost of vehicle parts skyrocketed as supply chain issues led to higher costs of material, labor, shipping, and distribution. And while shipping costs have come down some, the desire to improve supply chain resiliency may mean more parts will be sourced from countries where labor costs are higher but less subject to disruption.

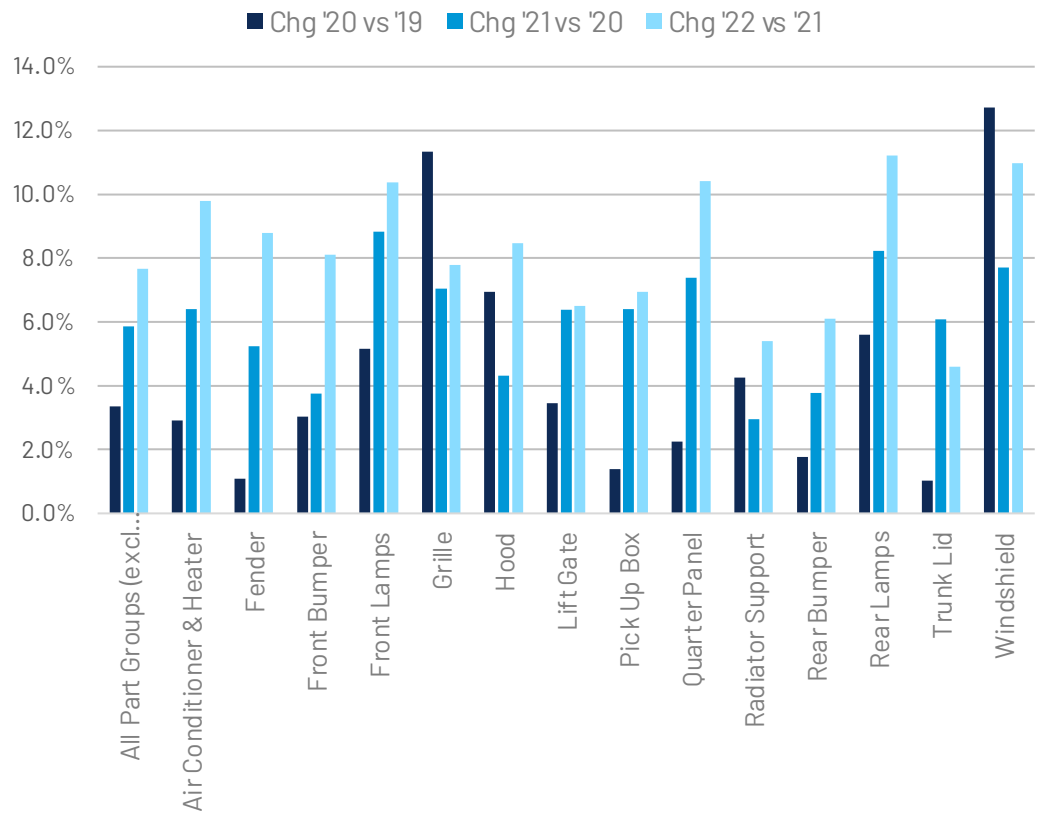
CCC National Industry Repairable Appraisals Average Cost per Part (Includes All Parts Incl Attachments Across All Part Types)



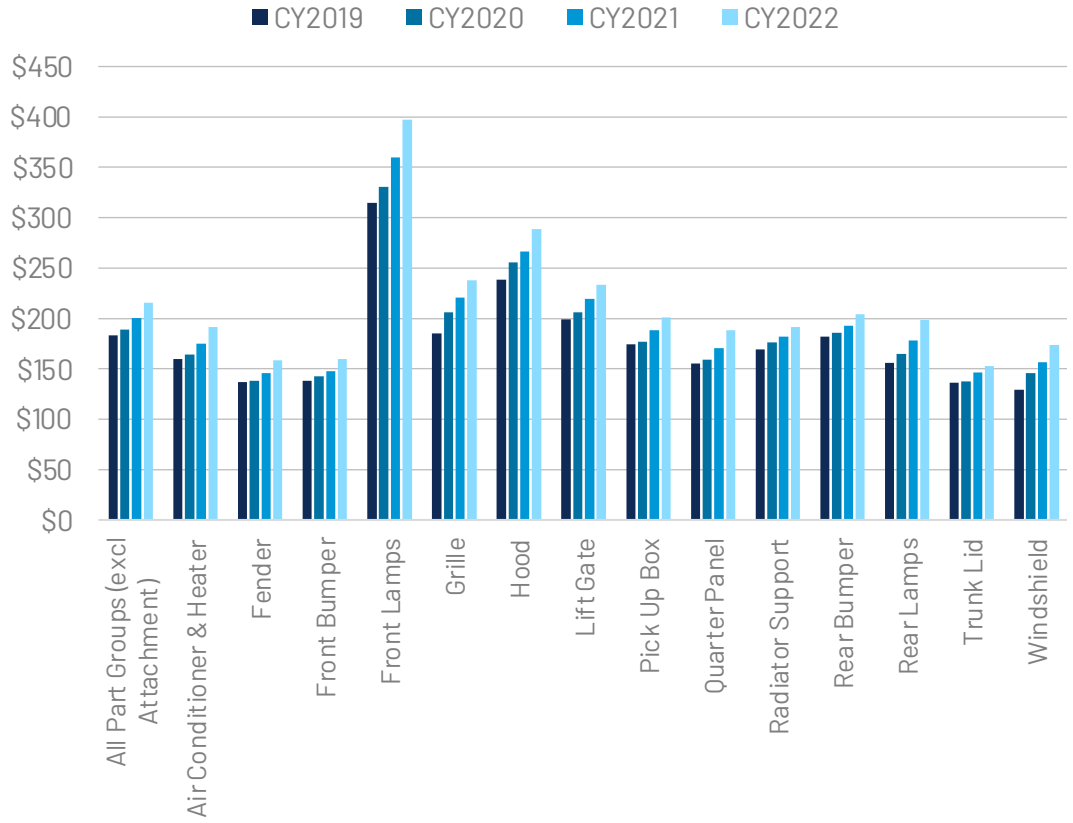
RISING COSTS DUE TO SEVERAL FACTORS

Part costs have increased across all major part groups from a combination of supply chain issues, tariffs, greater use of new material types like aluminum and carbon fiber, and greater complexity like the use of LED versus halogen in lamps.

CCC National Industry Repairable Appraisals c Percent Change in Average Cost Per Part Group Versus Prior Period (Includes All Parts Less Attachments)



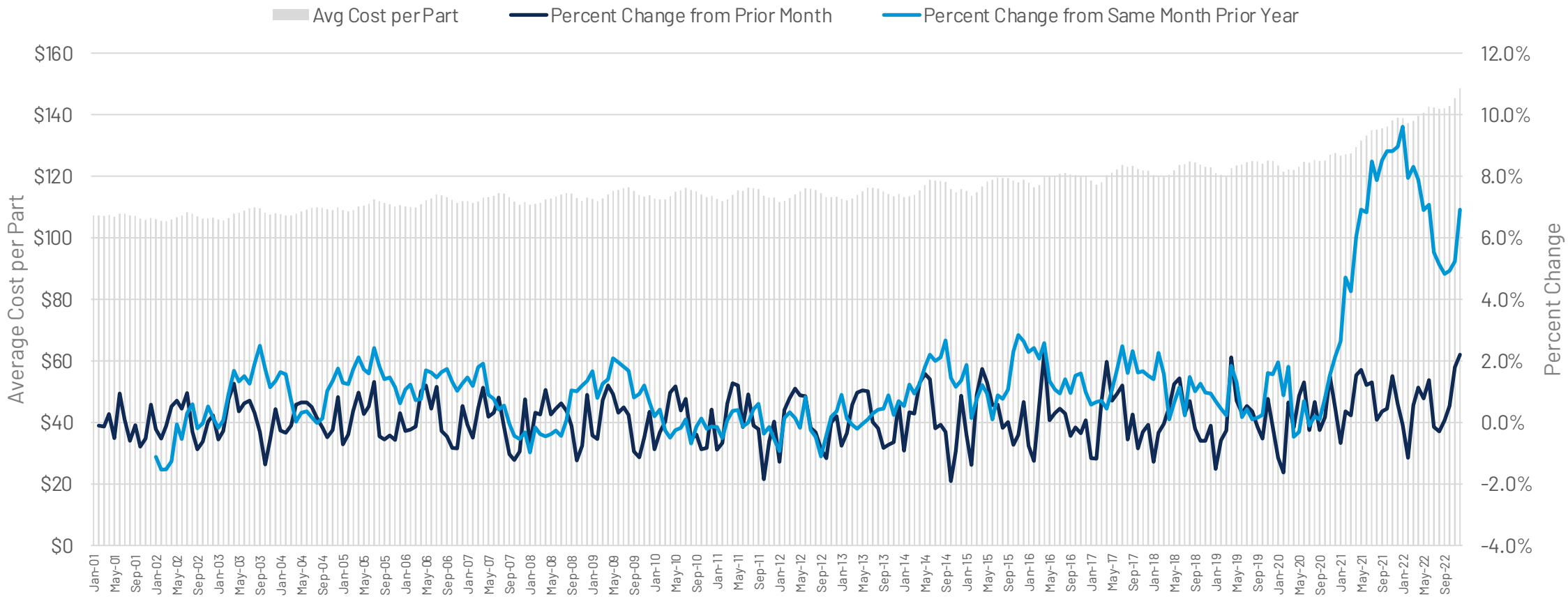
CCC National Industry Repairable Appraisals – Average Cost per Part Group by CY (Includes All Parts Less Attachments)



PARTS COST REACHED 20-YEAR HIGH IN 2022

The average cost per part soared in 2021 and 2022, experiencing larger increases month-over-month and year-over-year than seen in the last 20+ years.

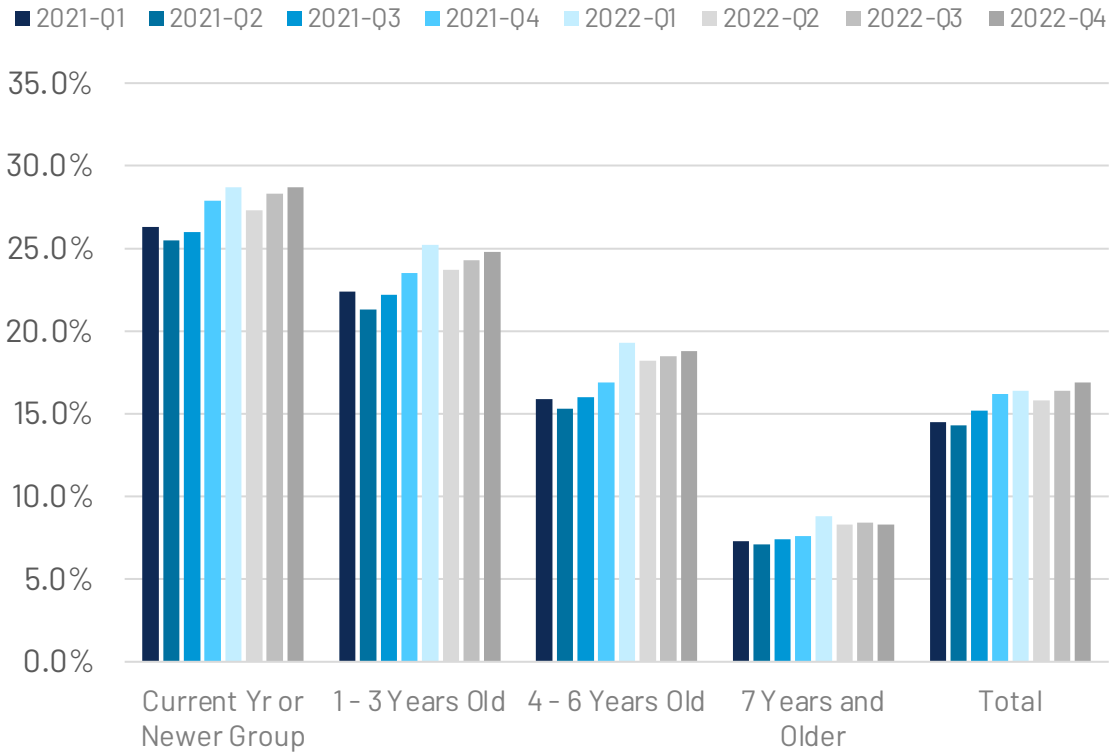
CCC National Industry Average Cost per Replacement Part (All Loss Categories Repairable Vehicle Appraisals)



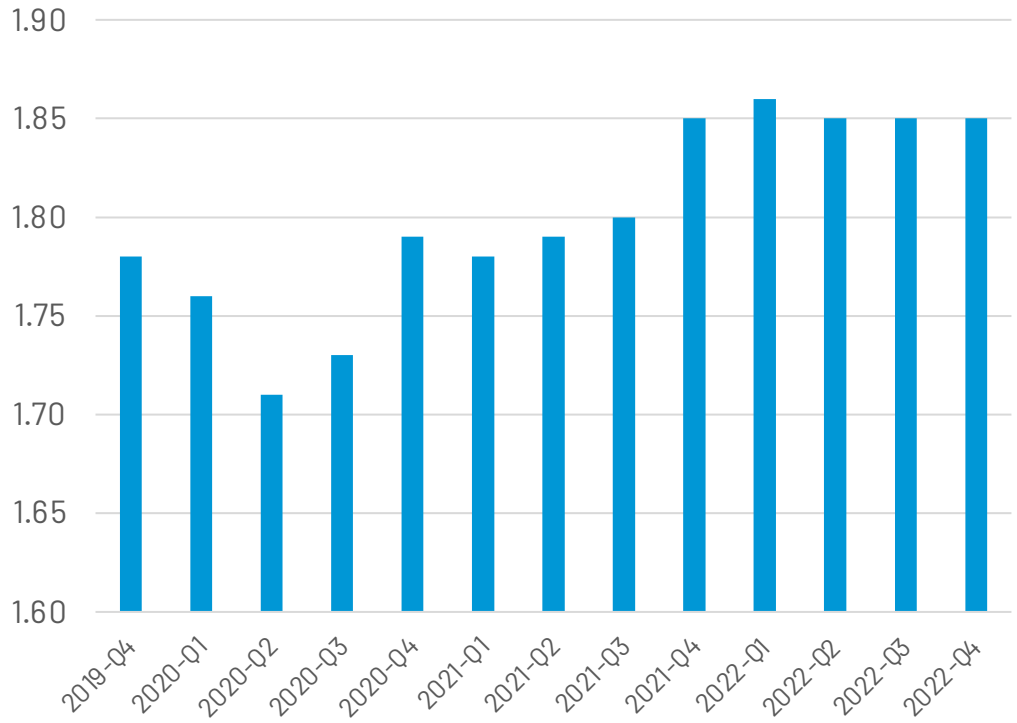
REPAIR OR REPLACEMENT OF ADAS-RELATED PARTS HAS GROWN

With more vehicles including features like backup cameras, rain-sensing windshield wipers, navigation, and ADAS, the share of appraisals that include repair or replacement of cameras or sensors has grown.

CCC National Industry Percent of Repairable Appraisals by Vehicle Age Group Including Repair/Replace/R&I of Camera/Sensor/Radar/ADAS-Related Part



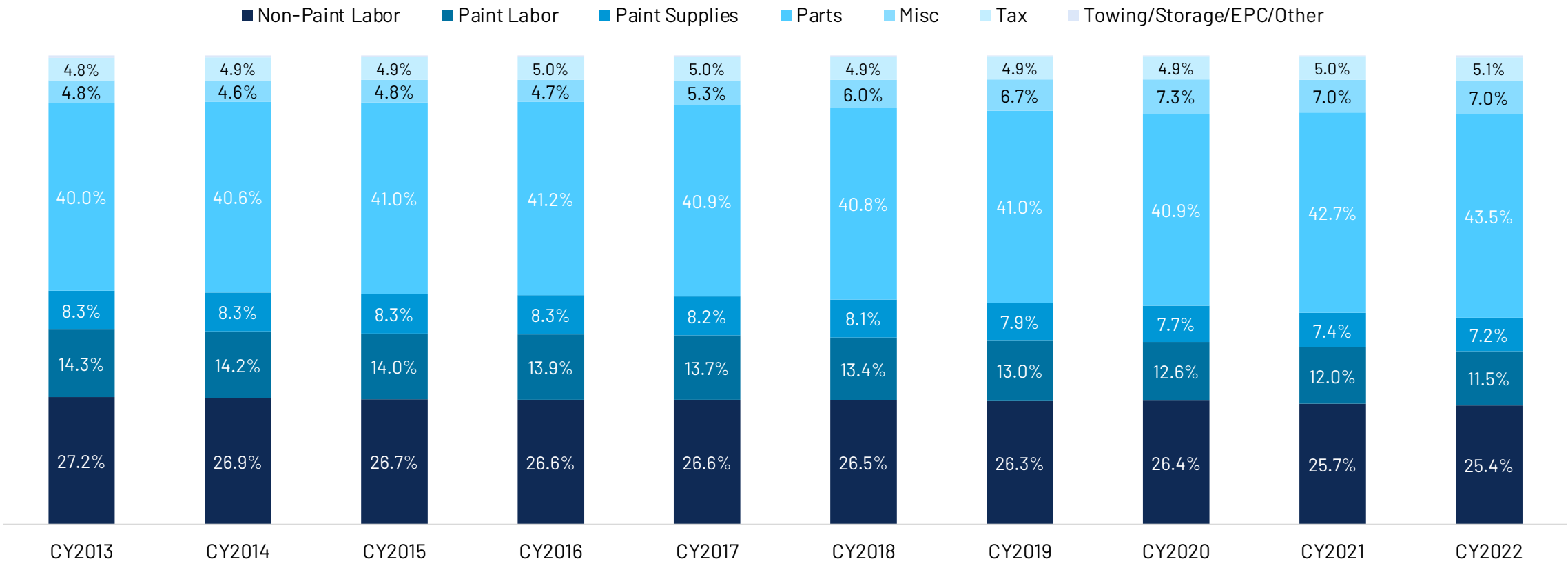
CCC National Industry Average Number of Line Entries for Camera/Sensor/Radar/ADAS-Related Part Included on Repairable Appraisals



PARTS ACCOUNT FOR LARGER SHARE OF OVERALL REPAIR COSTS

As the number of replaced parts has grown, and their average cost has risen, replacement parts have seen their share of overall repair cost grow. For collision repairers, this means less-profitable repair orders, as margins are historically higher on labor than on parts.

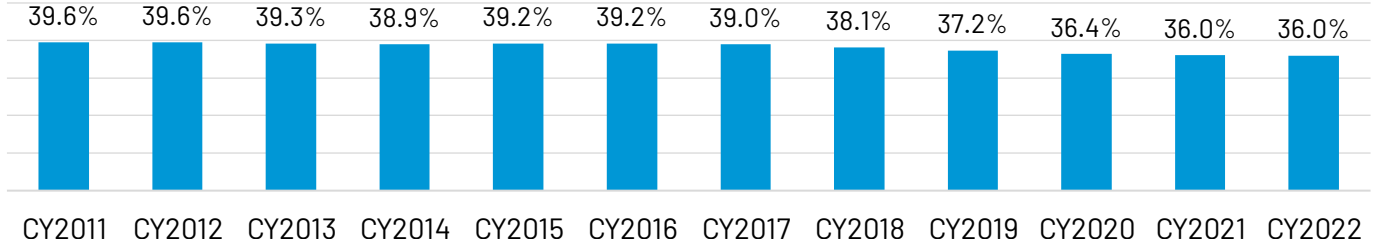
CCC National Industry Non-Comprehensive Repairable Appraisals – Share of Total Repair Cost



COMPLEX VEHICLES ARE CHANGING LABOR NEEDS

The increase in vehicle complexity is creating the need for more labor associated with part replacement, and for more specialized and expensive labor.

CCC National Industry Non-Comprehensive Repairable Appraisals – Repair % of Sheet Metal Labor Amt

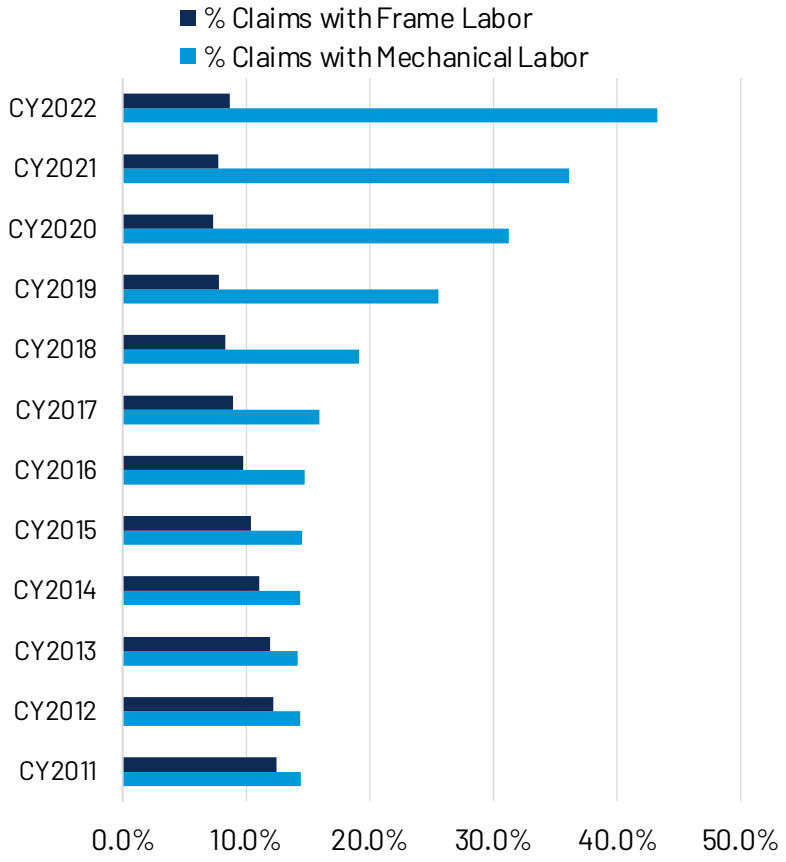


CCC National Industry Average Labor Rates per Labor Category CY2018-CY2022

	Average Hourly Rate (Weighted Average)					% Change From Prior Year				
Calendar Year	Body (Sheet Metal) Labor	Frame Labor	Mechanical Labor	Paint Labor	Paint Materials	Body (Sheet Metal) Labor	Frame Labor	Mechanical Labor	Paint Labor	Paint Materials
CY2018	$50.30	$58.33	$87.35	$49.89	$29.92	2.9%	3.2%	2.8%	2.5%	2.9%
CY2019	$51.44	$59.89	$90.06	$50.93	$30.78	2.3%	2.7%	3.1%	2.1%	2.9%
CY2020	$52.32	$61.37	$92.57	$51.65	$31.55	1.7%	2.5%	2.8%	1.4%	2.5%
CY2021	$52.92	$62.82	$95.48	$52.48	$32.10	1.2%	2.4%	3.1%	1.6%	1.7%
CY2022	$56.00	$67.87	$105.55	$55.57	$34.63	5.8%	8.0%	10.5%	5.9%	7.9%

Note: Labor rates as reported are an aggregation of industry data collected from customers that use CCC ONE® Estimating collision estimating software and/or communicate electronic appraisals via CCC's CCC ONE® Workflow network, where data has been aggregated by the geographic areas as defined within the report.

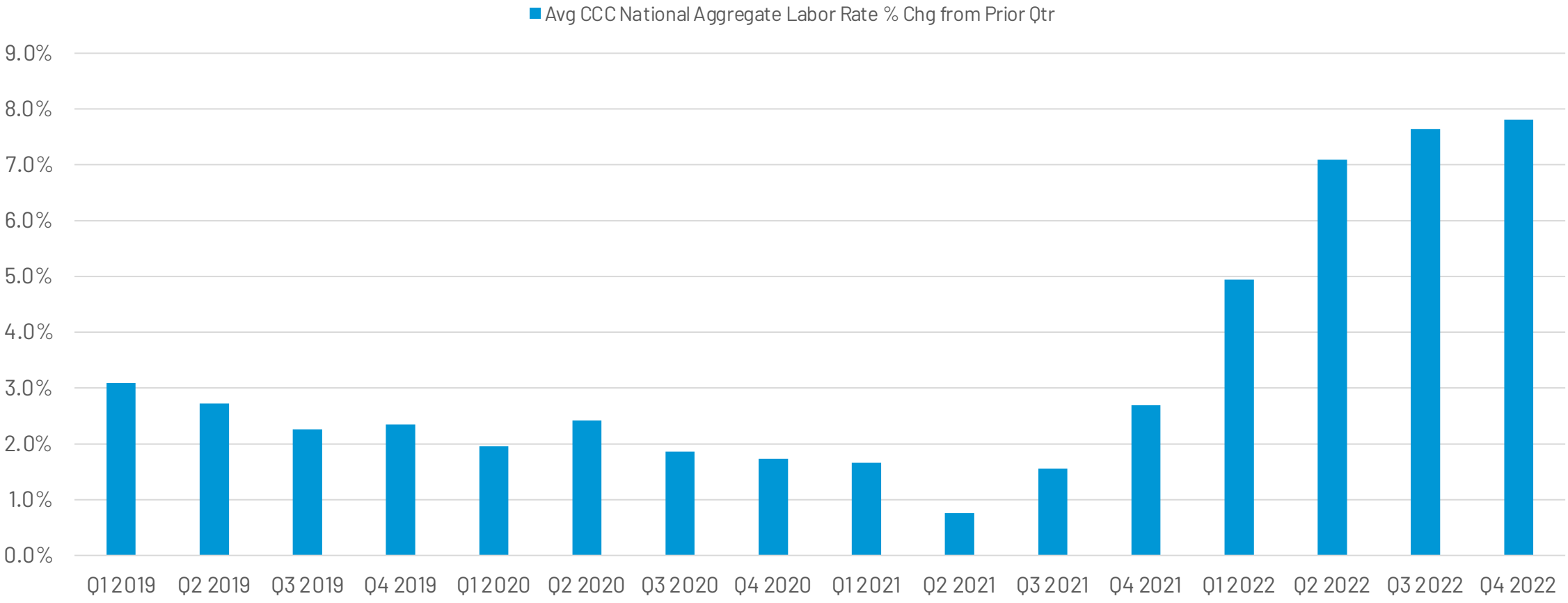
CCC National Industry Non-Comprehensive % of Claims with Frame Labor or Mechanical Labor



LABOR WAGES BEGIN TO OUTPACE REPAIR COSTS

The cost of labor for vehicle repairs has seen some of the largest increases in decades, but many repairers say they are still trailing the cost of wages they must pay in order to retain qualified technicians.

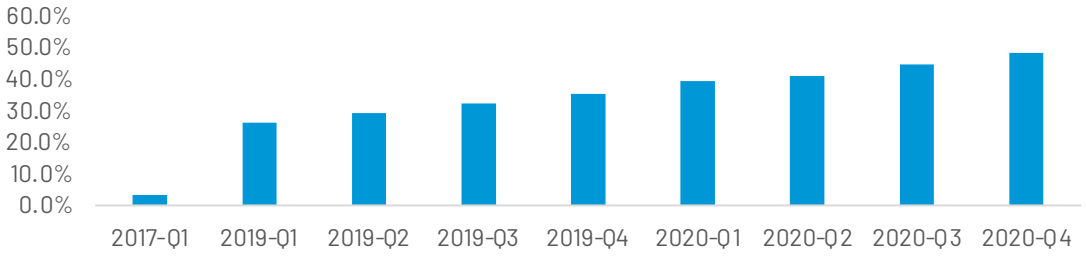
CCC National Industry Repairable Appraisals — Year-over-Year Increase Average Aggregate Labor Rate



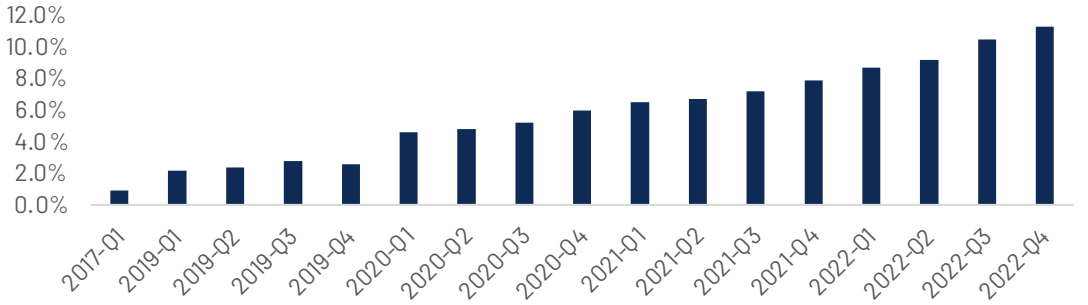
REPAIRING COMPLEX PARTS NOW REQUIRES MORE DIAGNOSTIC SCANS AND CALIBRATIONS

The number of appraisals that include additional dollars associated with vehicle diagnostic scan and/or calibration operations has also increased.

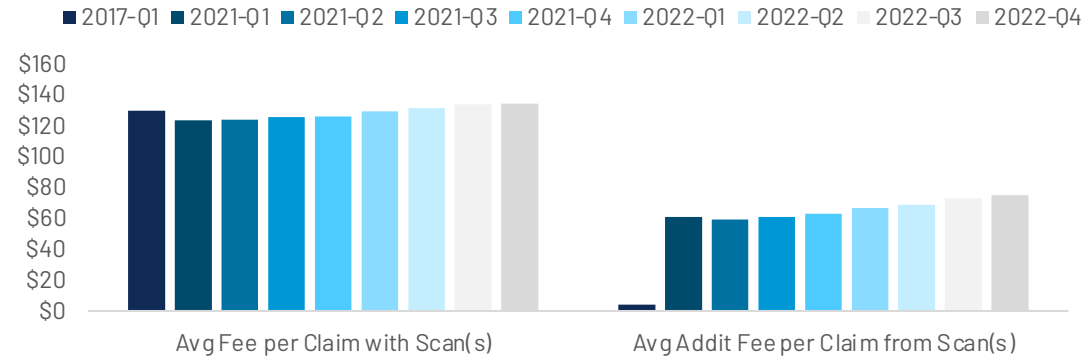
CCC National Industry Percent of Repairable Appraisals with Fees for Scan/Health/Diagnose/OBD



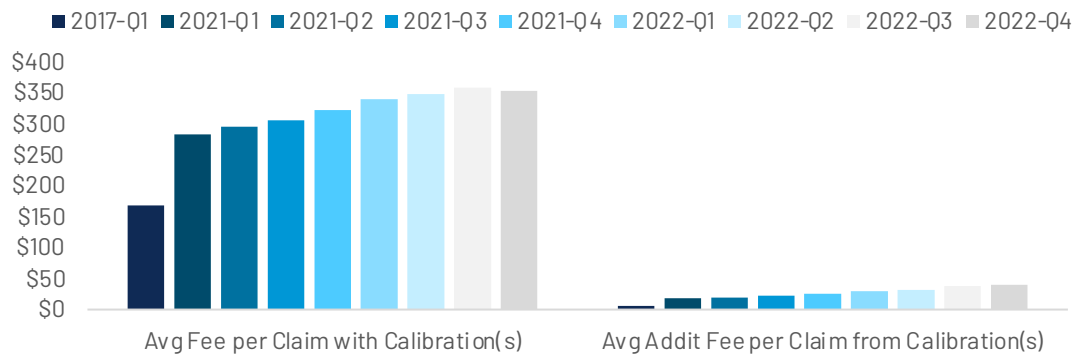
CCC National Industry Percent of Repairable Appraisals with Fees for Calibrate/Reflash/Aim Camera/Distance Sensor/ADAS/Program



CCC National Industry Average Fees for Scan/Health/Diagnose/OBD



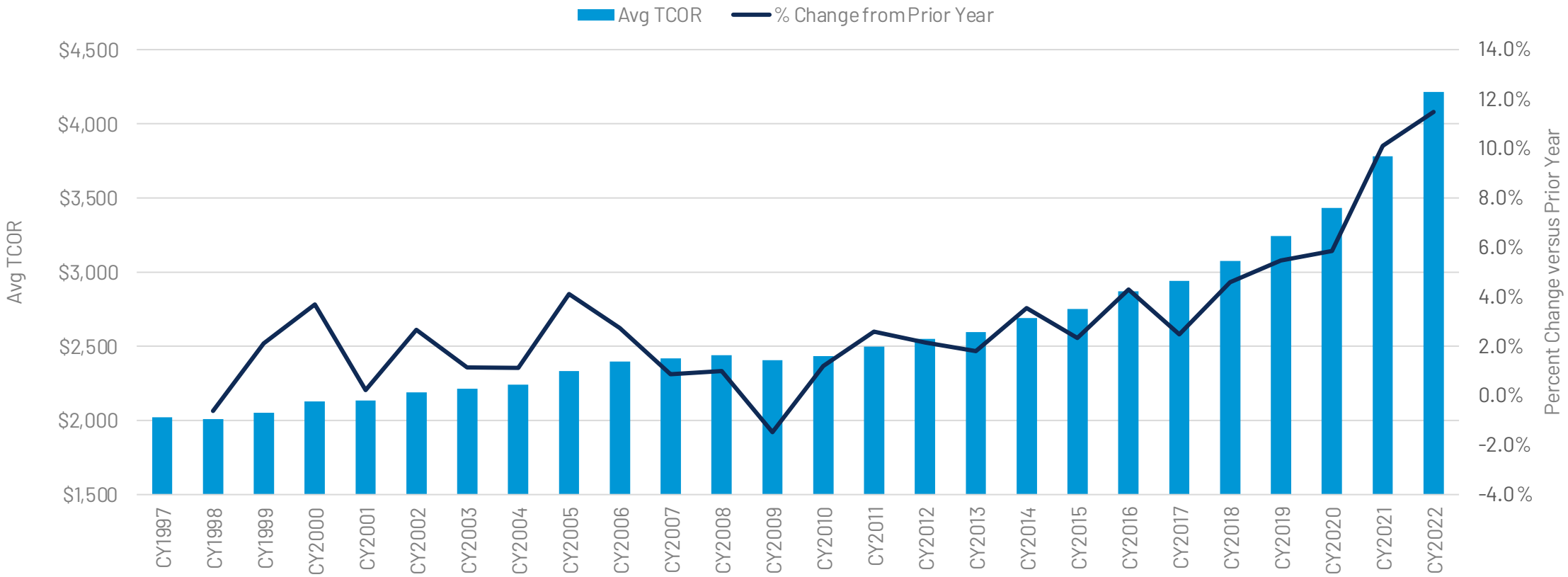
CCC National Industry Average Fees for Calibrate/Reflash/Aim Camera/Distance Sensor/ADAS/Program



REPAIR FOR ALL VEHICLE TYPES IS BECOMING MORE EXPENSIVE

More parts, labor, and operations for scan and calibration mean repair costs overall have risen, with repair costs experiencing their largest year-over-year increases recorded by CCC.

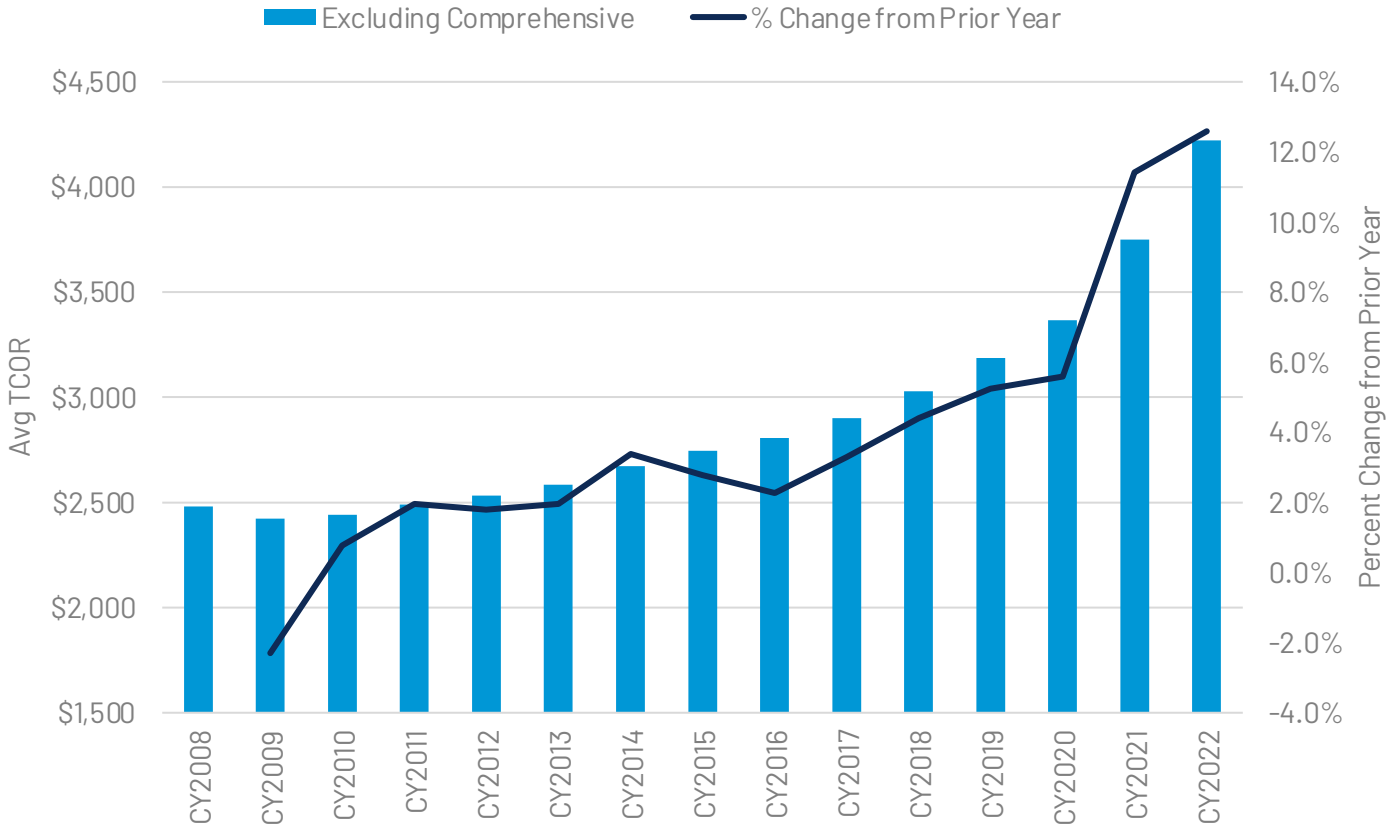
CCC National Industry, Average Total Cost of Repairs — All Loss Categories Repairable Appraisal Statistics



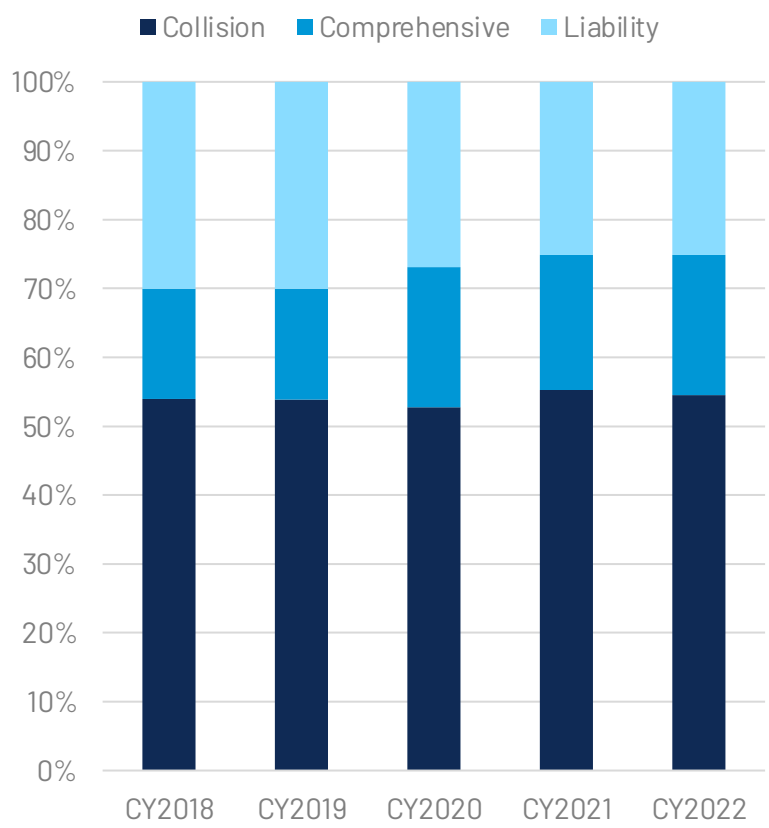
REPAIR COSTS ARE GREATER FOR NON-COMPREHENSIVE LOSSES

Repair costs have accelerated most for non-comprehensive losses that account for a majority of auto physical damage claim counts.

CCC National Industry, Average Total Cost of Repairs - Non-Comprehensive Losses Repairable Appraisal Statistics



CCC National Industry Repairable Appraisal Volume Share by Loss Category CY2018-CY2022

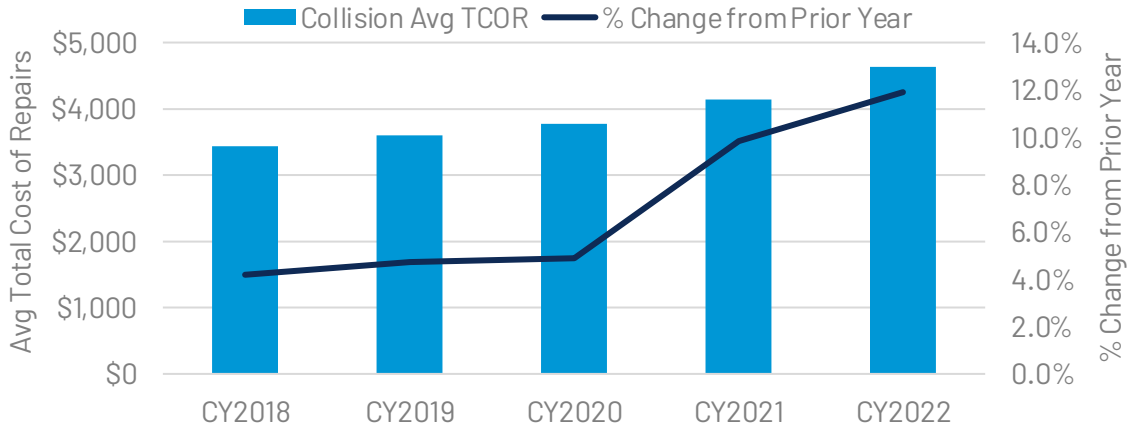


REPAIRABLE COLLISION LOSSES' IMPACT ON COST

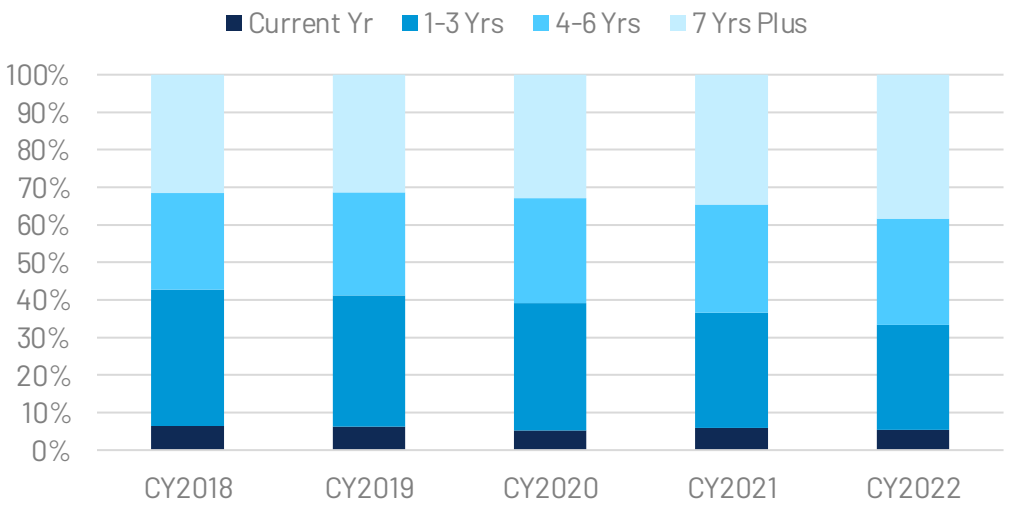
Average repair costs for collision losses experienced large year-over-year increases despite the vehicle age mix shifting older over the last several years.

More parts, labor, scan, and calibration operations are central to these increases, along with a shift to more front and side impacts where repair costs are higher.

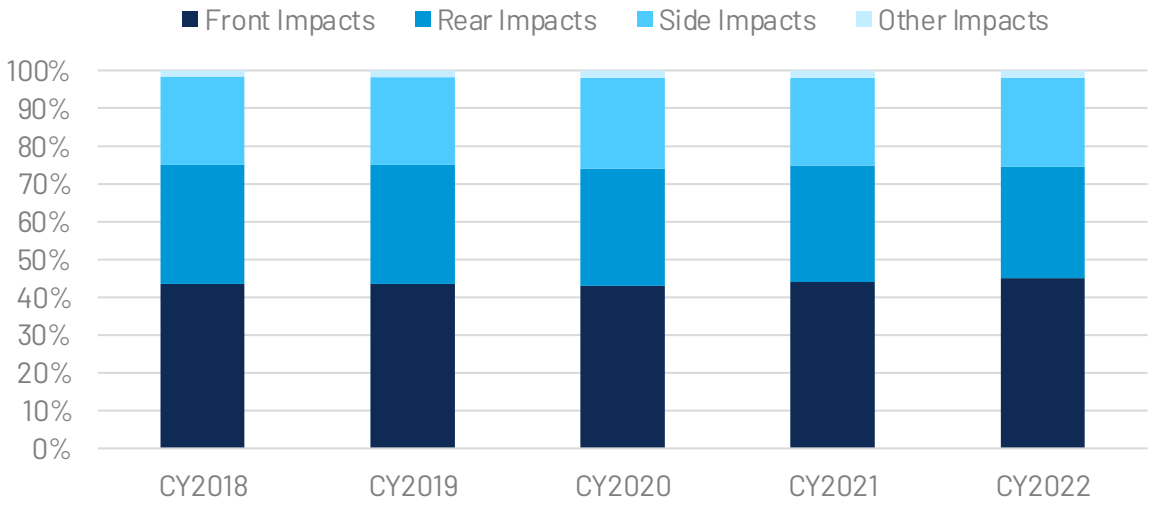
Collision Loss Category CCC National Industry Repairable Appraisals Avg Total Cost of Repairs



Collision Loss Category CCC National Industry Repairable Appraisal Volume Share by Vehicle Age Group



Collision Loss Category CCC National Industry Repairable Appraisal Volume Share by Primary Impact



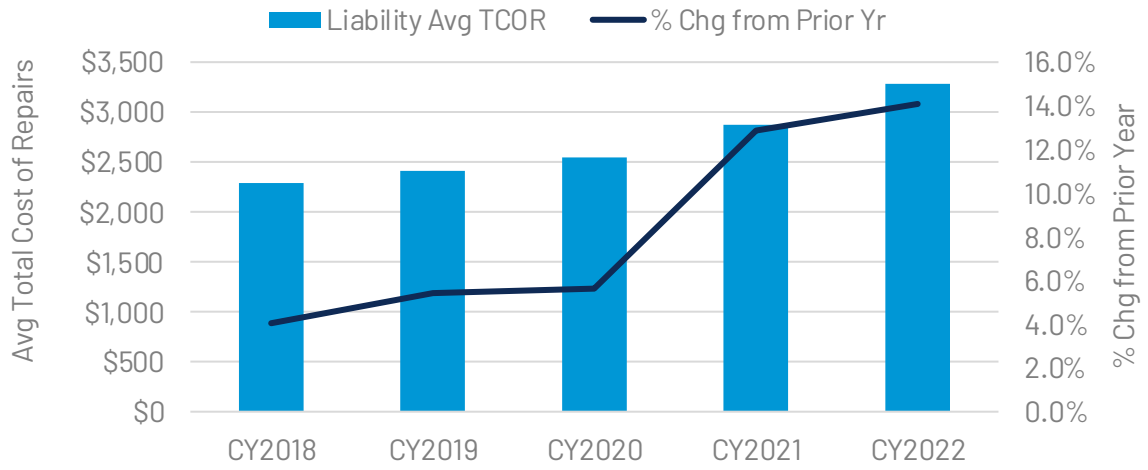
REPAIRABLE LIABILTY LOSSES' IMPACT ON COST

Average repair costs for liability losses also experienced large year-over-year increases.

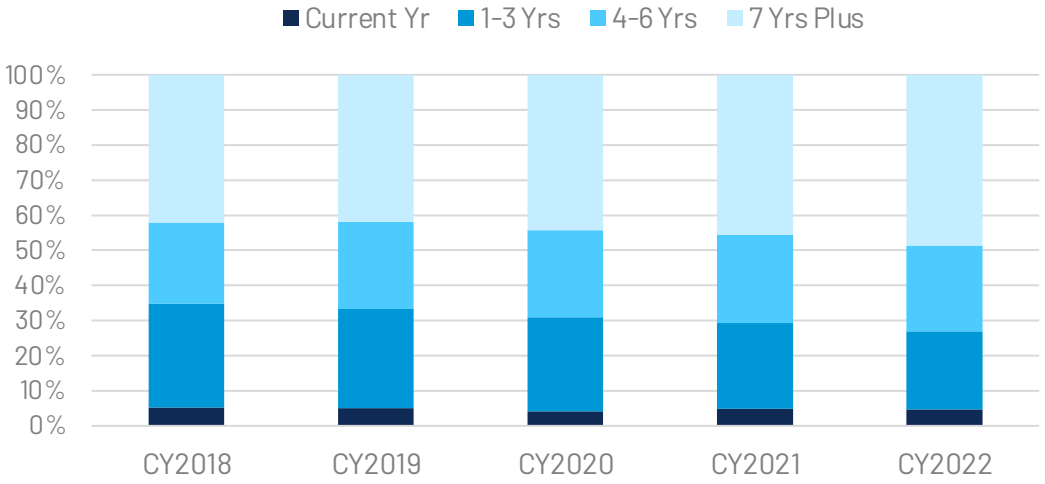
Liability losses saw a smaller shift to older vehicles than collision losses.

Additionally, liability losses saw an even larger increase in both front and side impacts than collision losses, a by-product of the shift in driving patterns that occurred with the pandemic.

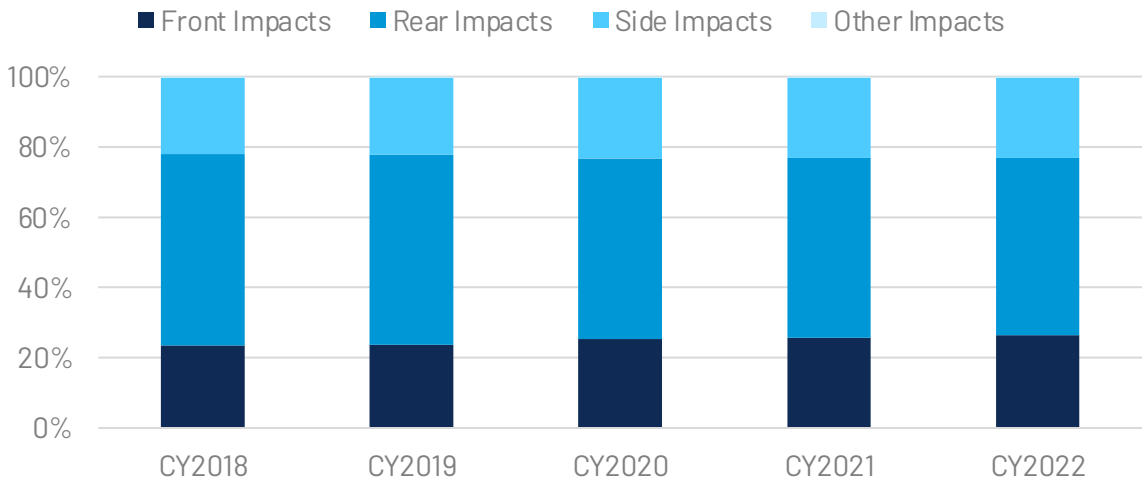
Liability Loss Category CCC National Industry Repairable Appraisals Avg Total Cost of Repairs



Liability Loss Category CCC National Industry Repairable Appraisal Volume Share by Vehicle Age Group



Liability Loss Category CCC National Industry Repairable Appraisal Volume Share by Primary Impact



SUPPLEMENT FREQUENCY HAS INCREASED

All Loss Categories

SOURCE: CCC NATIONAL INDUSTRY REPAIRABLE APPRAISAL SUPPLEMENT STATISTICS

	CY2018	CY2019	CY2020	CY2021	CY2022
% of Claims with Supplement(s)	53.2%	57.1%	61.9%	63.0%	60.0%
Supplement % of Total Cost of Repairs	17.2%	18.2%	19.2%	20.6%	22.0%
Avg Supplement Amt per Claim	$528	$589	$658	$779	$925
First Suppl to Last Suppl Days Average	12.1	12.4	12.4	17.0	18.5

Non-Comprehensive Losses

SOURCE: CCC NATIONAL INDUSTRY REPAIRABLE APPRAISAL SUPPLEMENT STATISTICS

	CY2018	CY2019	CY2020	CY2021	CY2022
% of Claims with Supplement(s)	53.3%	57.3%	62.1%	63.4%	61.0%
Supplement % of Total Cost of Repairs	17.3%	18.4%	19.3%	20.8%	23.0%
Avg Supplement Amt per Claim	$524	$585	$650	$779	$950
First Suppl to Last Suppl Days Average	11.9	12.2	12.1	17.0	19.0

As vehicle complexity has grown, supplement frequency has increased steadily over the years.

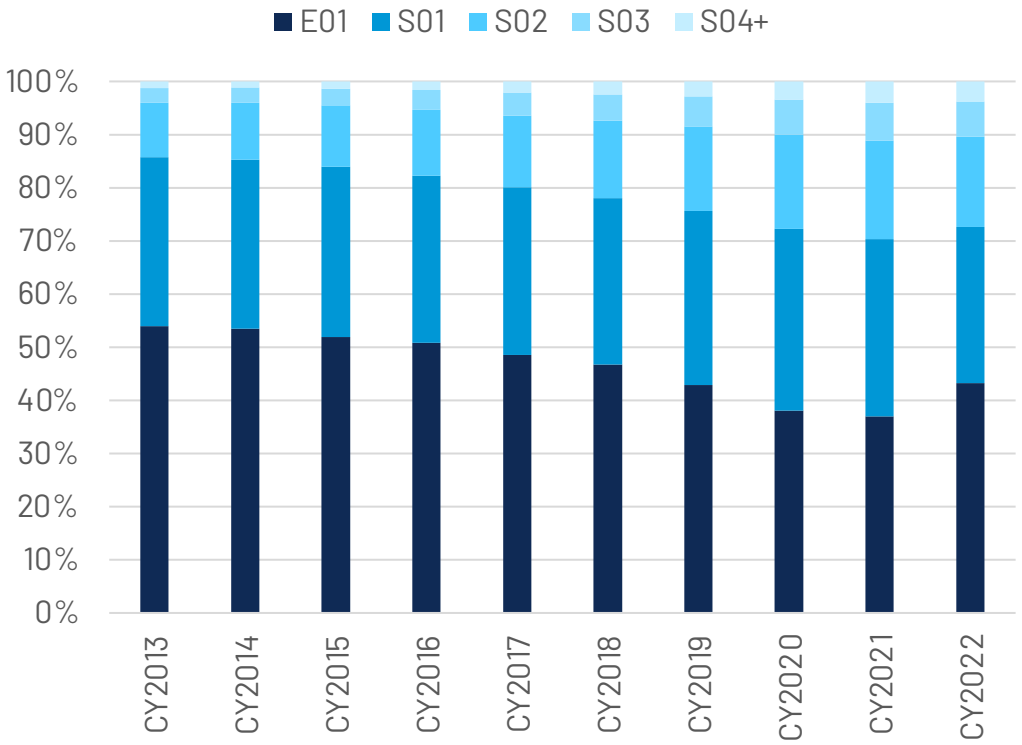
More appraisals now include at least one supplement, and the share of overall repair cost added during supplement(s) has also grown.

Finally, as capacity constrains the industry, cycle time from the first supplement to the last supplement has grown.

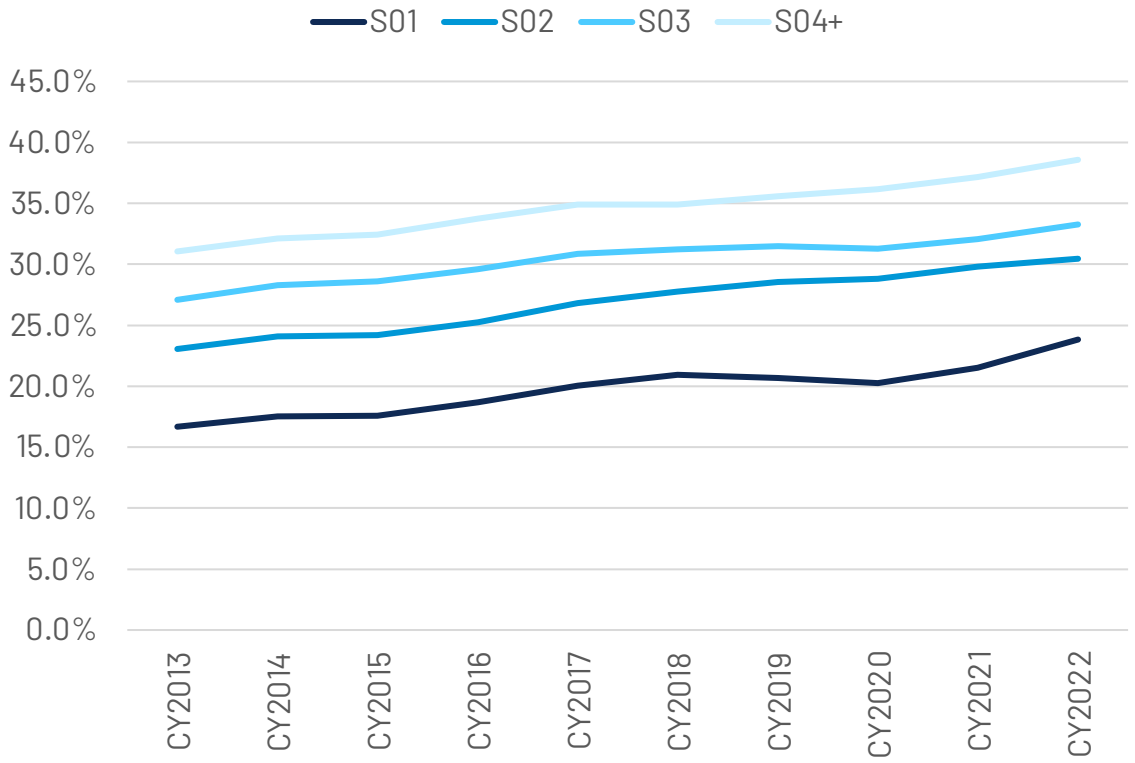
SUPPLEMENT FREQUENCY HAS INCREASED

A greater share of repairable appraisal volume now includes at least one supplement, with nearly 5% of appraisals including at least four or more supplements. And the share of overall repair costs identified in supplements has grown, accounting for nearly 40% of the overall repair cost for those appraisals with four or more supplements.

CCC National Industry Repairable Appraisals Share of Repairable Appraisal Volume by File Suffix



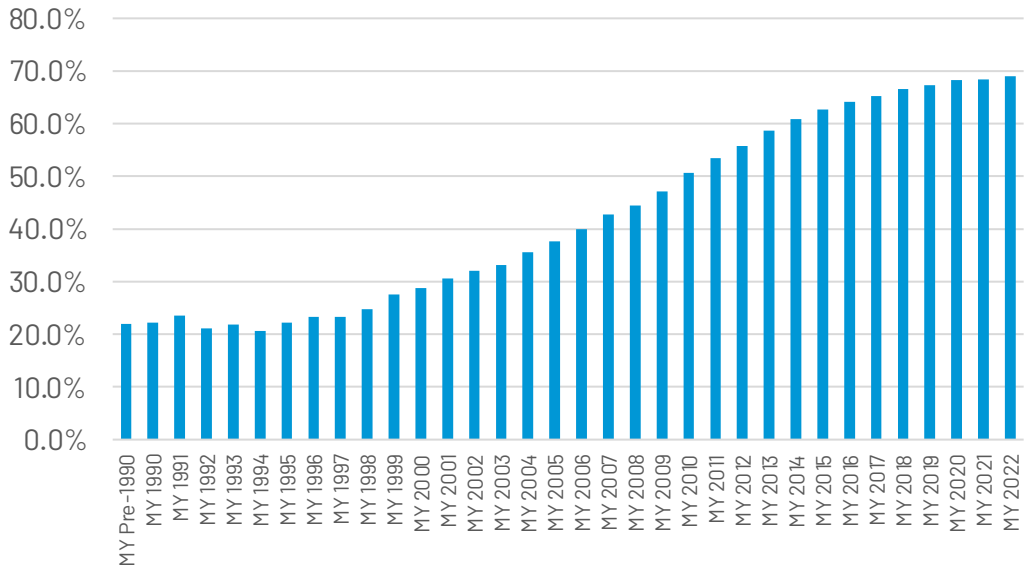
CCC National Industry Repairable Appraisals Supplement Share of Total Repair Cost



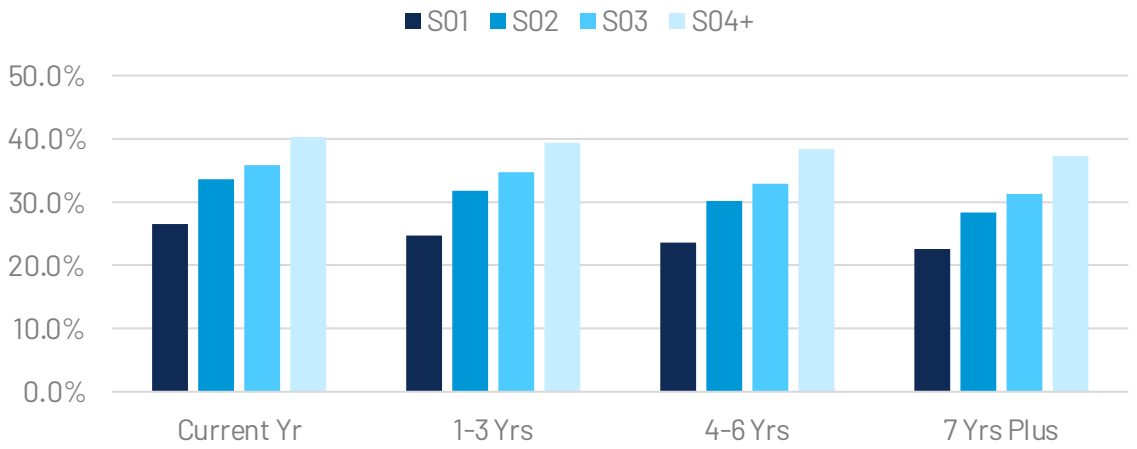
APPRAISALS FOR YOUNGER VEHICLES INCLUDE MORE SUPPLEMENTS

Newer vehicles have consistently seen a larger share of their repair costs from supplements as the comparison between data from CY2001 and CY2022 illustrates. And while vehicles of all ages have seen an increase in supplement frequency, supplement frequency is highest for the most recent model years where vehicle complexity has increased the most.

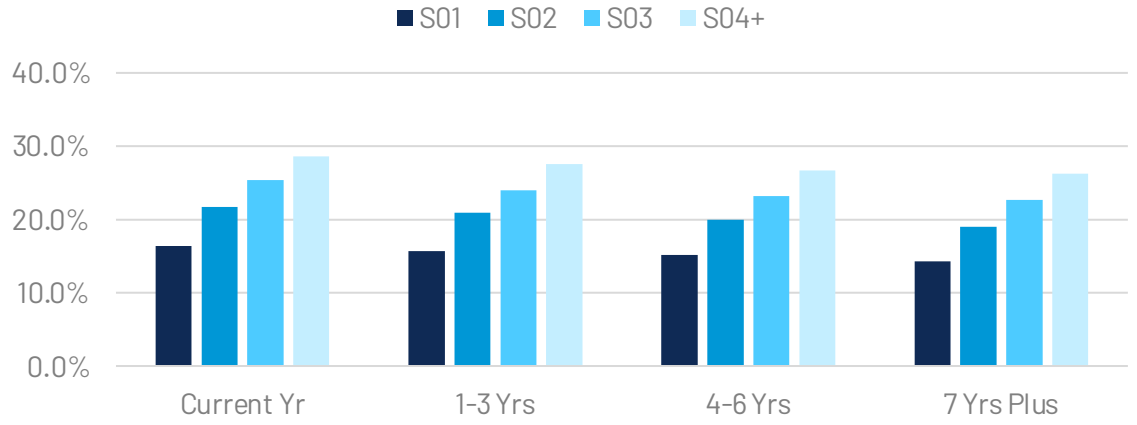
CY2022 Percent of CCC National Industry Repairable Appraisals by Vehicle Model Year with One or More Supplement(s)



CCC National Industry Repairable Appraisals CY2022 Supplement % of Total Repair Cost by Vehicle Age Group



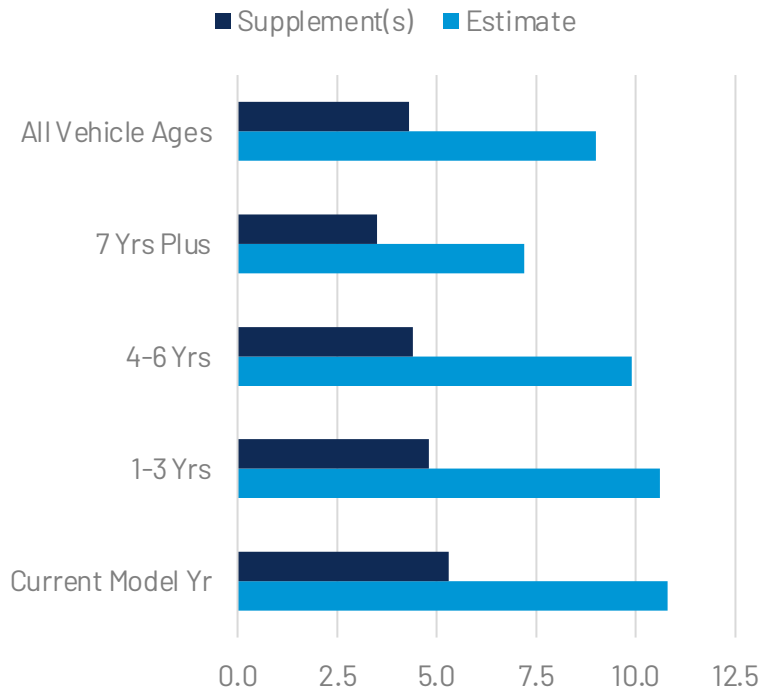
CCC National Industry Repairable Appraisals CY2001 Supplement % of Total Repair Cost by Vehicle Age Group



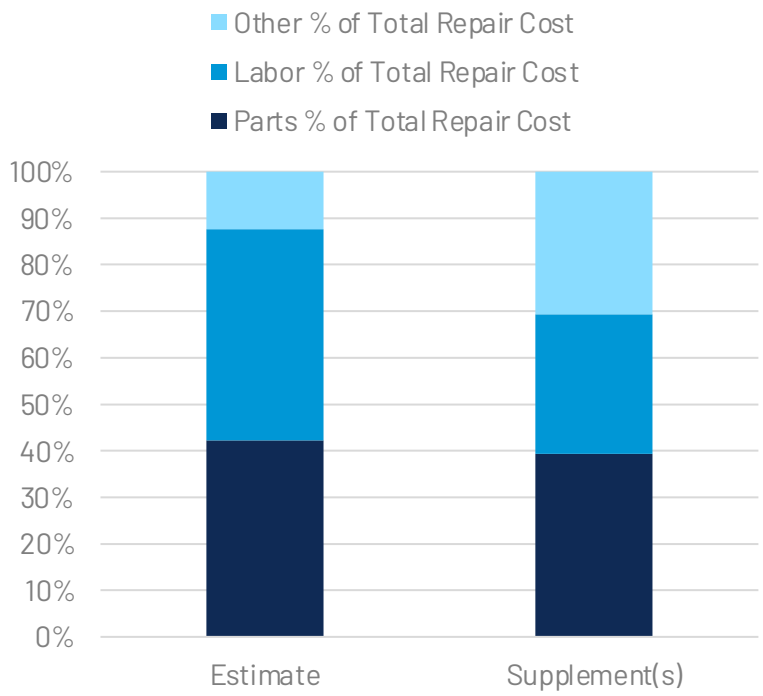
APPRAISALS FOR YOUNGER VEHICLES INCLUDE MORE SUPPLEMENTS

Comparison of the share of overall dollars per file type (estimates versus supplements) reveals that replaced parts account for a larger share of overall estimate dollars than of supplement dollars, while other charges account for a larger share of supplement dollars. Not surprisingly, current model year vehicles include more part replacements and labor hours in both estimates and supplements.

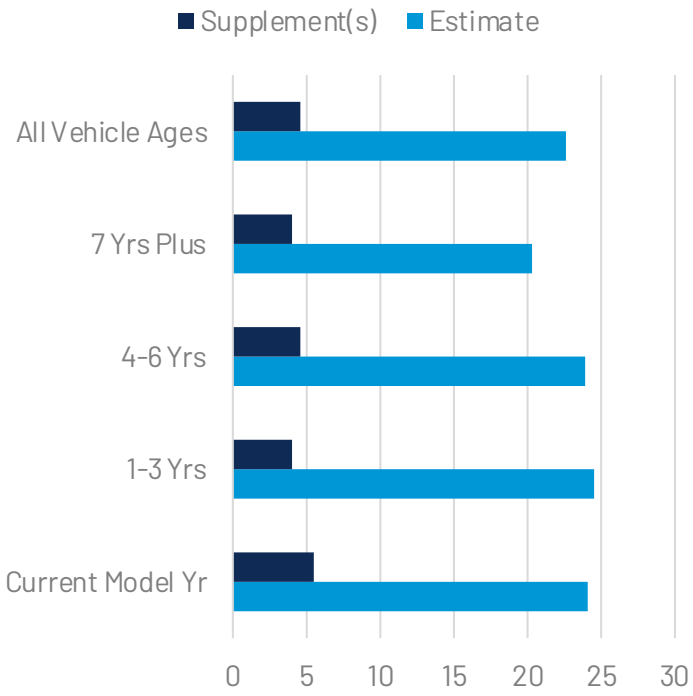
Average Part Replacements per CCC National Industry Repairable Appraisal File Type by Vehicle Age Group CY2022



Average Labor Hours per CCC National Industry Repairable Appraisal File Type by Vehicle Age Group CY2022



Average Labor Hours per CCC National Industry Repairable Appraisal File Type by Vehicle Age Group CY2022

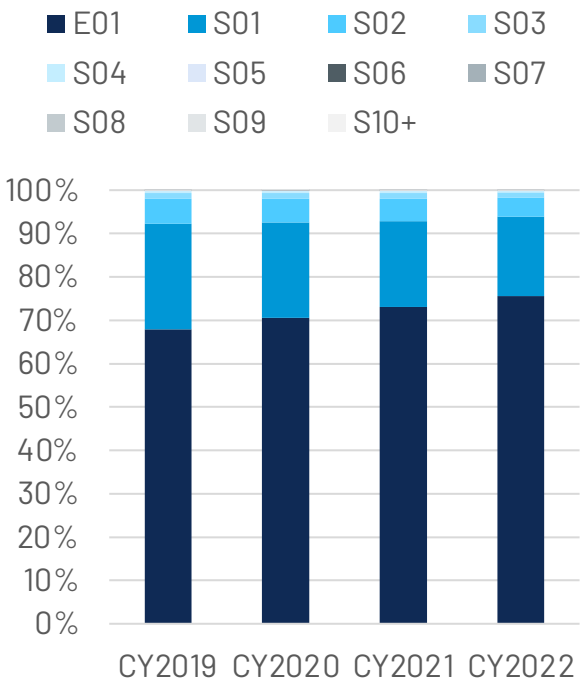


SCANS AND CALIBRATIONS CONTRIBUTE TO INCREASES IN SUPPLEMENT FREQUENCY

Many of the operations related to vehicle scan, calibration, or repair/replacement of ADAS-related components like cameras and sensors are added during supplements. Completing the proper diagnostics, determining which components are included in the repair that might require calibration, and reviewing the OEM repair procedures can help a repairer incorporate the calibration into the repair plan up front. These steps could potentially help avoid added costs and repair time identified later in supplements.

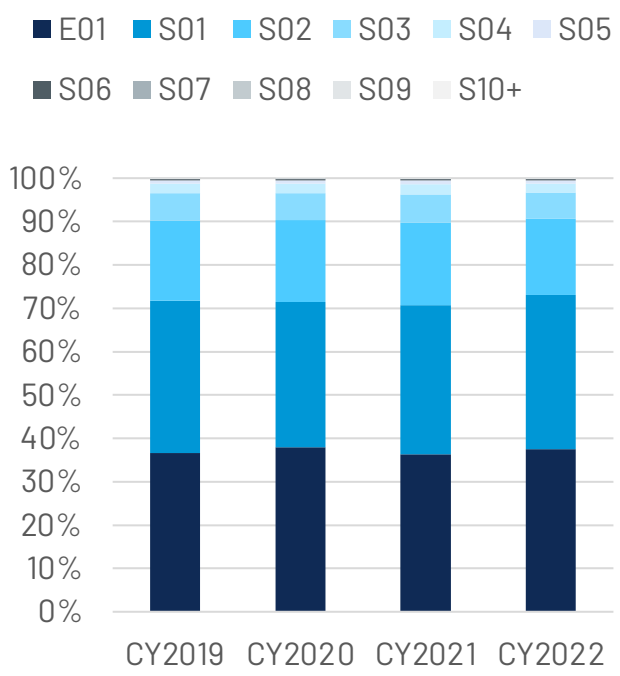
Scan Entries

SOURCE: CCC NATIONAL INDUSTRY



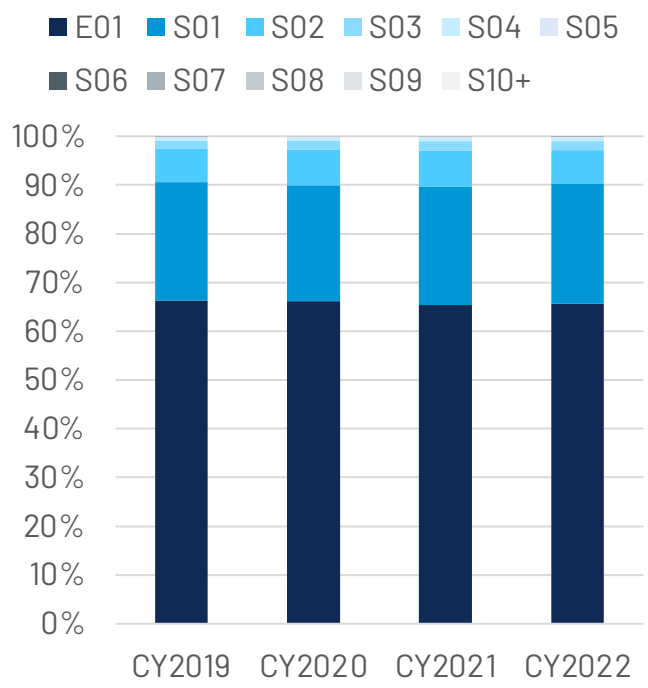
Calibration Entries

SOURCE: CCC NATIONAL INDUSTRY



ADAS— Related Entries

SOURCE: CCC NATIONAL INDUSTRY

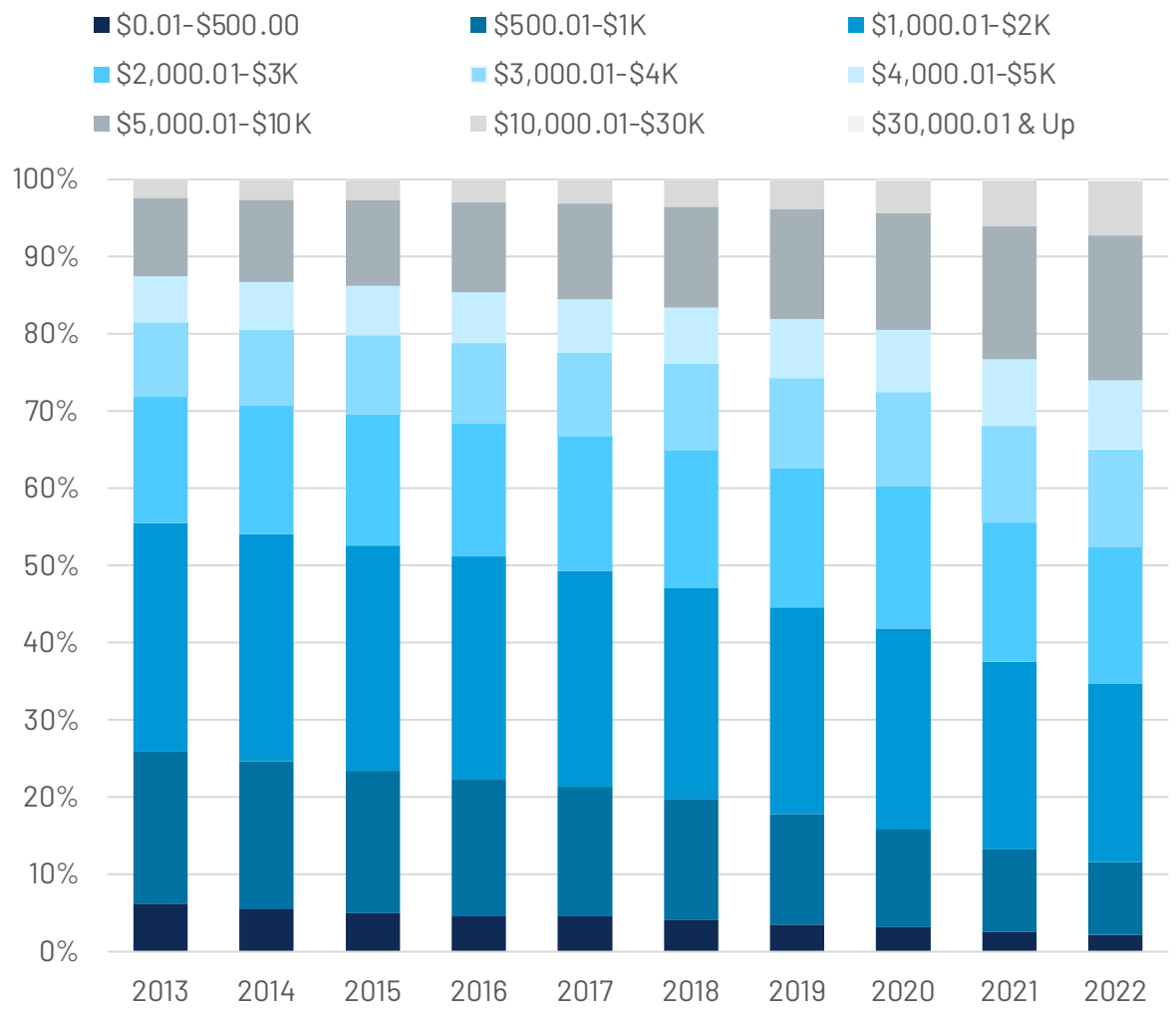


MORE REPAIRABLE CLAIMS FALL IN HIGHER DOLLAR REPAIR COST BRACKETS THAN EVER BEFORE

Increased vehicle complexity has led to increases in replaced parts, labor time, and need for new operations that may not have previously been necessary. All these factors contributed to driving up repair costs at a faster rate than in prior years beginning in 2018-2019.

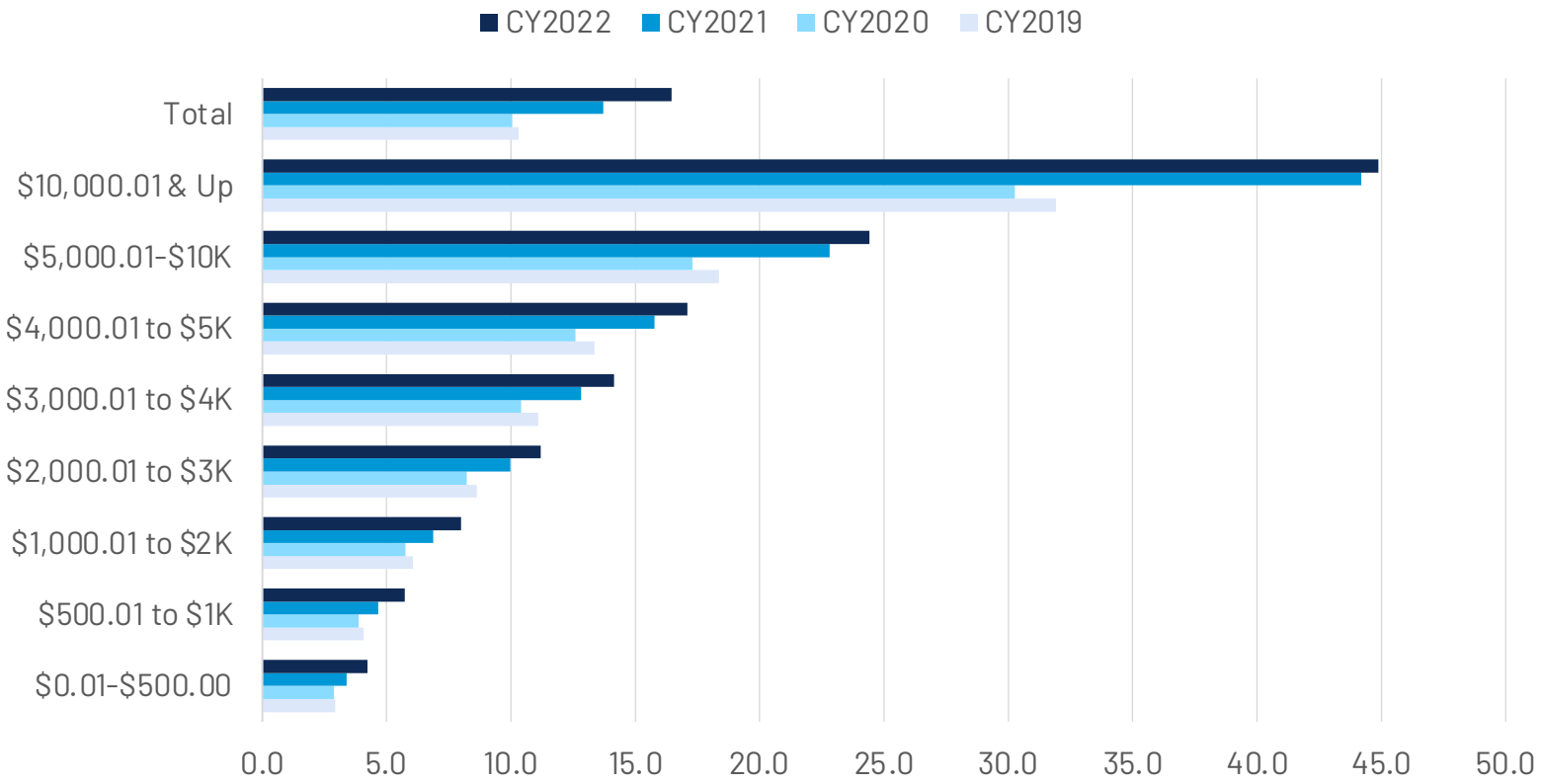
As automakers continue to add more electronic content to their vehicles, either through connected car, ADAS, or other features, vehicle complexity will grow further. And while there is hope that some features like certain ADAS capabilities will potentially help avoid certain accidents in the future, those that remain appear primed to see further increases in repair cost.

Non-Comprehensive CCC National Industry Repairable Appraisal Volume by Repair Cost Dollar Ranges



MORE REPAIRS IN HIGHER DOLLAR REPAIR COST BRACKETS MEANS REPAIR TIMES NOW TAKE LONGER THAN EVER BEFORE

DRP CCC National Industry Vehicle-In to Vehicle-Out Days Average by Repair Cost Ranges

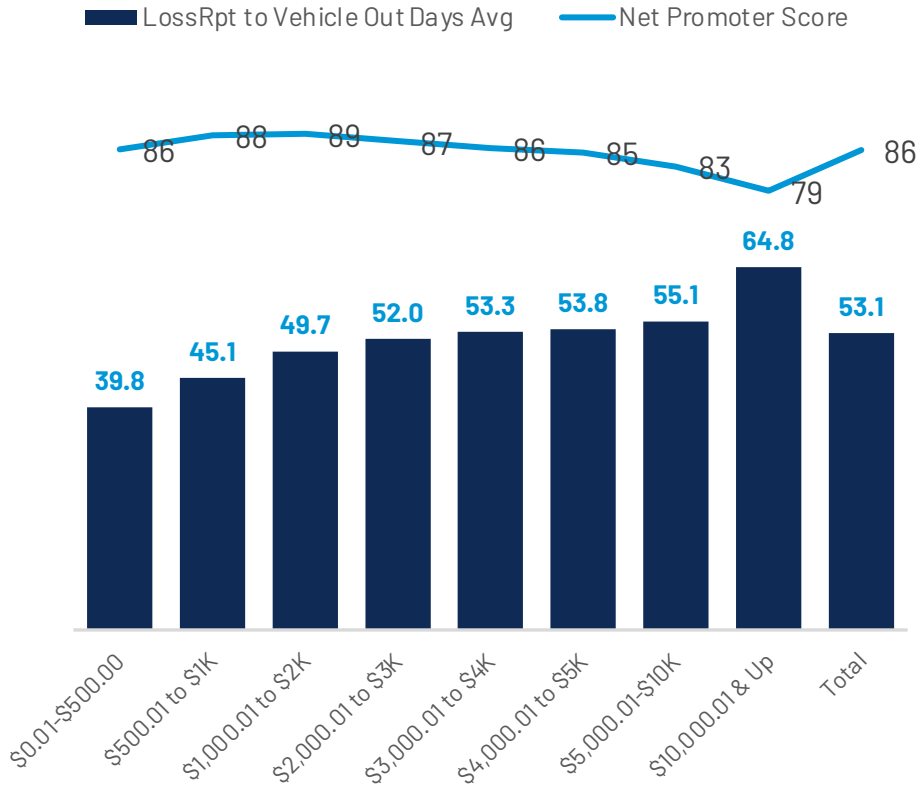


The average number of days from repair start to repair completion have grown substantially over the last several years.

With more repairs in the higher dollar repair cost brackets — where repair times are longer — the overall average has grown from 10.3 days in CY2019 to over 16 days in CY2022.

LONGER CYCLE TIMES MAY LEAD TO LOWER CUSTOMER SATISFACTION AND HIGHER VEHICLE RETURN RATES

DRP CCC National Industry CY2022 Repaired Vehicles Average Cycle Time and CSI



	$0.01-$500.00	$500.01 to $1K	$1,000.01 to $2K	$2,000.01 to $3K	$3,000.01 to $4K	$4,000.01 to $5K	$5,000.01-$10K	$10,000.01 & Up	Total
LossRpt to Vehicle Out Days Avg	39.8	45.1	49.7	52.0	53.3	53.8	55.1	64.8	53.1
Vehicle-In to Vehicle-Out Days Avg	4.3	5.7	8.0	11.2	14.2	17.2	24.5	45.4	16.7
Net Promoter Score	86	88	89	87	86	85	83	79	86
Repair Satisfaction %	95.5%	96.8%	96.5%	95.9%	95.5%	95.2%	94.1%	92.8%	95.4%
Survey % of Vehicles Returned	6.4%	6.2%	7.3%	9.1%	10.7%	12.0%	14.7%	20.0%	11.0%
Kept Informed %	93.8%	93.9%	94.3%	94.2%	93.9%	93.6%	93.1%	91.9%	93.7%
Avg Service Score	9.6	9.7	9.7	9.6	9.6	9.6	9.5	9.4	9.6
Avg Recommend Shop Score	9.5	9.6	9.6	9.6	9.5	9.5	9.4	9.3	9.5
Avg Insurer Handle Claim Score	9.1	9.3	9.4	9.3	9.4	9.3	9.2	9.1	9.3
Avg Recommend Insurer Score	8.9	9.2	9.3	9.3	9.3	9.3	9.2	9.1	9.2

NEW VEHICLE TECHNOLOGIES MORE RELIANT THAN EVER ON STEADY SUPPLY OF SEMICONDUCTOR CHIPS

As vehicle electronic content has grown, today's vehicles include more semiconductor chips than ever before, which is why automakers saw significant disruption when semiconductor chip supplies dropped sharply CY2020-2022.

Many industries, like automotive, had moved to a "just in time" inventory system prior to the pandemic — an approach that was sorely tested over the last several years as consumer demand increased much faster than anyone might have expected.

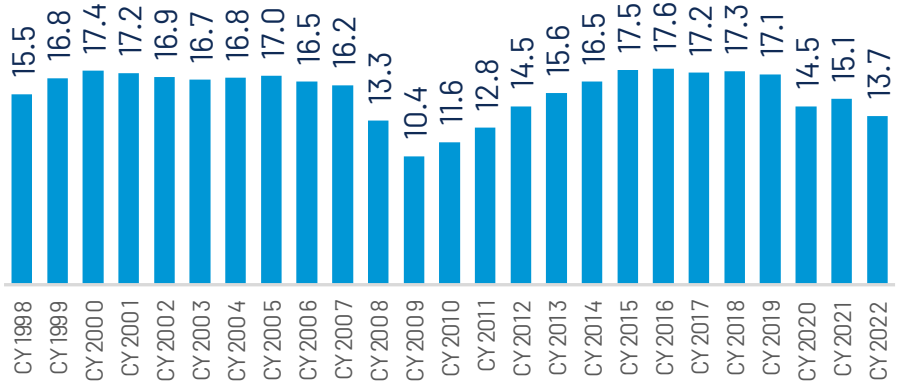
Automakers were unable to find enough semiconductor chips to meet their demand after they had canceled many orders in early 2020 in anticipation of slower auto sales. New vehicle production volumes fell globally by 10.5M in CY2021, 4.4M in CY2022, and are forecast to be down another 2.7M in CY2023.

New vehicle sales initially fell due to less inventory, and later due to affordability as automakers shifted production to their more expensive, profitable vehicles and — more recently — to much higher borrowing costs as the Federal Reserve began raising rates to combat surging inflation.

New vehicle sales have fallen for three consecutive years, but the average new vehicle transaction price has soared. As automakers introduce more EV models, the average transaction is expected to climb further as automakers face costlier raw materials used in EV batteries.

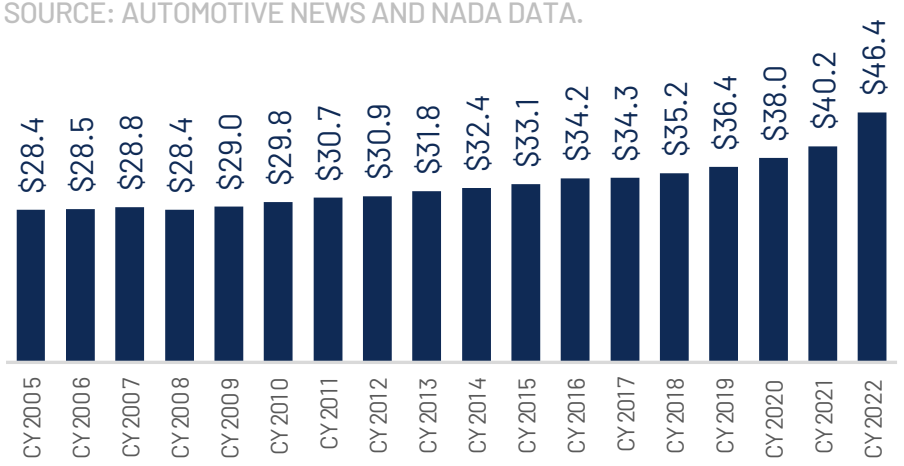
Total U.S. New Vehicle Sales (in millions) CY1998-CY2022

SOURCE: AUTOMOTIVE NEWS AND NADA DATA.



Average New Vehicle MSRP (in $1000's) CY2005-CY2022

SOURCE: AUTOMOTIVE NEWS AND NADA DATA.



LIMITED NEW VEHICLE INVENTORY DROVE DEMAND IN USED VEHICLE SEGMENT

With limited new vehicle inventory, the demand for used vehicles surged and prices increased sharply through the second half of CY2021 and the full year CY2022 for consumers and dealers. Between Apr'20 and Jan'22, the Manheim wholesale used vehicle value index rose 88%.

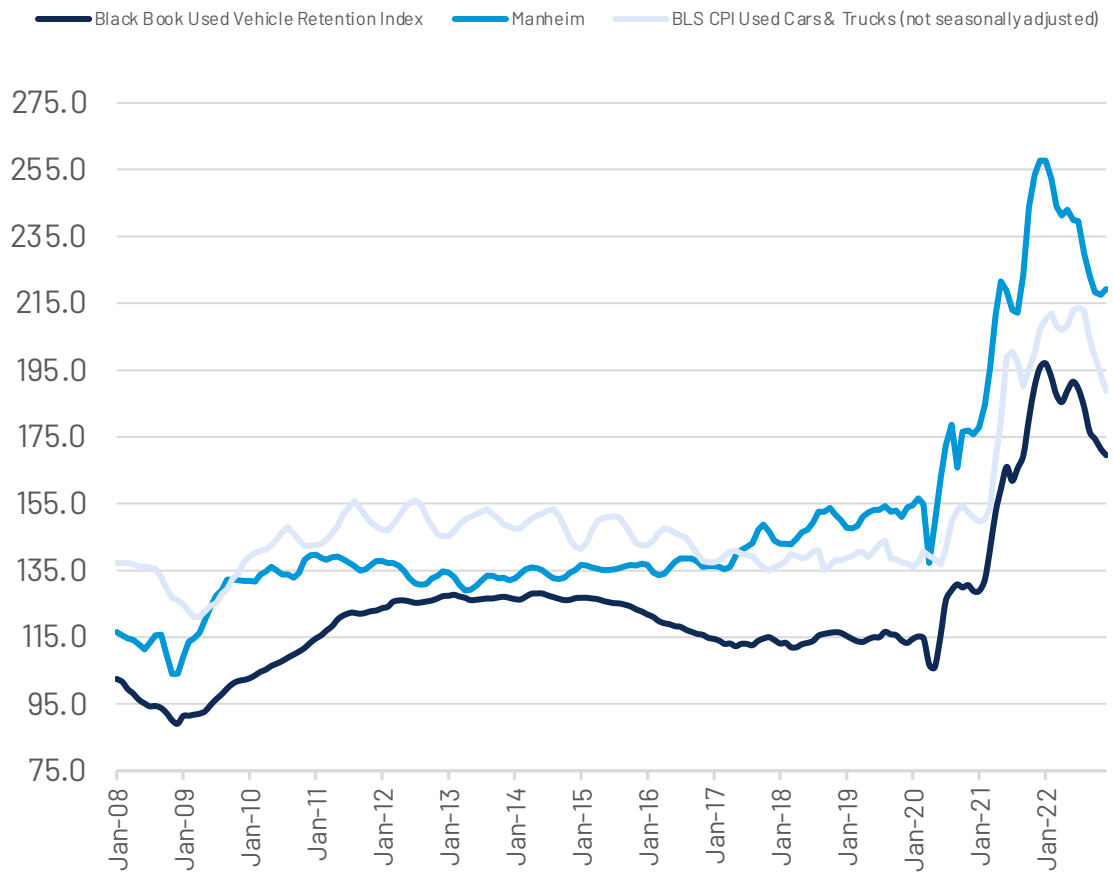
Used vehicle prices at wholesale began to soften in Q3 2022, with the Manheim wholesale used vehicle value index for Dec'22 down -14.9% versus Dec'21. Retail used vehicle prices, which tend to lag wholesale prices by 3-6 months, followed suit Nov-Dec'22.

Affordability issues and high interest rates have suppressed demand for used vehicles. Cox Automotive estimates 36.2M used vehicles were sold in CY2022, down over 10% versus CY2021.

Manheim has projected wholesale used vehicle prices will depreciate further in CY2023, with the index forecast to be down -4.3% in Dec'23 versus Dec'22. (64)

JP Morgan projects used vehicle retail prices will fall between 10-20% in 2023,(65) although retail pricing has not declined as quickly as wholesale prices yet, as dealers attempt to hold steady on record-high pricing. (66)

Black Book Used Vehicle Retention Index and Manheim Wholesale Used Vehicle Values and Bureau of Labor Consumer Price Index for Used Cars and Trucks (January 2008 – December 2022)

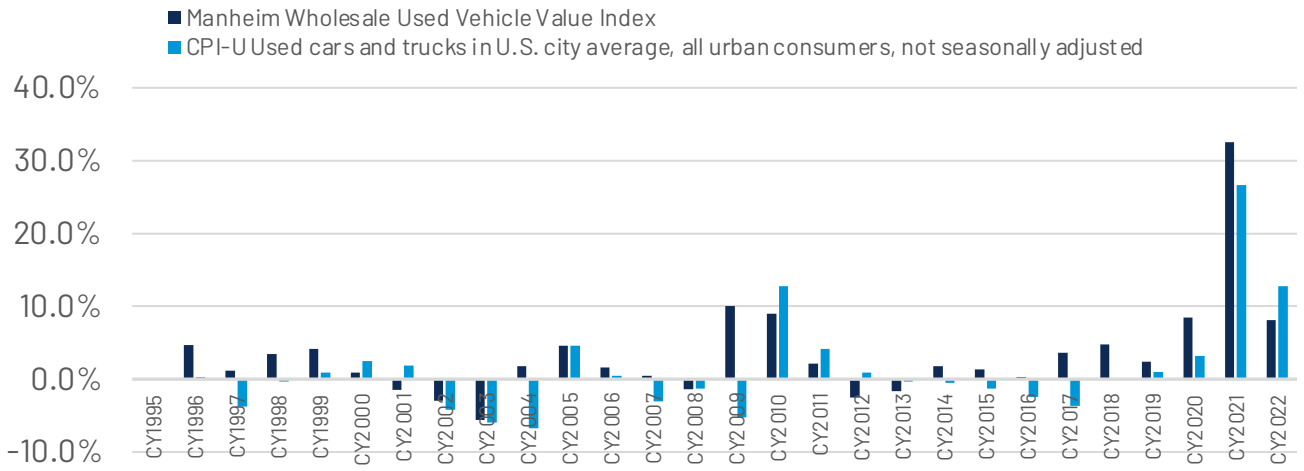


USED VEHICLE PRICES EXPECTED TO SOFTEN BUT REMAIN ELEVATED FROM PRE-PANDEMIC LEVELS

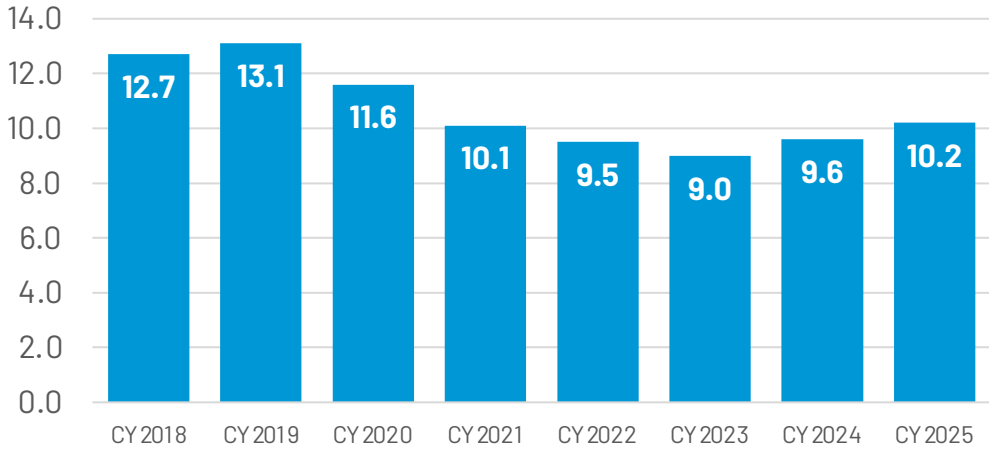
Increased new vehicle inventory, still elevated vehicle prices, higher interest rates, fewer trade-ins, and no more stimulus money suggest used vehicle sales may fall further in CY2023. Yet, while most analysts project prices will fall in CY2023, it's expected that the decline will be gradual throughout the year versus an immediate decline.

Additionally, fewer sales into lease or fleet over the last several years means used vehicle supplies over the next several years will remain constrained. So, while new vehicle inventory will improve and shift some demand from the used vehicle market, tighter supplies will keep used vehicle prices as much as 20% higher than pre-pandemic.

Used Vehicle Prices – BLS CPI and Manheim Indices CY1995 – CY2022 Percent Change from Same Prior Year

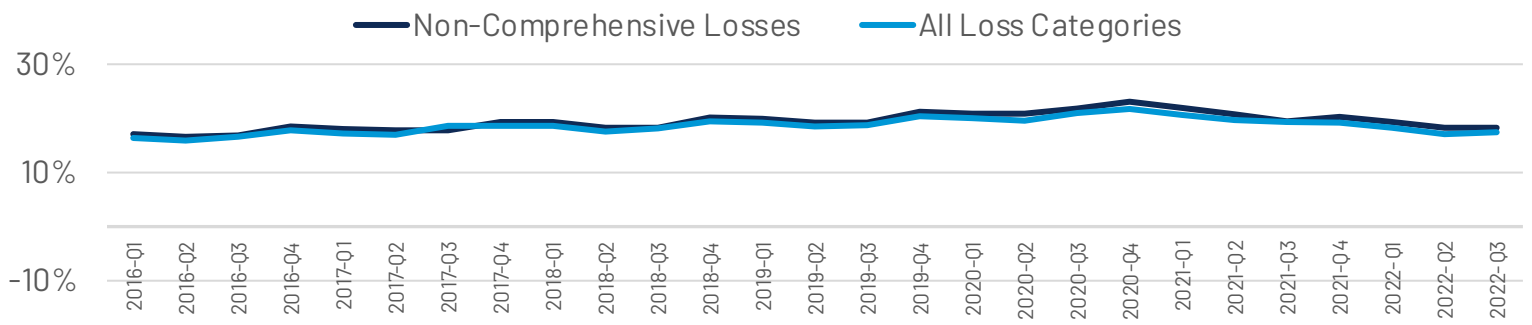


Cox Automotive/Manheim Estimated Wholesale Volumes (Annual Volume in millions)

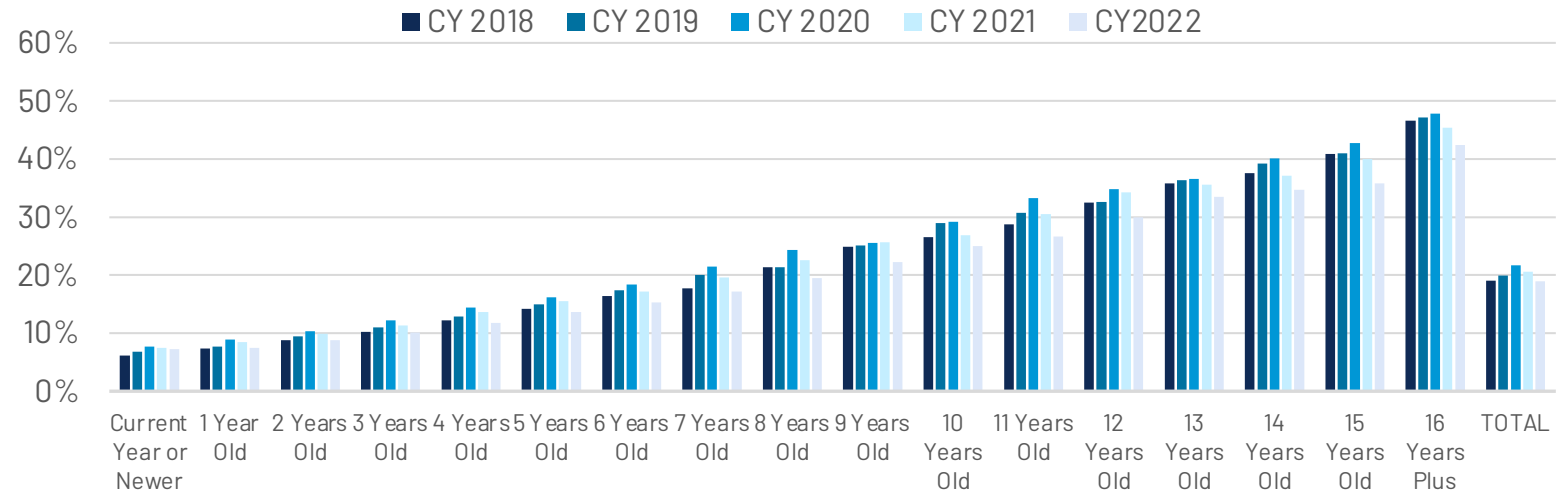


HIGHER VEHICLE VALUES MEANT FEWER TOTAL LOSSES

CCC National Industry Total Loss Share of Claim Count CY 2016-CY 2022



CCC National Industry Percent of Non-Comprehensive Appraisals Flagged Total Loss by Vehicle Age



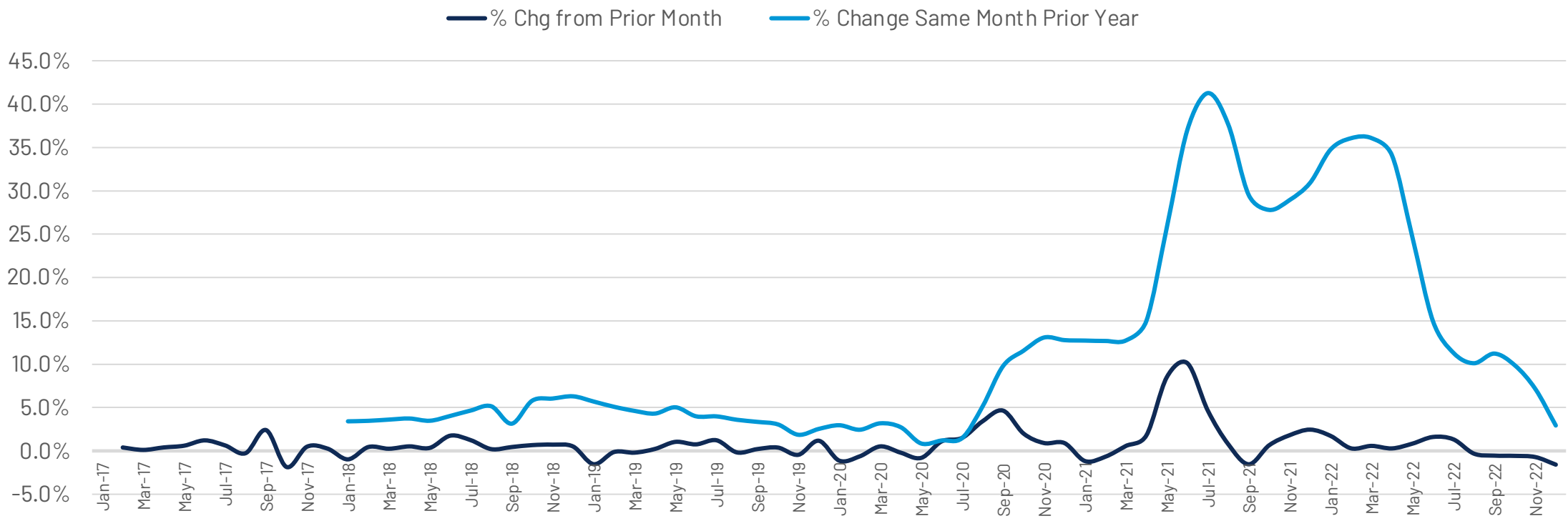
Higher total loss prices in 2021 and 2022 meant more vehicles were repaired versus totaled.

As used vehicle prices soften, expect total loss frequency to climb again, particularly given the aging fleet and soaring vehicle repair costs.

TOTAL LOSS VEHICLE VALUES BEGIN TO SOFTEN

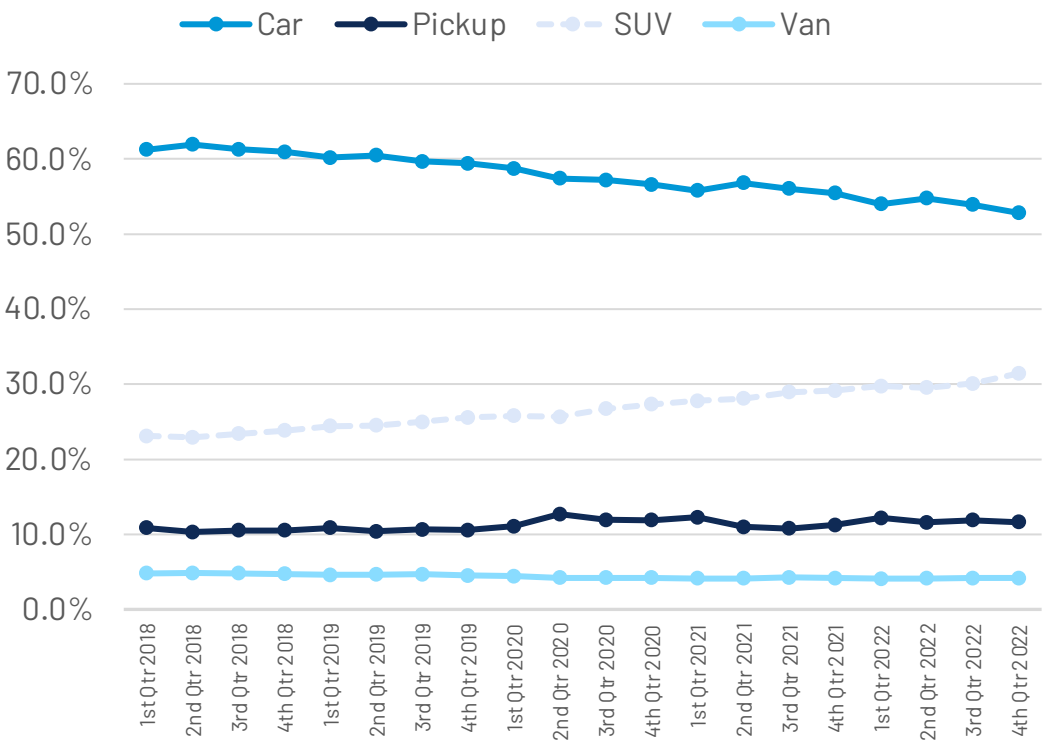
Total loss costs have begun to fall on a per loss basis, but with consumers opting for more expensive light trucks and luxury vehicles over the last several years, total loss claims will factor into overall higher loss costs for the insurance industry.

CCC National Industry Non-Comprehensive Average Adjusted Total Loss Vehicle Value by Calendar Month

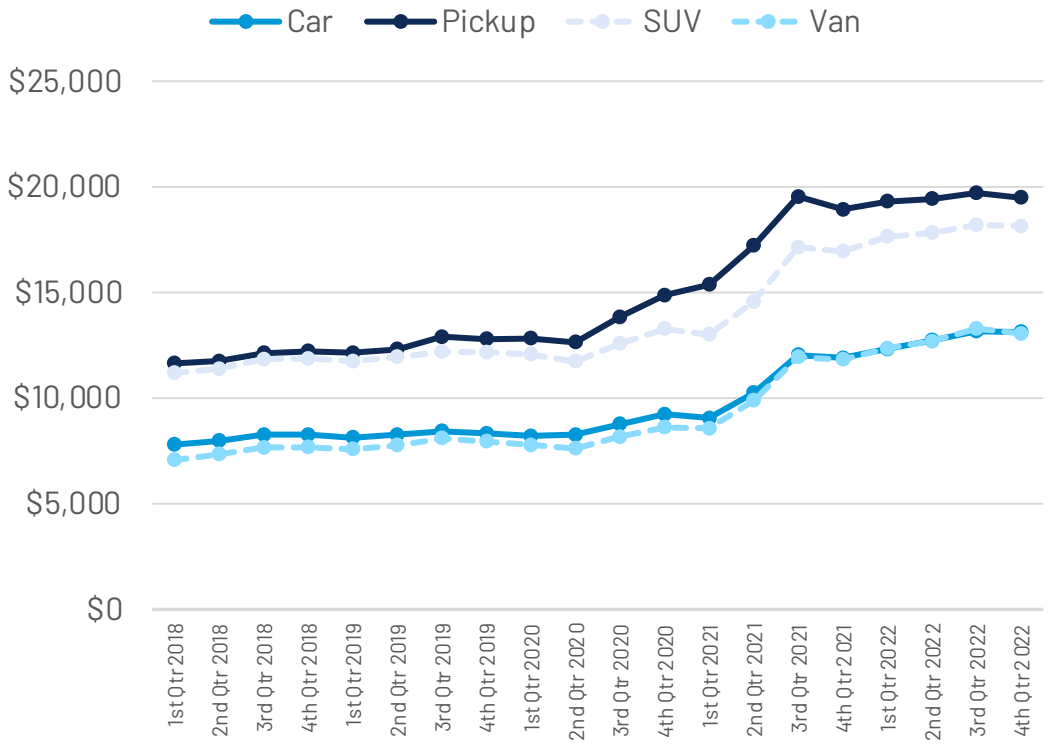


SUV'S ACCOUNT FOR GROWING SHARE OF TOTAL LOSS VEHICLES WHERE TOTAL LOSS VALUES TREND HIGHER THAN FOR CARS

CCC National Industry All Loss Categories Share Total Loss Valuation Count by Vehicle Type



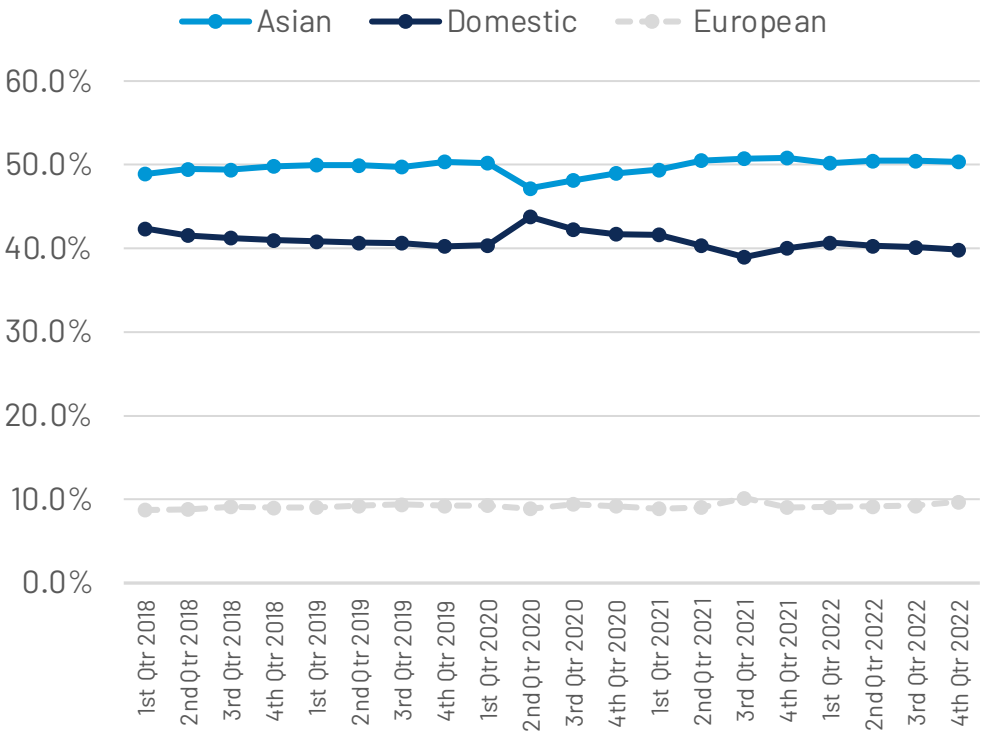
CCC National Industry All Loss Categories Avg Adjusted Vehicle Value Amt by Vehicle Type



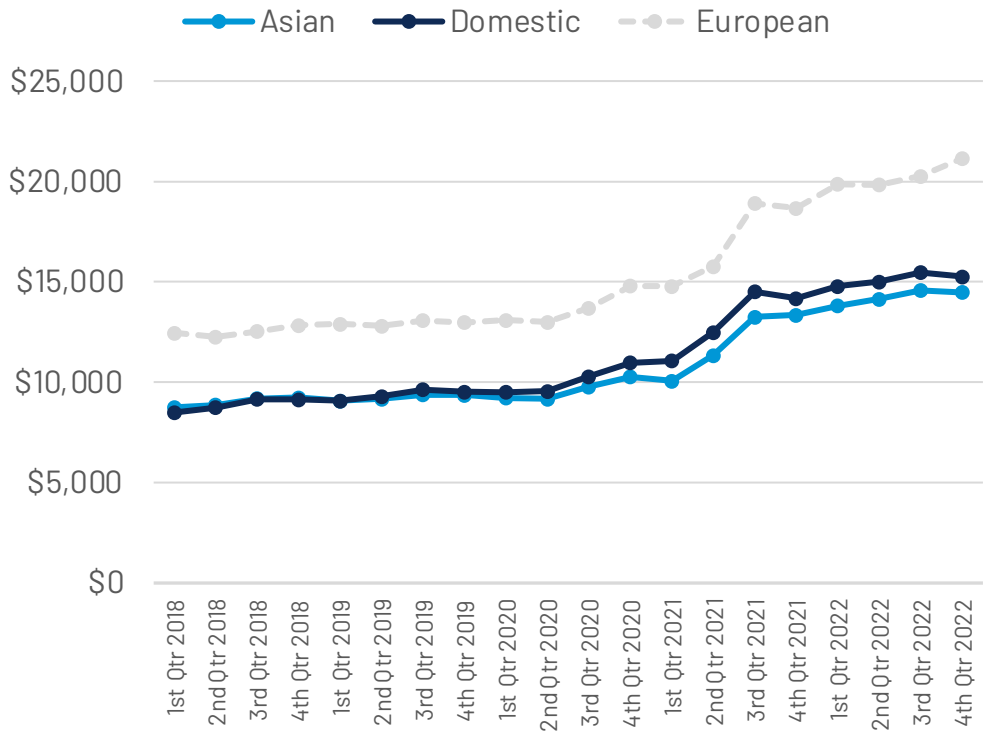
NON-DOMESTIC VEHICLES ACCOUNT FOR A LARGER SHARE OF TOTAL LOSS VEHICLES AND THEIR COSTS ARE HIGHER

Vehicles with European manufacturer country-of-origin have the highest total loss vehicle values.

CCC National Industry All Loss Categories Share Total Loss Valuation Count by Vehicle Source

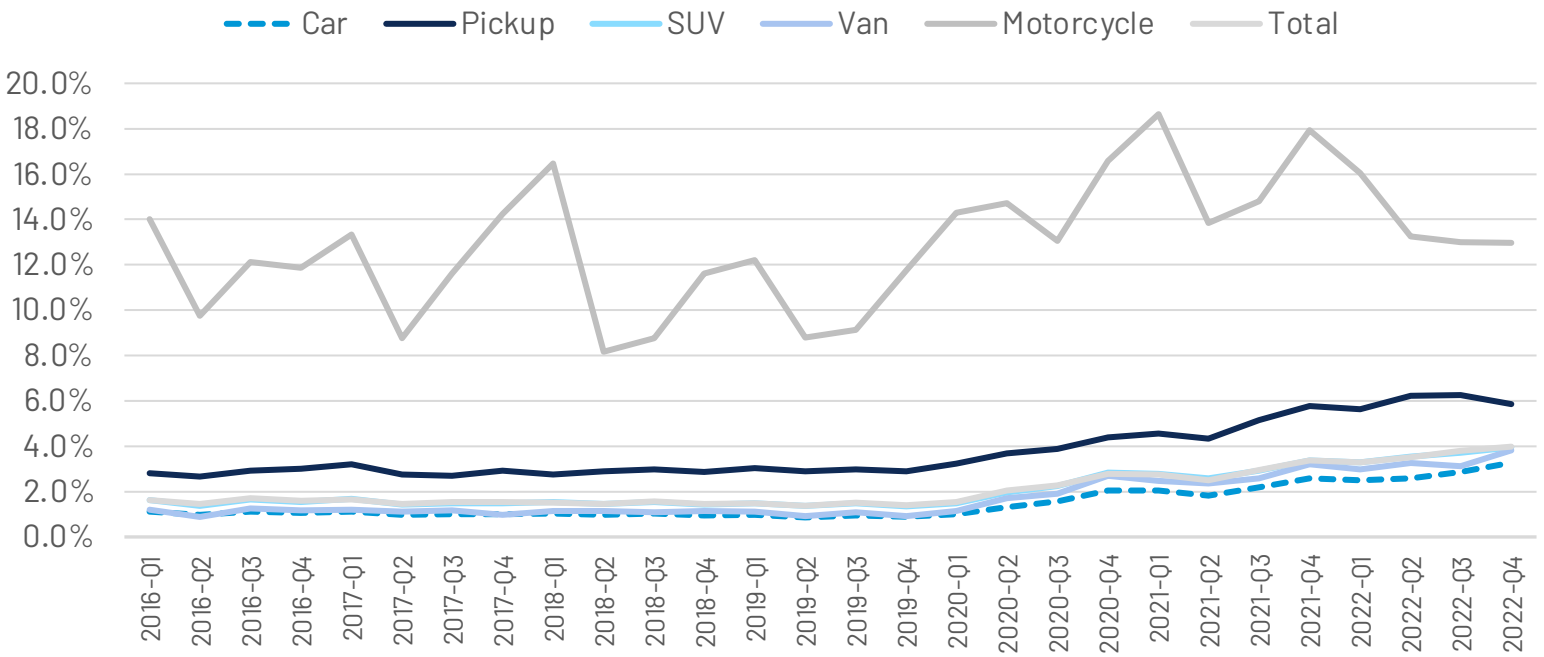


CCC National Industry All Loss Categories Avg Adjusted Vehicle Value Amt by Vehicle Source



AS VEHICLE THEFTS HAVE SOARED IN THE U.S., TOTAL THEFTS' SHARE OF VOLUME HAS GROWN, PARTICULARLY FOR MOTORCYCLES AND PICKUPS

CCC National Industry Thefts as Percent of Total Loss Valuation Counts CY 2016 – CY 2022 by Quarter



CCC data shows the number of total loss theft claims jumped 143% in the last five years as the theft percent of all valuations rose from 1.5% in CY2018 to 3.7% in CY2022.

Thefts of motorcycles, luxury vehicles, and SUVs saw some of largest increases.

NICB report auto thefts in CY 2021 were up 16.5% versus CY 2019 and nearly 27% versus CY 2017. In the first three quarters of 2022 thefts were up 24% versus the same period in 2019.

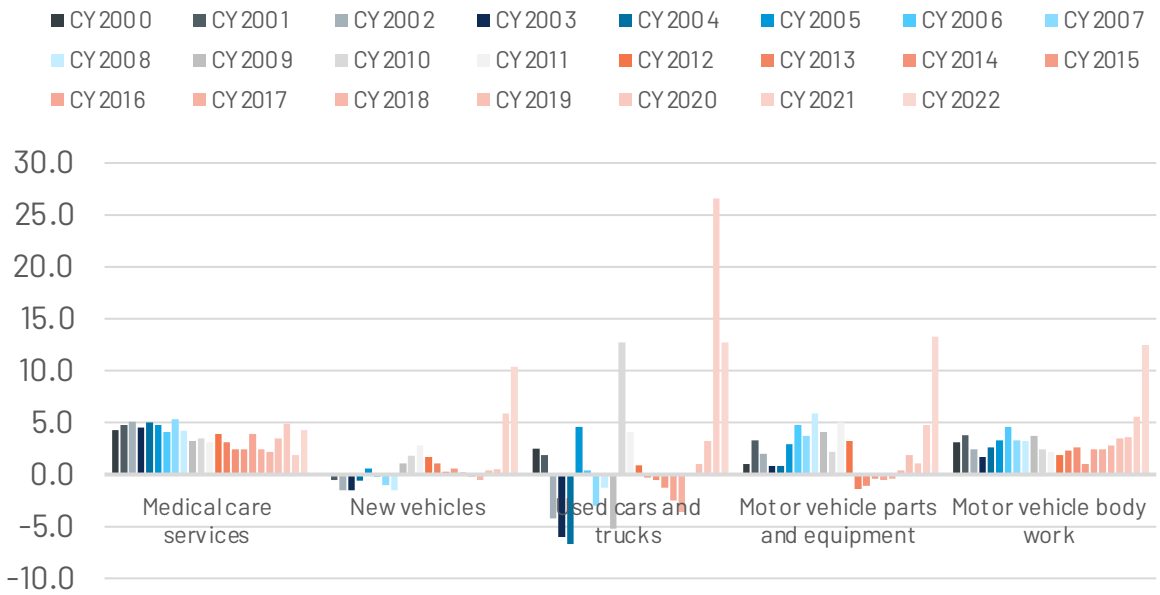
Many large cities have seen triple-digit increases in carjackings.

HIGHER INFLATION LED TO HIGHER LOSSES FOR INSURANCE INDUSTRY

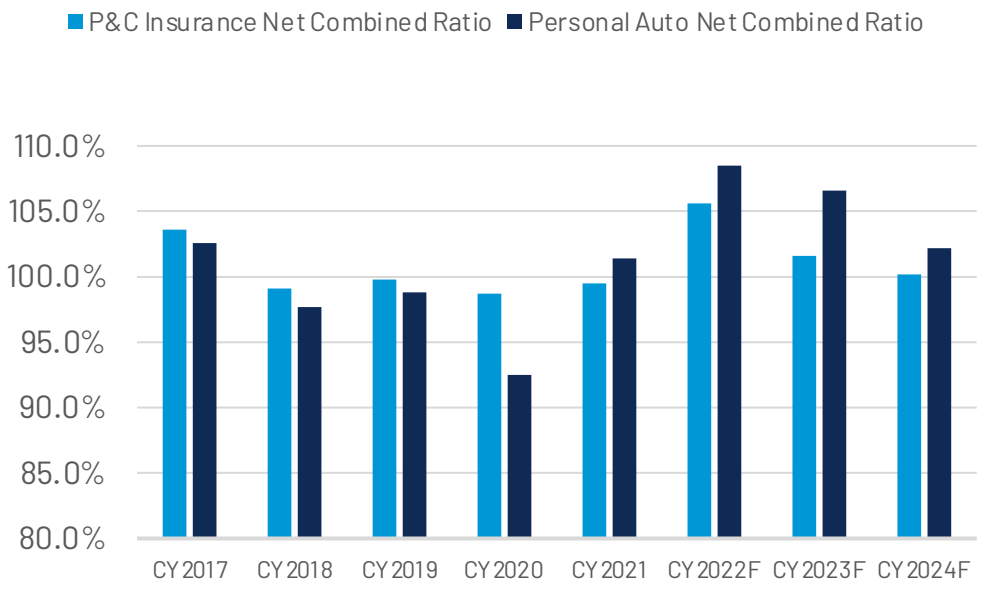
Supply chain disruptions drove higher new and used vehicle prices, but that's not all. Inflation was pervasive, impacting the cost of repair as well. All combined have meant profitability for insurers may prove elusive for some time.

The net result is auto claims costs will remain elevated through 2023,[67] leading many carriers to continue to seek rate further increases.

Bureau of Labor CPI 12-Month Percent Change CY2000-CY2022 U.S. city average, all urban consumers, not seasonally adjusted



U.S. Property Casualty Insurance Industry Net Combined Ratio CY2017-CY2024F



GROWING CAPACITY ISSUES IMPACT TO OUR INDUSTRY

While supply chain challenges may be improving, and there are signs that inflation is abating, the industry faces a challenge that does not have an immediate fix. Capacity issues remain that will likely continue to lead to higher labor costs, longer repair times, and demand for digital tools and AI to help align resources where they have the most impact.

The collision repair and insurance industries are facing a labor shortage. Acute technician shortages exist that don't have a quick fix, and this shortage of qualified labor is having impacts on the collision repair and P&C insurance industries in the following ways:

COLLISION REPAIR INDUSTRY:

- Longer cycle times to produce estimate and repair vehicles.
- Higher labor costs.
- Increased focus on enabling digital/AI to maximize employee efficiency and customer engagement.
- Further complication of decisions around necessary investments repairers must make to ensure they have the tools and training and people necessary to repair today's vehicles.
- Increased need for more capital investment that may ultimately mean more consolidation in the industry.

P&C INSURANCE INDUSTRY:

- Increased focus on enabling digital/AI to focus staff on key customer engagement.
- Increased adoption of technology like smart estimating, AI audits, fraud detection, payments, automated lienholder release, and more to improve employee efficiency.
- Longer claim cycle time.
- Increased adoption of UBI and telematics to combat higher premiums and provide additional benefits like improved driving habits, faster notification, less fraud, and more.

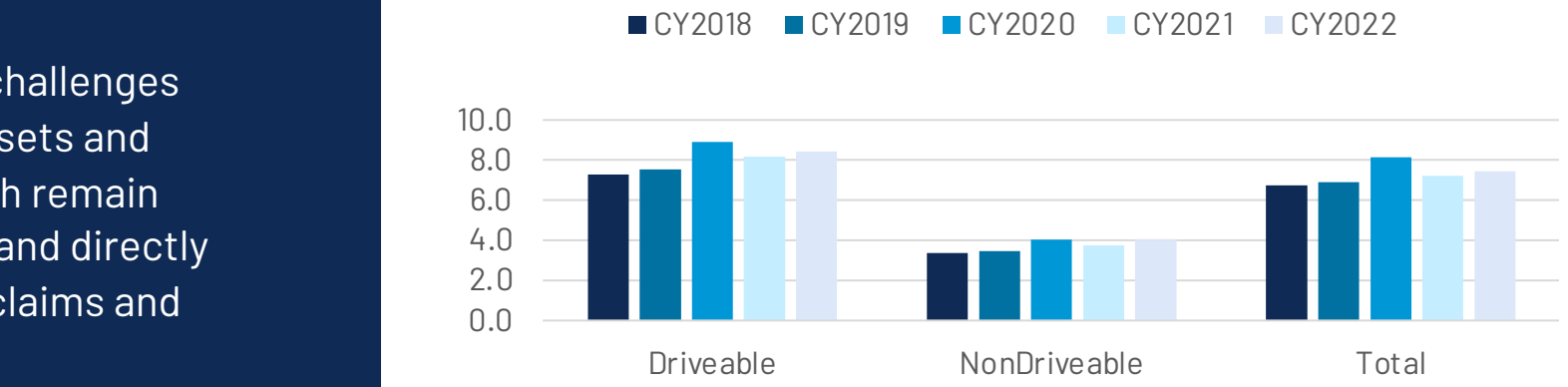
LABOR SHORTAGES IMPACT CLAIM CYCLE TIME

Earlier in this report, we discussed the challenges of finding employees with the right skill sets and meeting demands for higher wages. Both remain key challenges for our industry in 2023, and directly impact the industry's ability to process claims and vehicle repairs in a timely manner.

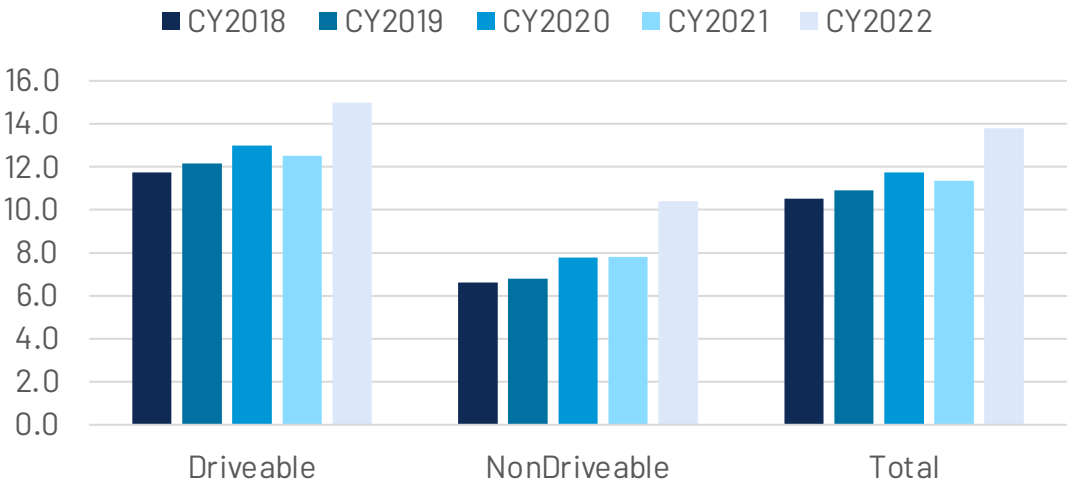
For starters, claimants are taking longer to report their loss. The average days from date of loss to the date the loss was reported peaked during CY2020, but in CY2022 remains higher than pre-pandemic *and* last year's numbers.

The average number of days from when the loss is reported to when the assignment for estimate is made has also grown, trending higher in CY2022 than in the four prior years.

CCC National Industry Repairable Appraisals Date of Loss to Date Loss Reported Days Average



CCC National Industry Repairable Appraisals Loss Report to Assignment Sent Days Average



ESTIMATES TAKE LONGER FOR ALL MOI'S EXCEPT PHOTO

The time from the last assignment to when an estimate is completed and uploaded has grown for driveable and non-driveable vehicle claims, as repairers and insurers struggle with capacity and a higher volume of non-driveable losses.

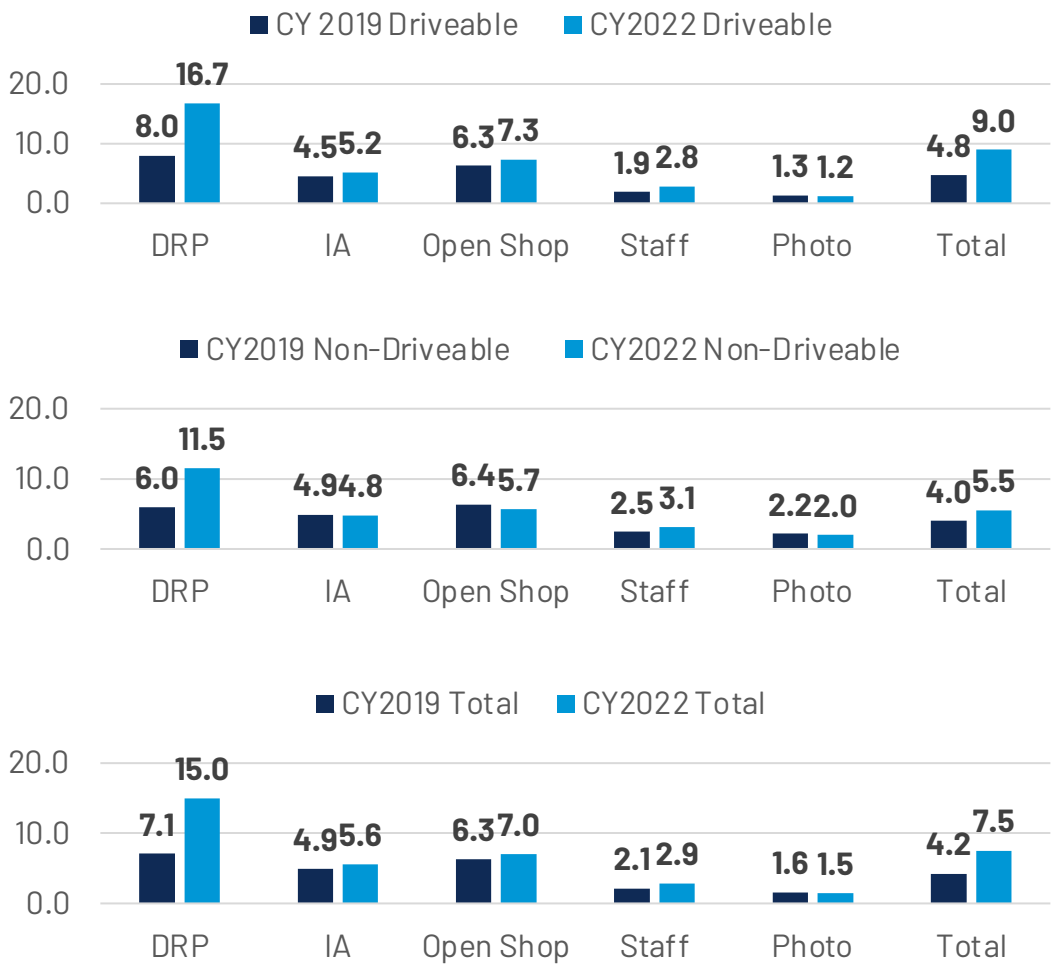
Only appraisals generated via photo estimating technology saw an improvement in the average number of days it took from last assignment sent to estimate sent for both driveable and non-driveable vehicles.

With photo estimating, insurers can continue to provide customers with their initial appraisal and the information they need to make decisions much faster, like whether they want to have their car repaired and if so, where.

Photo estimating usage continues to see strong adoption, with 27.3% of all estimates generated via photo estimating as the initial method of inspection in CY2022, versus 22.5% in CY2021, and 15.2% in CY2019.

According to J.D. Power's 2022 U.S. Claims Digital Experience Study(SM), customer experience with the estimation process is the most notable of digital satisfaction, adding 66 points to overall satisfaction scores when it is done well.

CCC National Industry Repairable Appraisals Last Estimate Assignment Sent to Estimate Sent Days Average by Method of Inspection (CY2019 versus CY2022)

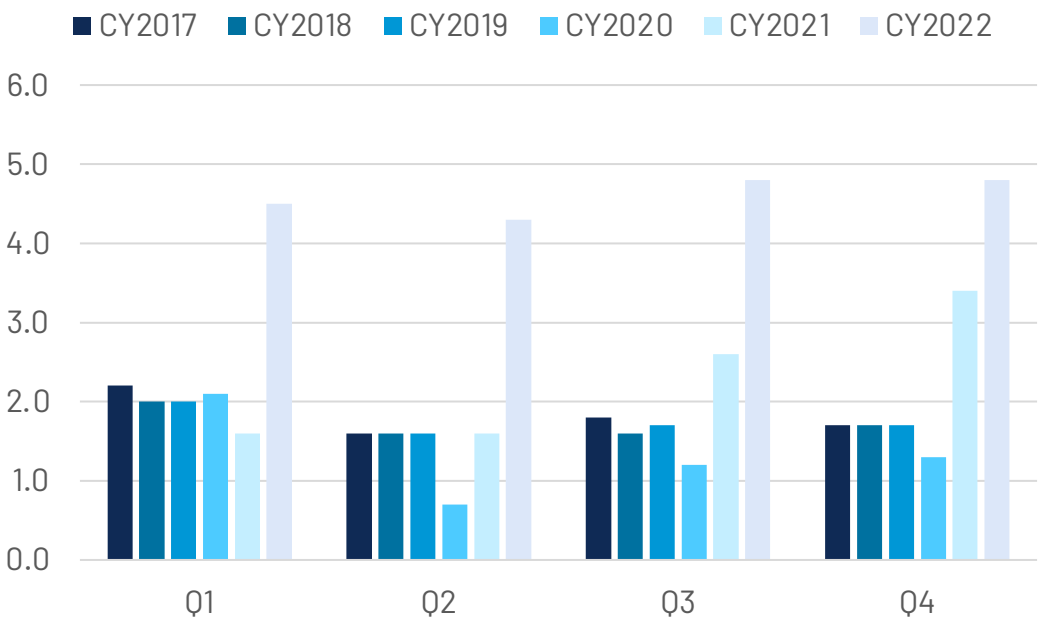


REPAIRER BACKLOGS AT ALL-TIME HIGH

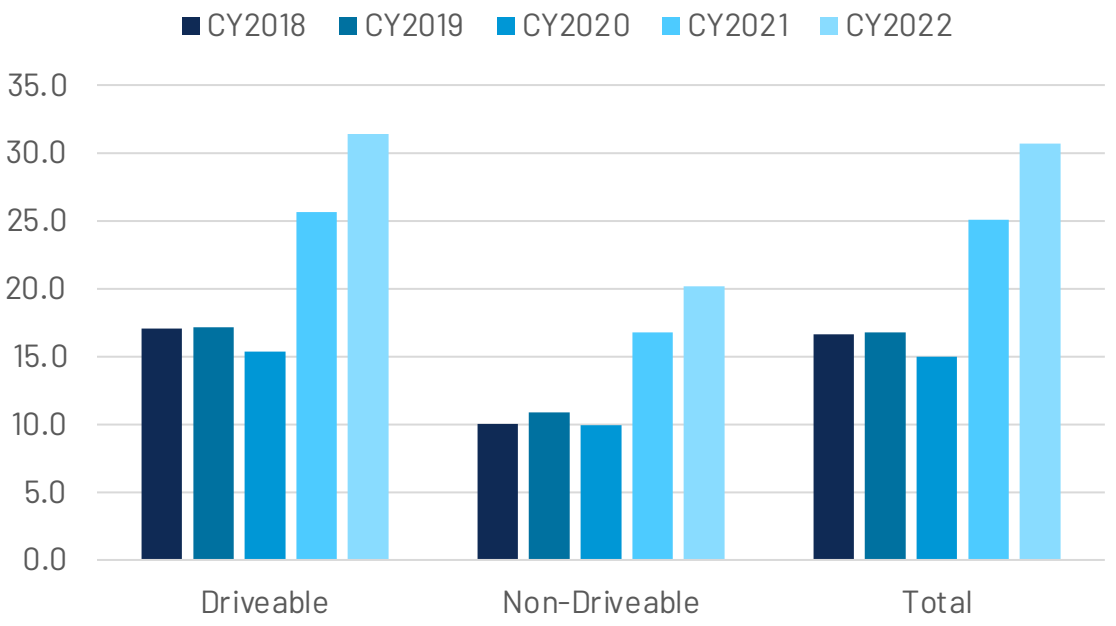
With repairers experiencing record backlogs, once the appraisal is complete, the time to get the vehicle in for repairs is now longer, driving up overall claim cycle time even further.

Most repairers indicate the technician shortage has been the primary reason for longer backlogs of work. Repair work is up as auto accident frequency has risen.

CRASH Network's U.S. National Collision Repair Scheduling Backlog in Weeks



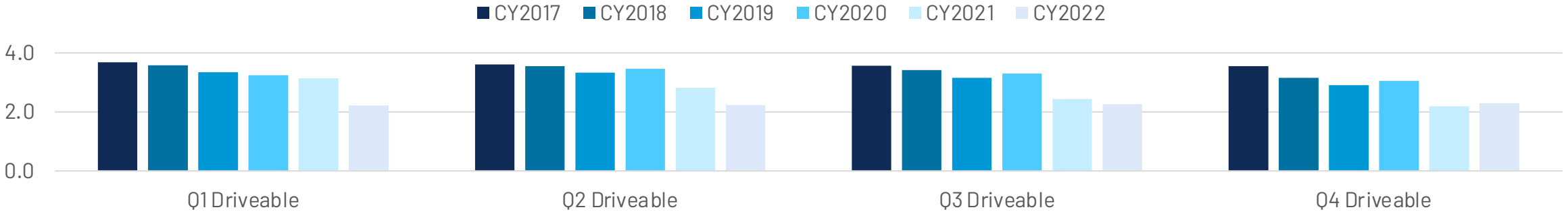
DRP Repairs CCC National Industry Estimate Sent to Vehicle In Days Average by Driveable Flag



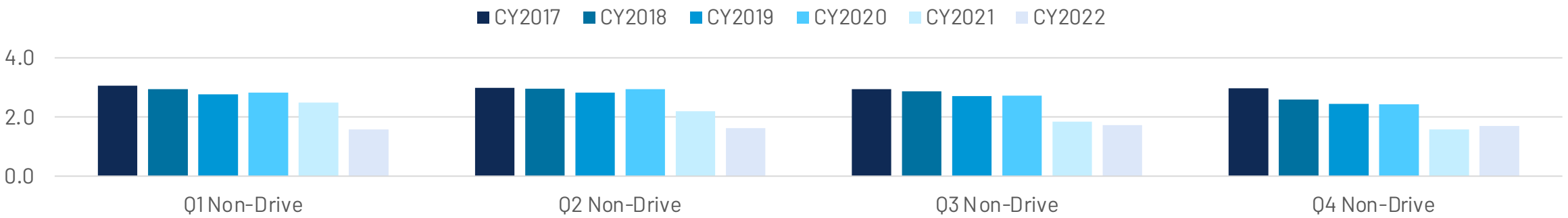
REPAIRER PRODUCTIVITY HAS FALLEN

As previously stated in this report, many shops have indicated they cannot repair as many vehicles at the same time as they did before the pandemic. Analysis of repairer productivity for both driveable and non-driveable vehicles underscores this sentiment.

Driveable DRP Repairs CCC National Industry: Labor Hours per Repair Day by Quarter



Non-Driveable DRP Repairs CCC National Industry : Labor Hours per Repair Day by Quarter



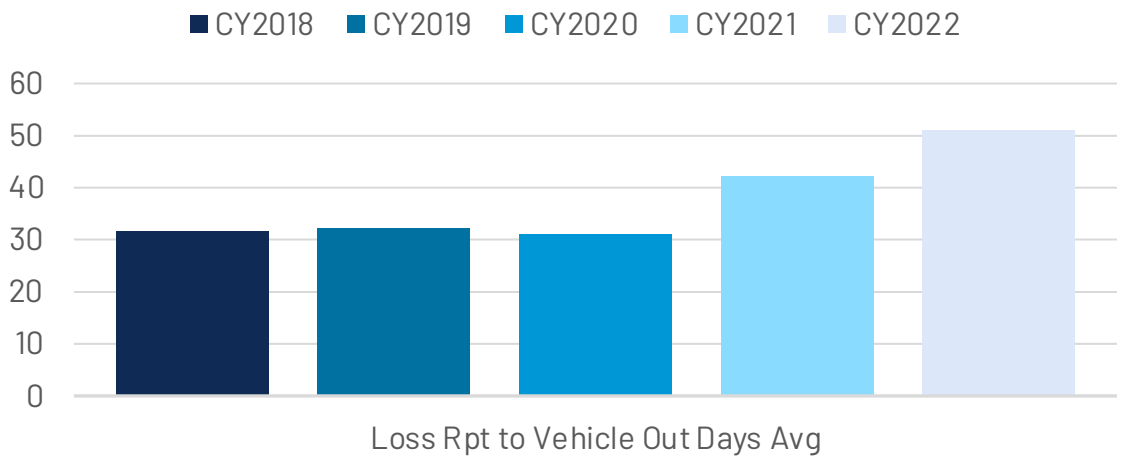
CAPACITY ISSUES DRIVING UP OVERALL CLAIM CYCLE TIMES AND DRIVING DOWN CUSTOMER SATISFACTION

All combined, the average number of days from when a loss is reported to when the vehicle is picked up after repair has grown to nearly 50 days.

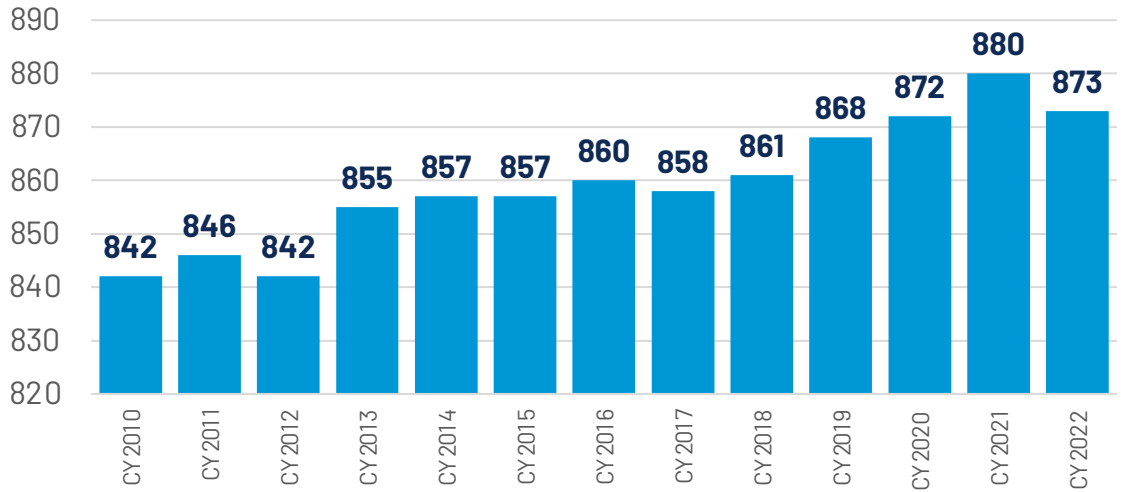
The J.D. Power 2022 U.S. Auto Claims Satisfaction Study(SM) saw a 7-point drop in overall satisfaction with the insurance claims process "... as customers start to lose patience with the claims process."

As vehicle repair cycle times have grown due to supply chain issues, J.D. Power's survey shows satisfaction with the repair process also fell in CY2022 by 9 points.

CCC National Industry Average Claim Cycle Times CY2018-CY2022



J.D. Power 2022 U.S. Auto Claims Satisfaction Study(SM) Auto Claims Satisfaction (1,000 scale)



COLLISION REPAIR INDUSTRY FACES FURTHER TRANSFORMATION

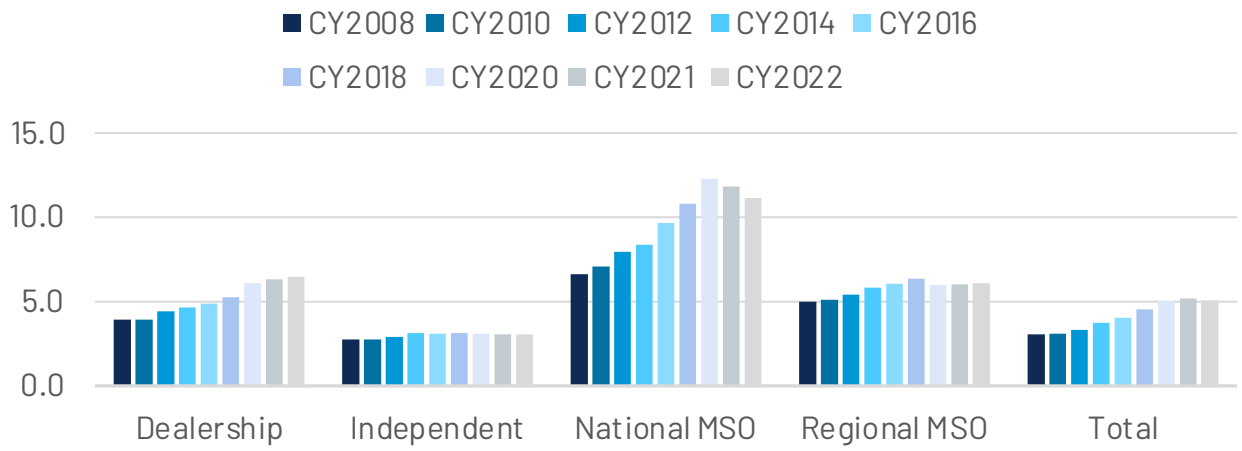
Finding qualified technicians is just one of many challenges facing the collision repair industry.

Growth in vehicle complexity is driving the need for repairers to make more significant investments in tooling and training than perhaps ever before.

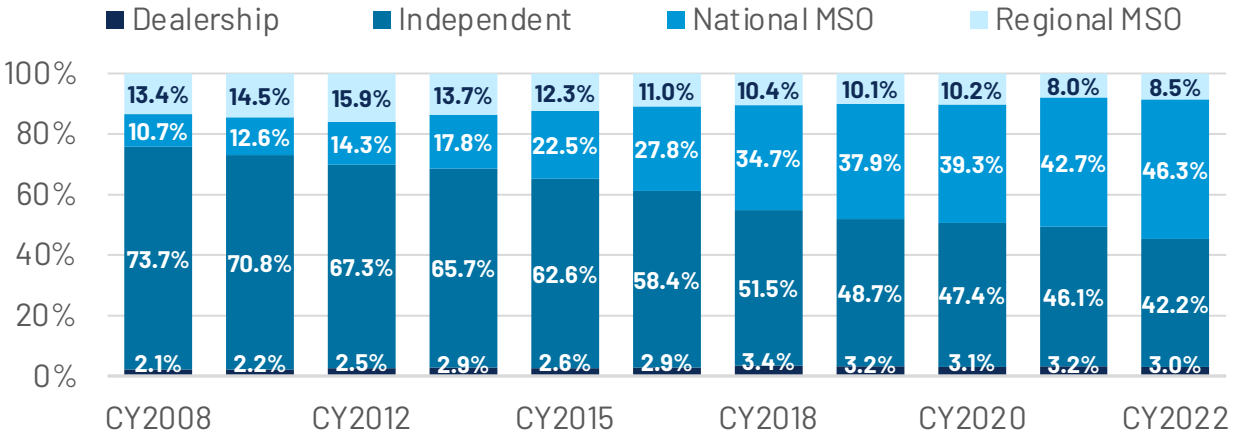
Determining when to make those investments, what the priority of those investments should be, and which insurer and automaker programs to participate in are just some of the decisions they must make.

Not surprisingly, we continue to see growth in market share of repairers with multiple locations, either at a regional or national level, and DRP program participation has fallen for some shops as repairers are no longer competing for repair volume, but rather for the most profitable business.

Average Number of Direct Repair Programs Repairers Participate in by Shop Type CCC National Industry CY 2008 to CY 2022



Share of CCC National Industry Annual Uploaded DRP Appraisal Count



PERFORMANCE: INDUSTRY IMPACT
AUTO PHYSICAL DAMAGE — SUMMARY

Heading into CY2023, the industry continues to see auto accident and claim counts rebuild to pre-pandemic levels, but how people are driving now appears permanently changed. Drivers remain highly distracted and prone to dangerous behaviors like speeding and driving distracted. Vehicle complexity will increase further as automakers take us further down the ACES path towards more connectivity, autonomy, and electrification.

With rising repair complexity and capacity constraints, repair and claim cycle times will remain elevated. Customer satisfaction typically falls as claim and repair costs and cycle times rise. Consumers may need more frequent updates to feel informed throughout the process, so staying connected is more critical than ever to customer engagement and their experience.

Supply chain issues, labor shortages, ever-growing vehicle complexity, and higher inflation means customers are paying and waiting more than ever before. Use of digital and AI has been shown to help reduce cycle time, focus staff on the most meaningful customer touchpoints, reduce fraud, keep the customer up-to-date, and manage costs. But there is still much to be done.

Now, more than ever, it is essential for the automotive, P&C insurance, and collision repair industries to stay current on new technologies, tooling, and training. Managing complexity while continuing to improve the consumer experience remains the challenge.

KEY **TAKEAWAY**

- Driving behaviors appear permanently changed.
- Vehicle complexity and capacity constraints will continue to rise.
- Customers are paying and waiting more.
- Now, more than ever, technology is needed to bridge the divide.

PERFORMANCE: CASUALTY

ERIK BAHNSEN

SENIOR MANAGER, INDUSTRY ANALYTICS, CCC

A best-in-class claim experience harnesses a deft combination of technology and "personal" touch by way of omnichannel interface flexibility, reduced touchpoints, proactivity, and speed to resolution/payment.

PERFORMANCE: INDUSTRY IMPACT — CASUALTY

THE NEW NORMAL

Disparate factors including shifted traffic patterns, evolving vehicle technology, persisting risky driving behaviors, aging driver population, medical care inflation, and medical provider revenue/staffing challenges collide to play their part in the developing story for casuality claims.

MEETING TODAY'S CHALLENGES

The industry continues to experience a combination of treatment avoidance from continuing public health concerns, and medical care capacity constraints arising from labor shortages, negative financial margins, and increased mergers and acquisitions. Despite severity and staffing challenges, insurers embracing enhanced bill audit capabilities and tightened workflows have shown improved outcomes.

WHAT'S CHANGING

New medical treatment patterns are emerging, with increased focus on the front end of the treatment cycle. Higher impact severity translates to more head injury diagnoses and increasing concentration of dollars into rapidly inflating diagnostic radiology, evaluation and management, and hospital inpatient procedures.

MEDICAL PROVIDER TRENDS

STRUGGLING FINANCIAL PERFORMANCE as most hospital and health systems had projected negative margins through 2022, mainly due to inflation of overhead and labor costs, the latter exacerbated by a shortage of labor. Rural health systems have been especially vulnerable with many closing or cutting services.

DEFERRED PATIENT CARE & REDUCED SERVICES as providers cut departments and services to stabilize finances. Capacity problems due to spikes in COVID variants, seasonal cold/flu, and patient financial pressures from inflation and recession concerns.

REBOUNDING MERGERS & ACQUISITIONS, most notably "mega-mergers" of large hospital systems. In addition, private equity firms have been purchasing physician and specialty practices at an accelerated rate.

INCREASED DIGITIZATION AND TECHNOLOGY IMPLEMENTATION for operational efficiency, safeguards from cybersecurity threats, and expanded patient care via telehealth.

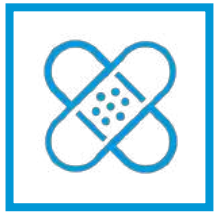
KEY **TAKEAWAY**

Formidable challenges faced by medical providers will ultimately affect the quality and availability of medical care for a growing number of U.S. communities in the short-term.

1ST PARTY CASUALTY OVERVIEW

FREQUENCY

- Claim frequency has stabilized at 18% lower than the pre-pandemic baseline over the last two years.
- Factors contributing to reduced frequency include treatment avoidance due to COVID variants, reduced medical care access and availability, age demographic shifts, and ecommerce growth (driver injury claims go to work comp).



SEVERITY

- Bill line severity is increasing, as of H2 2022, after seeing little change over the previous two years.
- Increases track with CPI medical care inflation, which peaked at 6%in Q3 2022.

TREATMENT

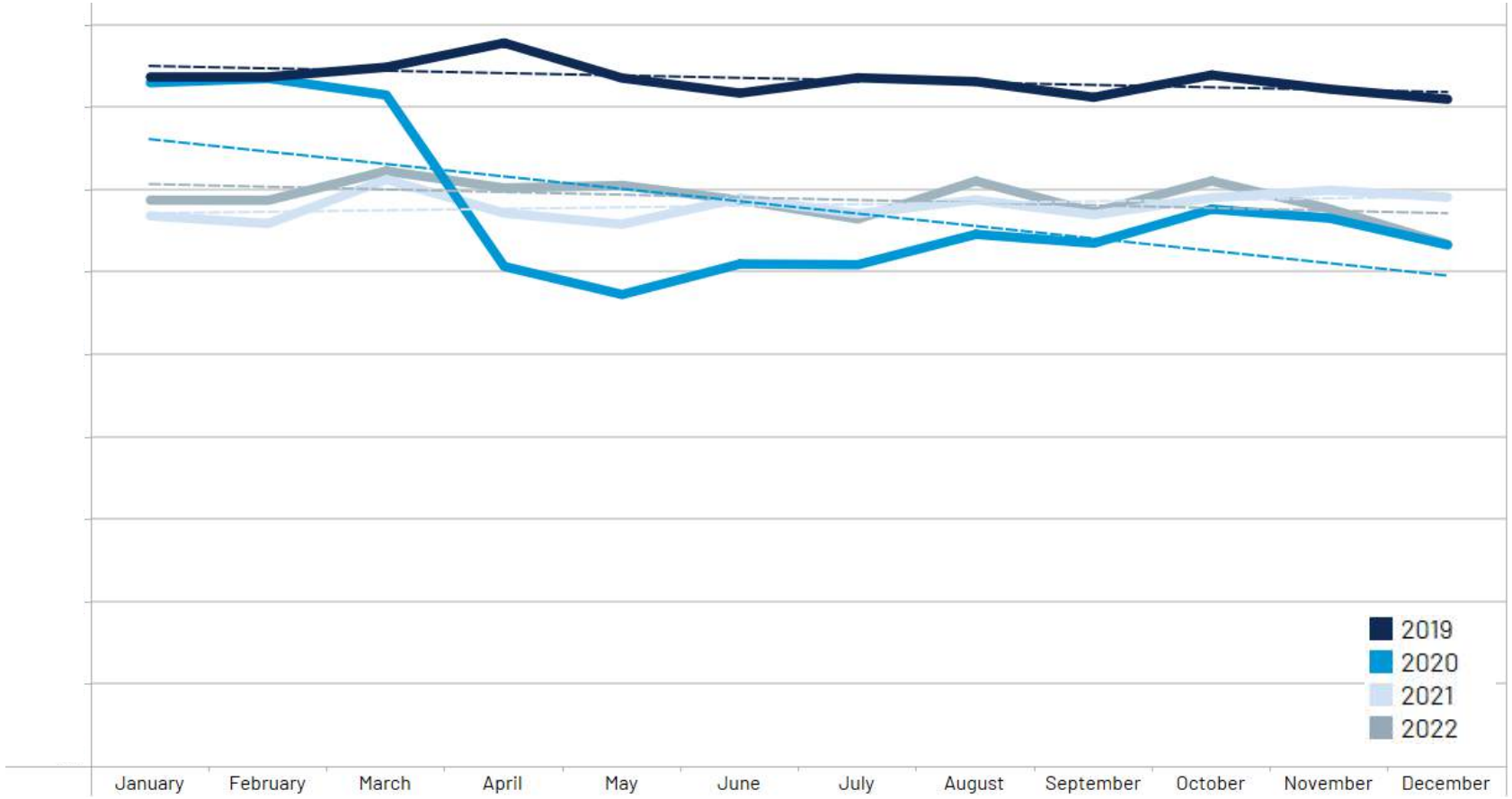
- Treatment has shifted to increased percentage of Evaluation & Management, Physical Therapy & Chiropractic Care, Inpatient, and Radiology procedure dollars in 2022.
- Primary diagnoses of Head Injury and Fracture have increased as a percentage of all diagnoses.
- Injured parties aged 31-40 and 61-80 have increased as a percentage of all injured parties.

1ST PARTY CASUALTY

FREQUENCY REMAINS LOWER

1st Party Frequency | Count of Distinct Claims Received

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



*Trend shows only customers in full production during time period

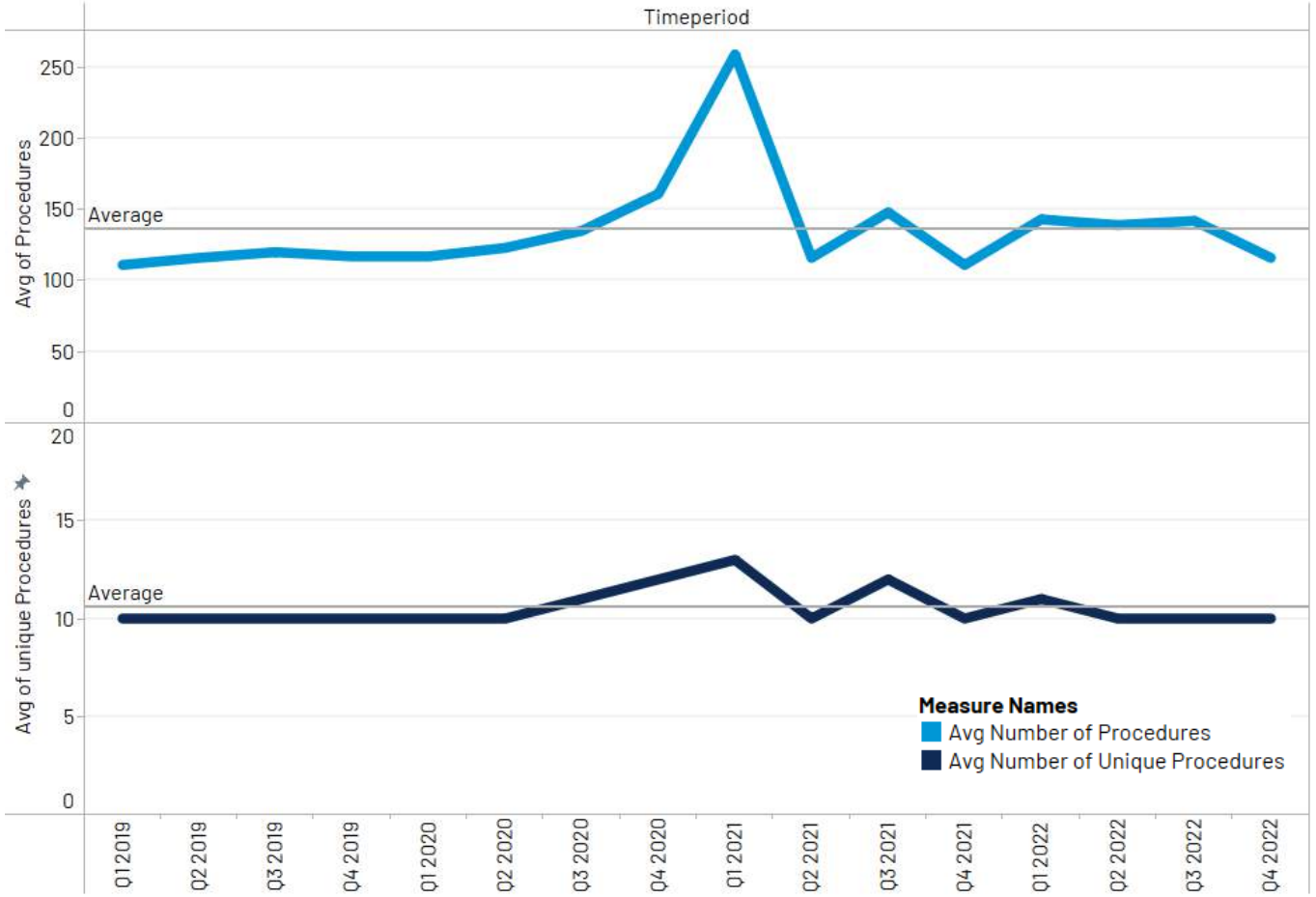
Claim frequency remains **18% LOWER** than the 2019 baseline despite recovered vehicle miles traveled, likely due in part to factors such as age demographic shifts, continued COVID variants, e-commerce and commercial share growth, and medical care availability and access.

1ST PARTY CASUALTY

TREATMENT COMPLEXITY REMAINS STABLE

Average Total and Unique Procedure Per Injured Party

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



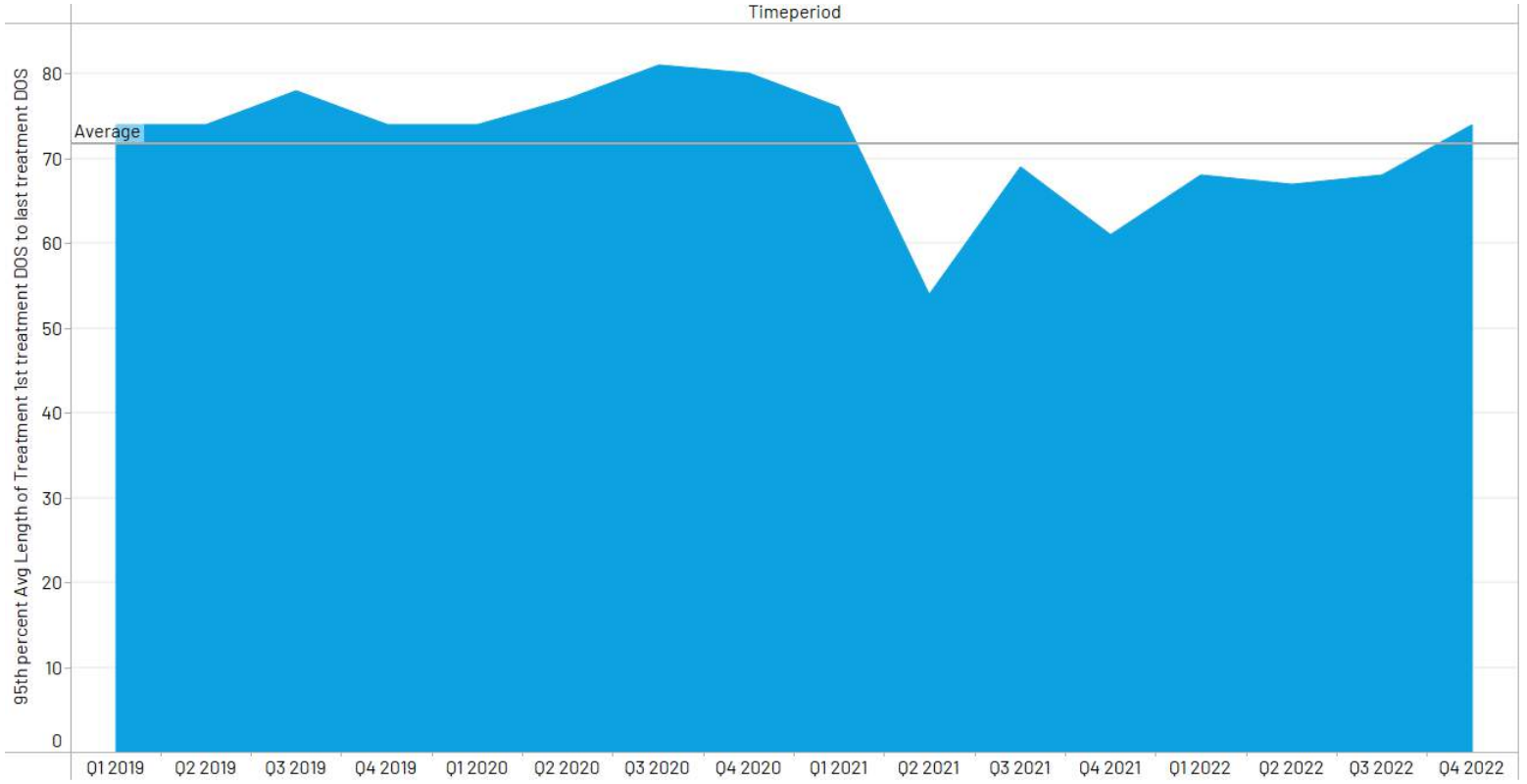
Average treatment complexity has remained relatively stable over the last year.

1ST PARTY CASUALTY

CYCLE TIME FLAT TO 2019

Average Length of Treatment Per Injured Party 1st DOS to Last DOS (Days)

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



*Top 5% of cycle times have been excluded from this view

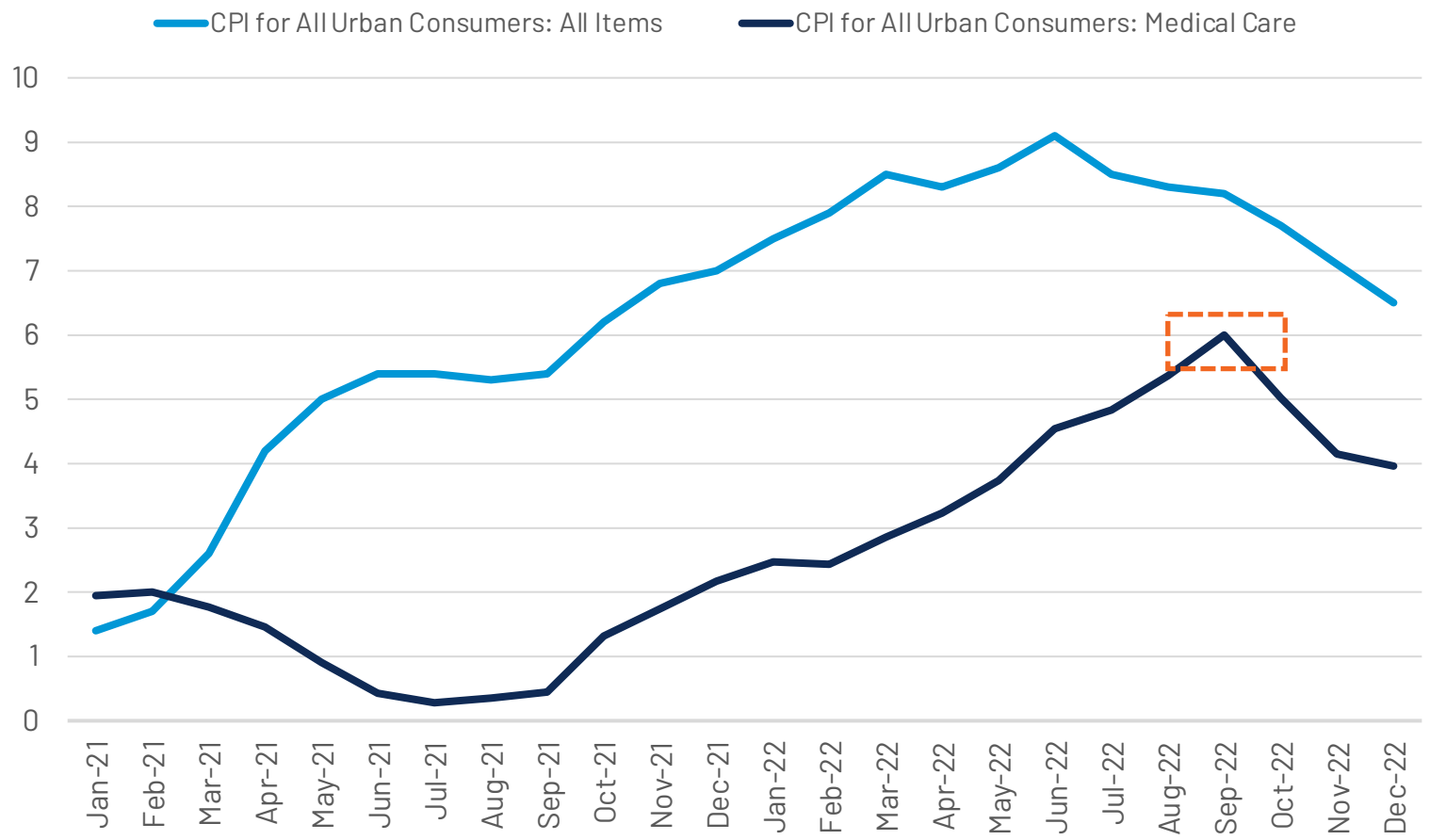
Average treatment cycle time is comparable to 2019 baseline.

1ST PARTY CASUALTY

CPI SEVERITY HAS PEAKED

Average Length of Treatment Per Injured Party 1st DOS to Last DOS (Days)

SOURCE: U.S. BUREAU OF LABOR STATISTICS



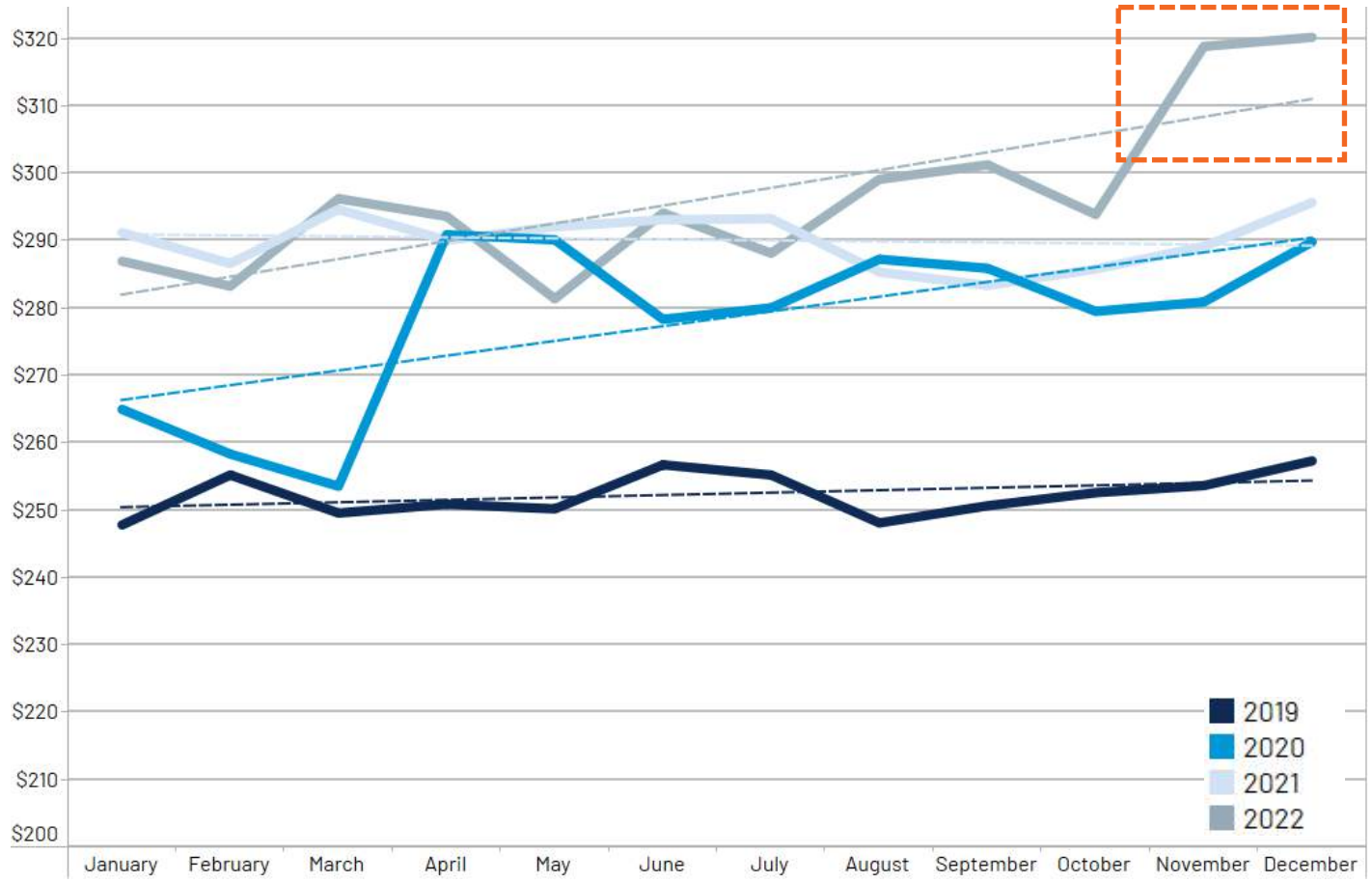
CPI medical care inflation appears to have **PEAKED AT 6%** as of September 2022.

1ST PARTY CASUALTY

BILL LINE SEVERITY INCREASES ACCELERATING

Average Billed Per Lines Less Dups by Client Received Date

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



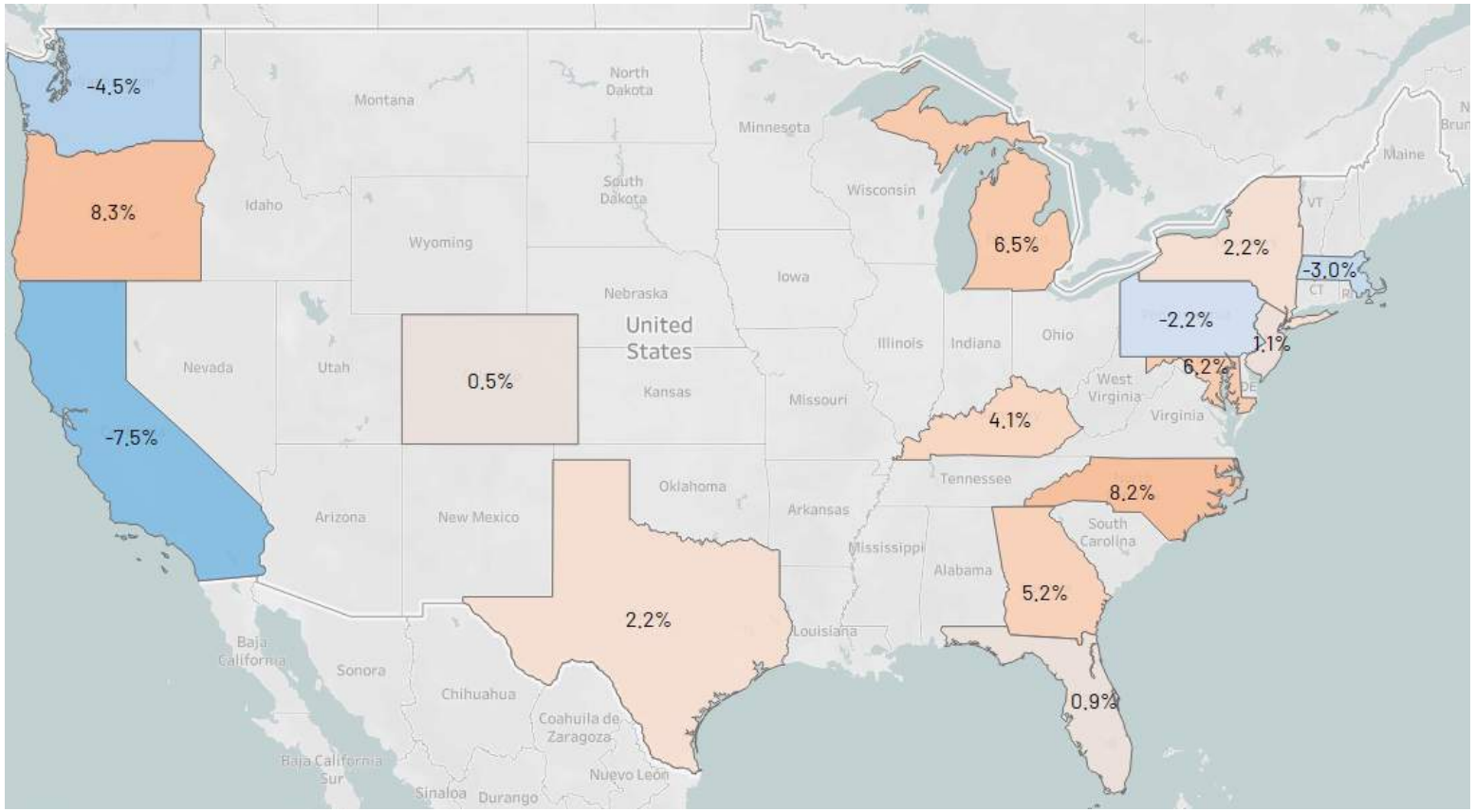
Bill line severity increases have accelerated as of H2 2022 after remaining flat for most of the post-pandemic period.

1ST PARTY CASUALTY

BILL LINE SEVERITY INCREASES VARY BY STATE

Key States: Percentage in Average Billed 2021 VS 2022

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



Bill line severity increases have been largest in the following key U.S. States:

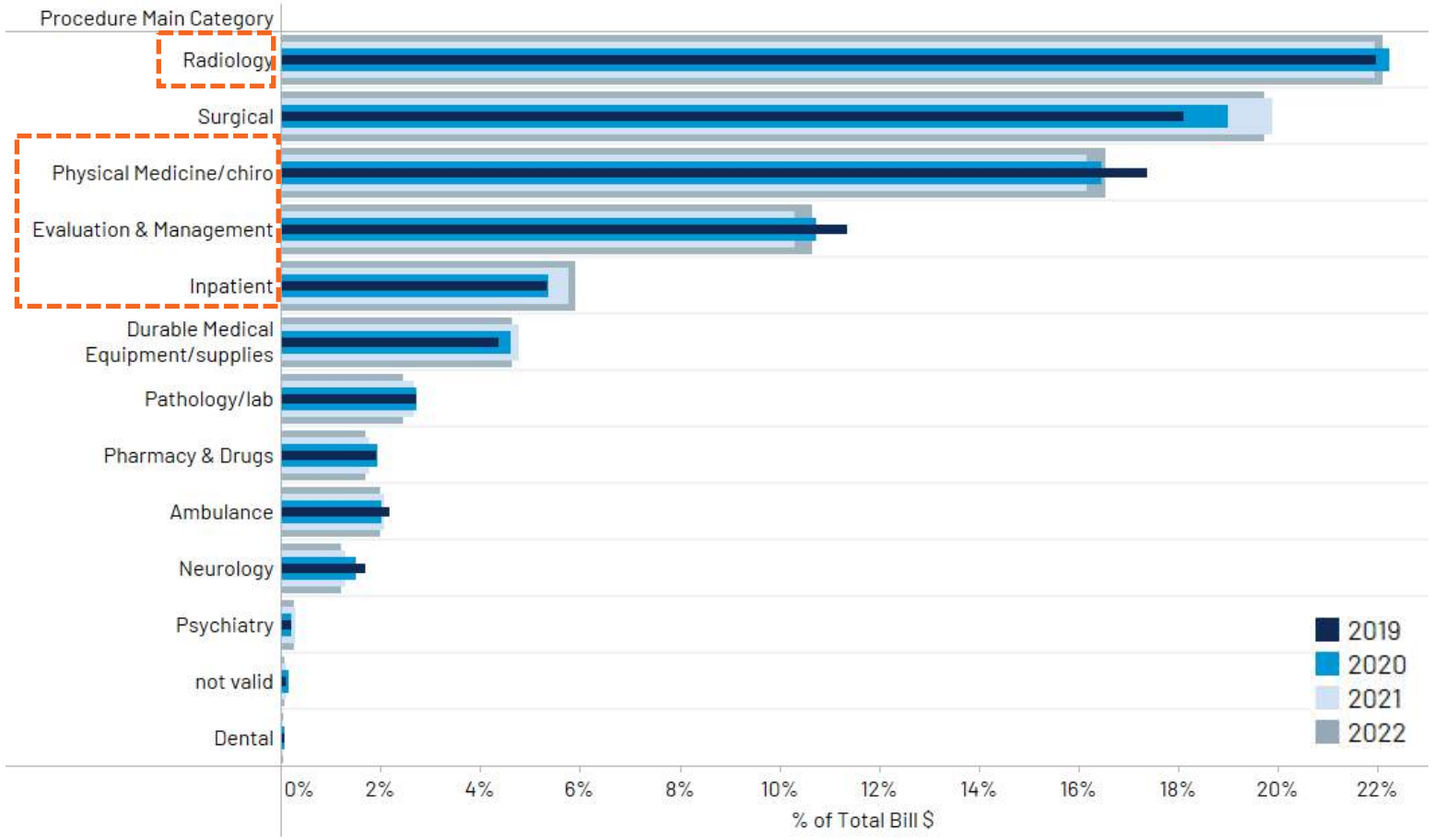
- North Carolina
- Oregon
- Maryland
- Michigan
- Georgia

1ST PARTY CASUALTY

PROCEDURE COSTS HAVE SHIFTED

Procedure Categories | Percentage of $ Billed by Client Received Date

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



Treatment has shifted to increased Evaluation & Management, Physical Therapy and Chiropractic, Radiology, and Inpatient Procedure dollars in 2022.

1ST PARTY CASUALTY

LINE LEVEL SEVERITY INCREASED ON NEARLY ALL PROCEDURES SUB-CATEGORIES

Procedure Frequency and Average $ Billed 2021 VS 2022

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.

Procedure Main Category	Procedure Sub Category	Avg. Bill $ 2021	Avg. Bill $ 2022	% of Total Bill Lines 2021	% of Total Bill Lines 2022
Physical Medicine/chiro	Active Physical Medicine/chiro	$83	$85	28.64%	29.24%
	Passive Physical Medicine/chiro	$48	$49	43.51%	43.62%
Evaluation & Management	High Level E&m	$1,342	$1,425	1.06%	1.05%
	Low Level E&m	$198	$210	1.58%	1.53%
	Moderate Level E&m	$388	$417	2.55%	2.51%
	Other Evaluation & Management	$215	$219	1.25%	1.30%
Inpatient	Inpatient Drg	$49,308	$57,646	0.01%	0.01%
	Inpatient Revenue Codes	$14,931	$15,118	0.09%	0.09%
Radiology	Computerized Tomography	$2,625	$2,700	1.37%	1.38%
	Magnetic Resonance Imaging	$1,594	$1,616	0.94%	0.95%
	Other Radiology	$908	$792	0.27%	0.23%
	Ultrasound	$455	$383	0.24%	0.31%
	X-ray	$338	$356	2.75%	2.71%

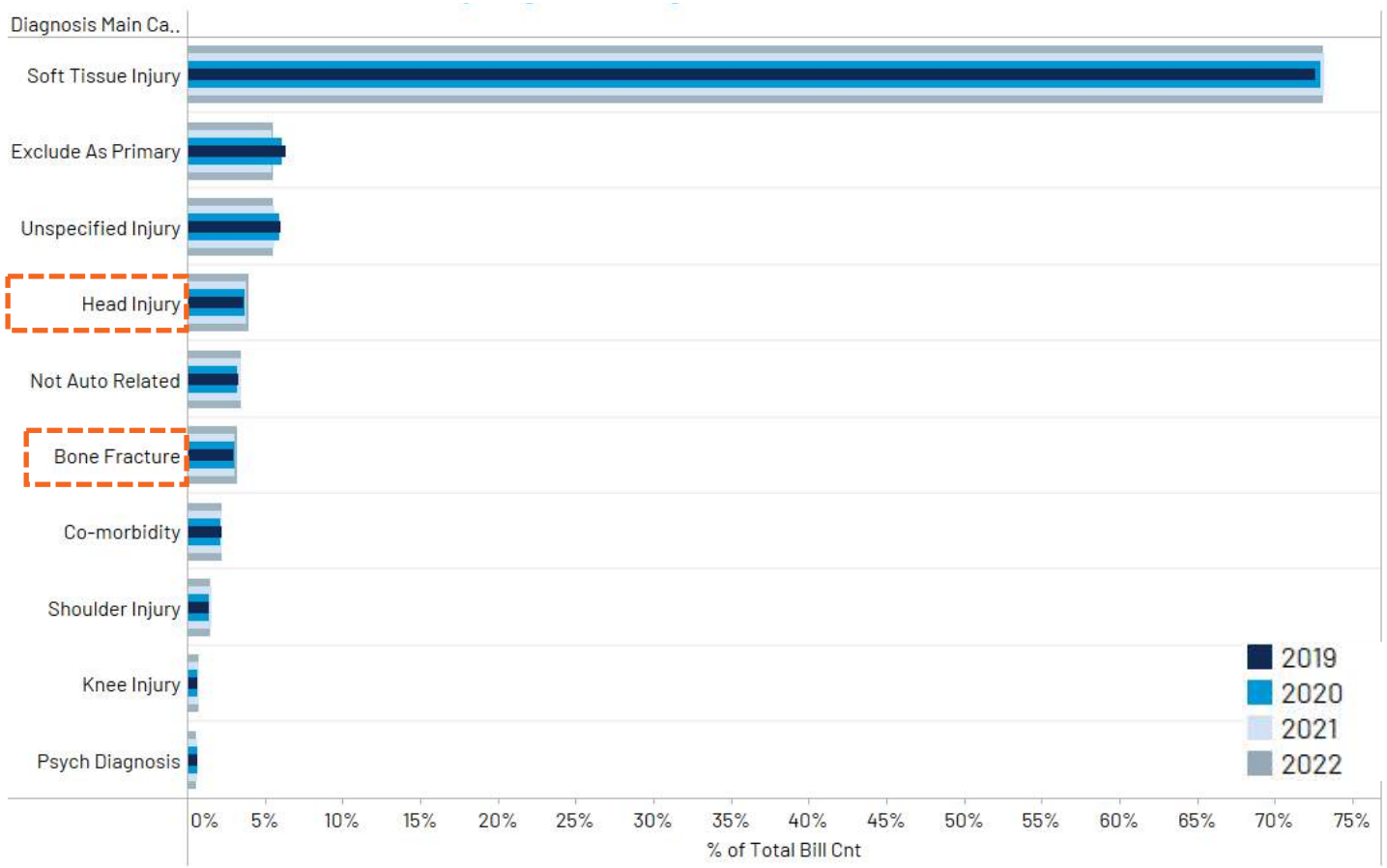
Line level severity increases were observed on nearly all procedure subcategories, with notable frequency increases observed on Physical Therapy and Chiropractic procedures.

1ST PARTY CASUALTY

DIAGNOSIS OF HEAD INJURIES AND FRACTURES INCREASED

Primary Diagnosis Categories: Percentage of All Bills (Count)

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



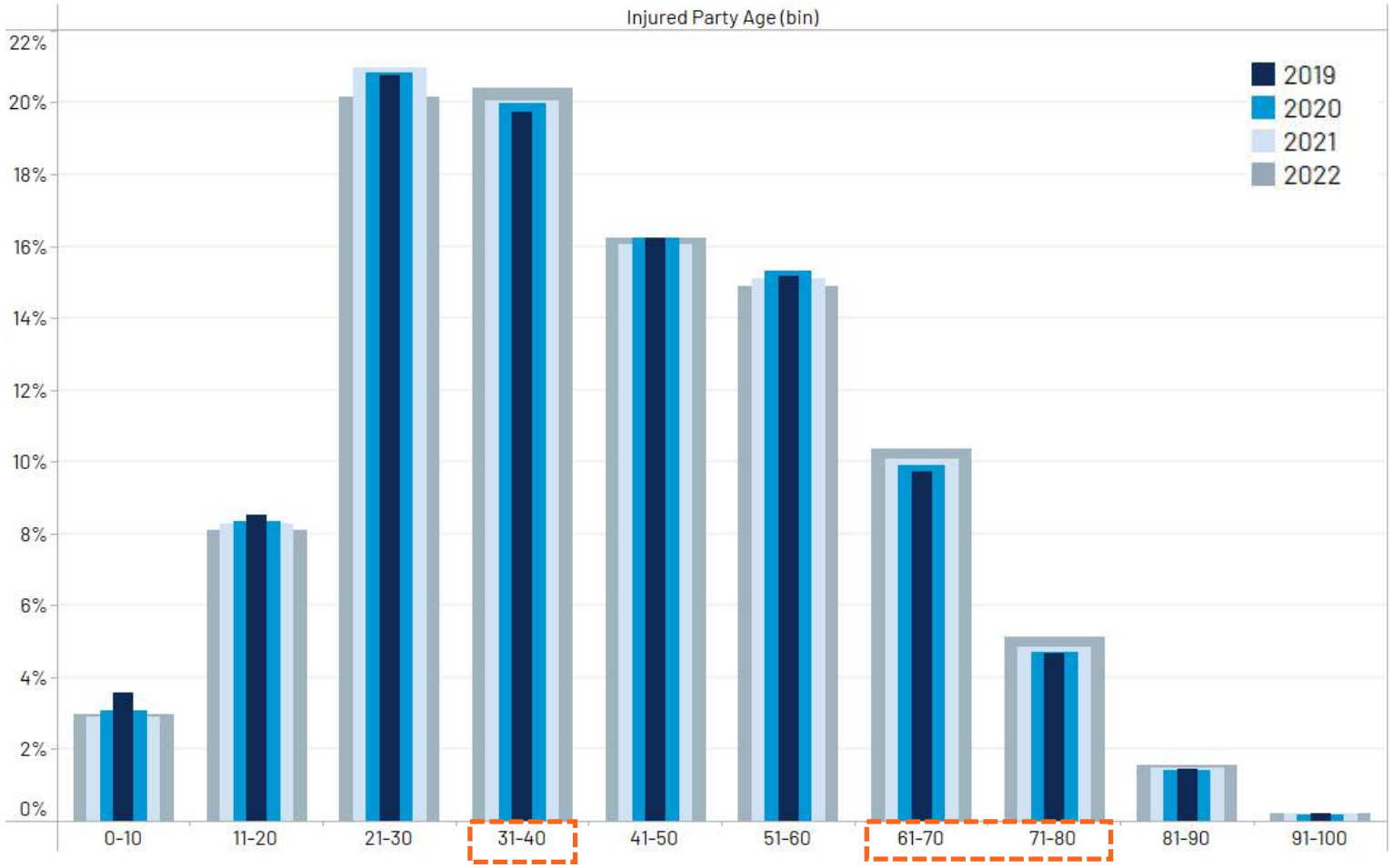
Primary diagnoses of head injuries and fractures have increased slightly in 2022.

1ST PARTY CASUALTY

INCREASES IN SOME AGE SEGMENTS

Injured Party Age Distribution

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



There were notable increases in injured parties aged 31-40 and 61-80 in 2022.

3RD PARTY CASUALTY OVERVIEW

CLAIMS

- Claim frequency has increased to within a few percentage points of pre-pandemic baseline.
- Bill line severity increases have accelerated as of H2 2022 on the heels of ramping CPI medical care inflation.
- Injured party level severity increases have also accelerated, although they're partially offset by reduced treatment complexity.

TREATMENT

- Treatment has shifted to increased percentage of Radiology, Evaluation & Management, and Inpatient procedure dollars in 2022.
- Primary diagnoses of Head Injury have increased as a percentage of all diagnoses.
- Injured parties aged 61-80 have increased as a percentage of all injured parties.

OUTCOMES

- Configurable adjuster tools are effectively counteracting excessive rises in severity, as demonstrated by rising medical bills submitted vs more modest rises in final settlement outcomes

3RD PARTY CASUALTY

CLAIM FREQUENCY NEARS 2019 BASELINE

Industry Frequency | Count of Original Demand Packages Complete

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.

*Data shows only customers in full production during time period

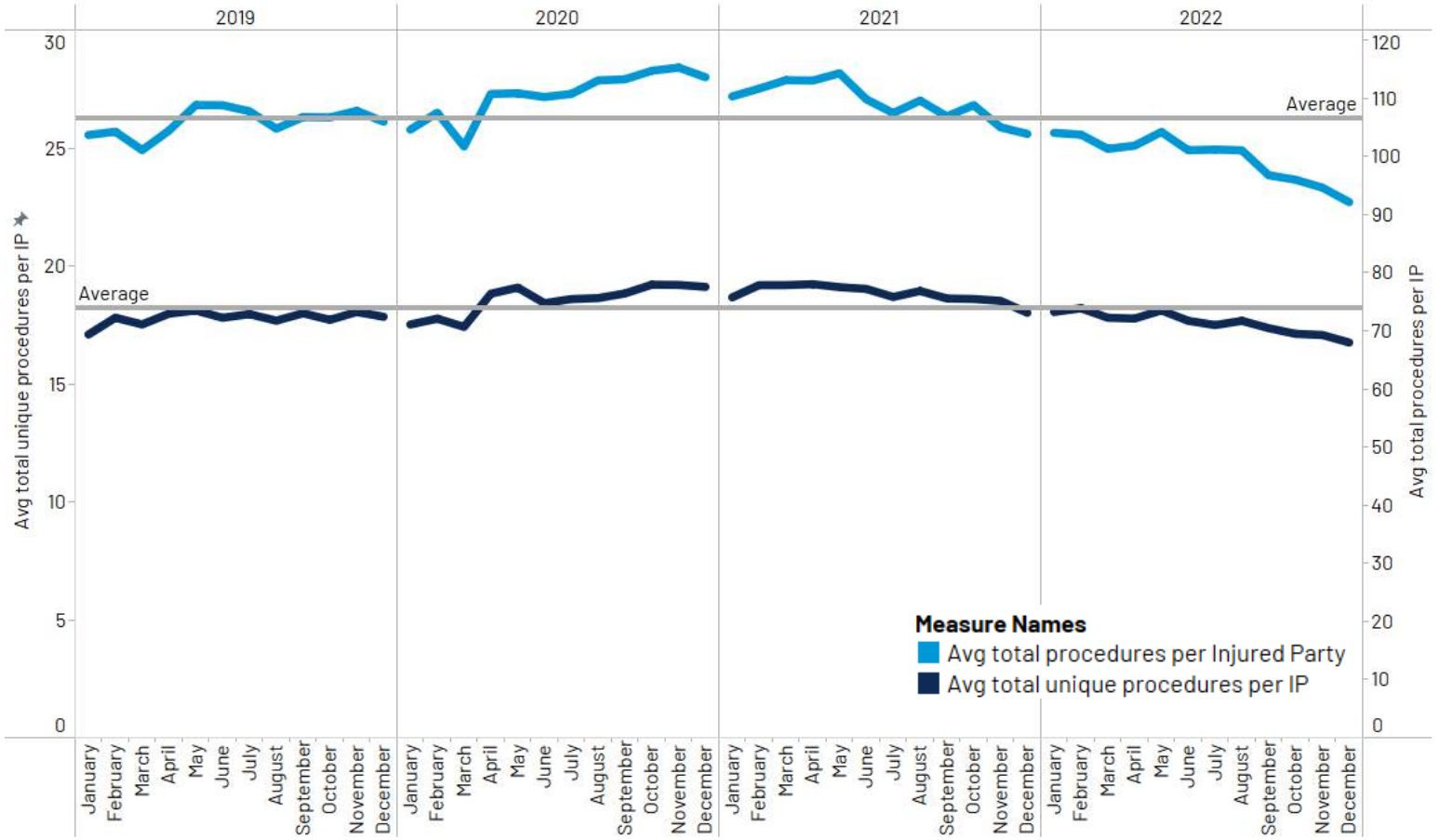
Claim frequency has increased to within 4% of 2019 baseline, as of Q4 2022.

3RD PARTY CASUALTY

CLAIM COMPLEXITY DROPS BELOW 2019 BASELINE

Complexity Total and Unique Procedure Per Injured Party

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



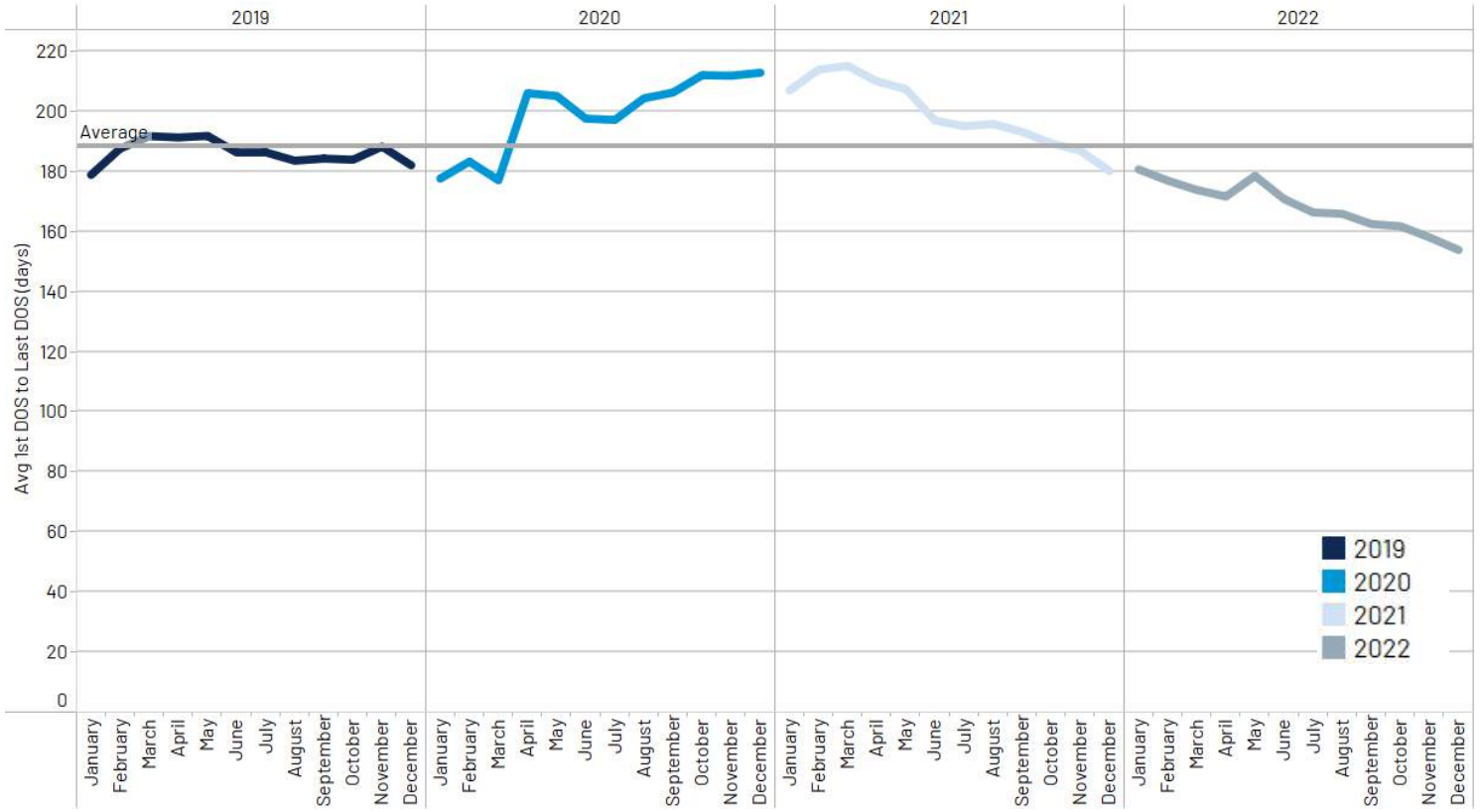
Average **CLAIM COMPLEXITY DROPPED** below the 2019 baseline in 2022.

3RD PARTY CASUALTY

CLAIM CYCLE TIMES DROP BELOW 2019 BASELINE

Cycle Time Average Days 1st DOS to Last DOS Per Injured Party

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



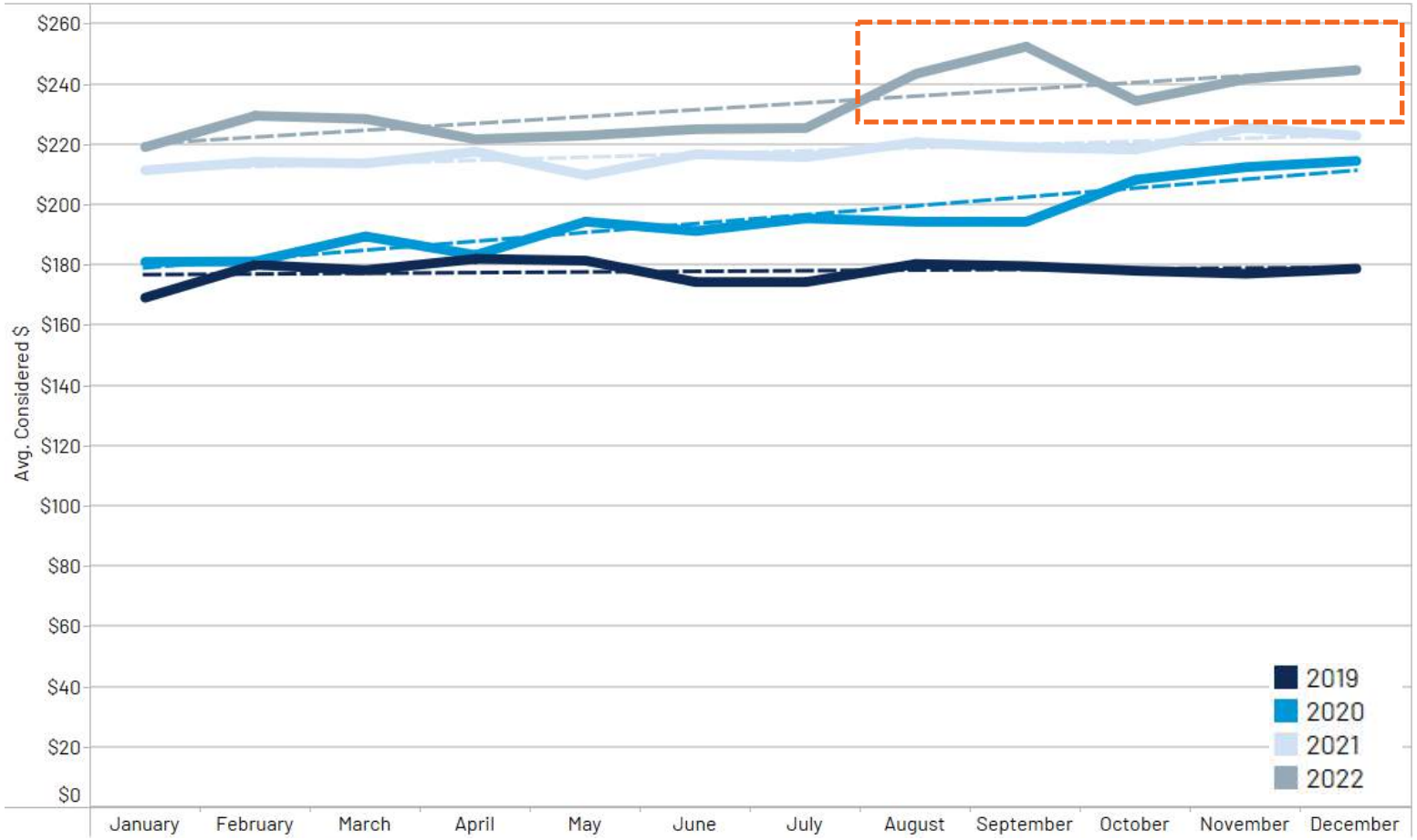
Average claim cycle times dropped below the 2019 baseline in 2022.

3RD PARTY CASUALTY

BILL LINE SEVERITY ACCELERATES

Average Medical Bill $ Submitted Per Bill Line

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



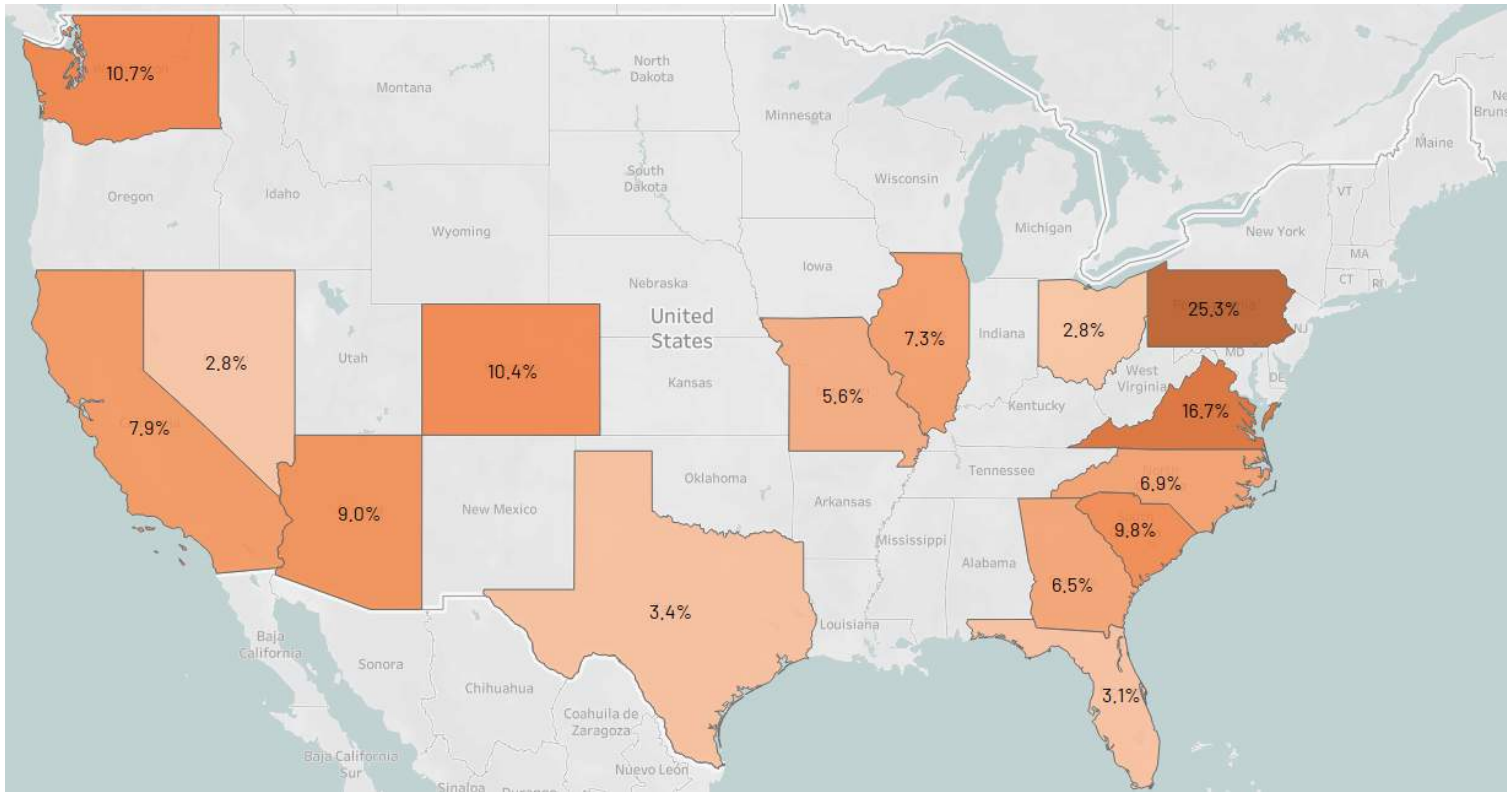
Bill line severity increases have accelerated as of H2 2022, consistent with CPI medical care inflation increases.

3RD PARTY CASUALTY

BILL SEVERITY INCREASES ACROSS ALL KEY STATES

Key States Average Med Bill $ Submitted Per Bill Line: Percentage Change 2021 VS 2022

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



All key states have sustained bill line severity increases over the last year, with the largest increases observed in the following U.S. States:

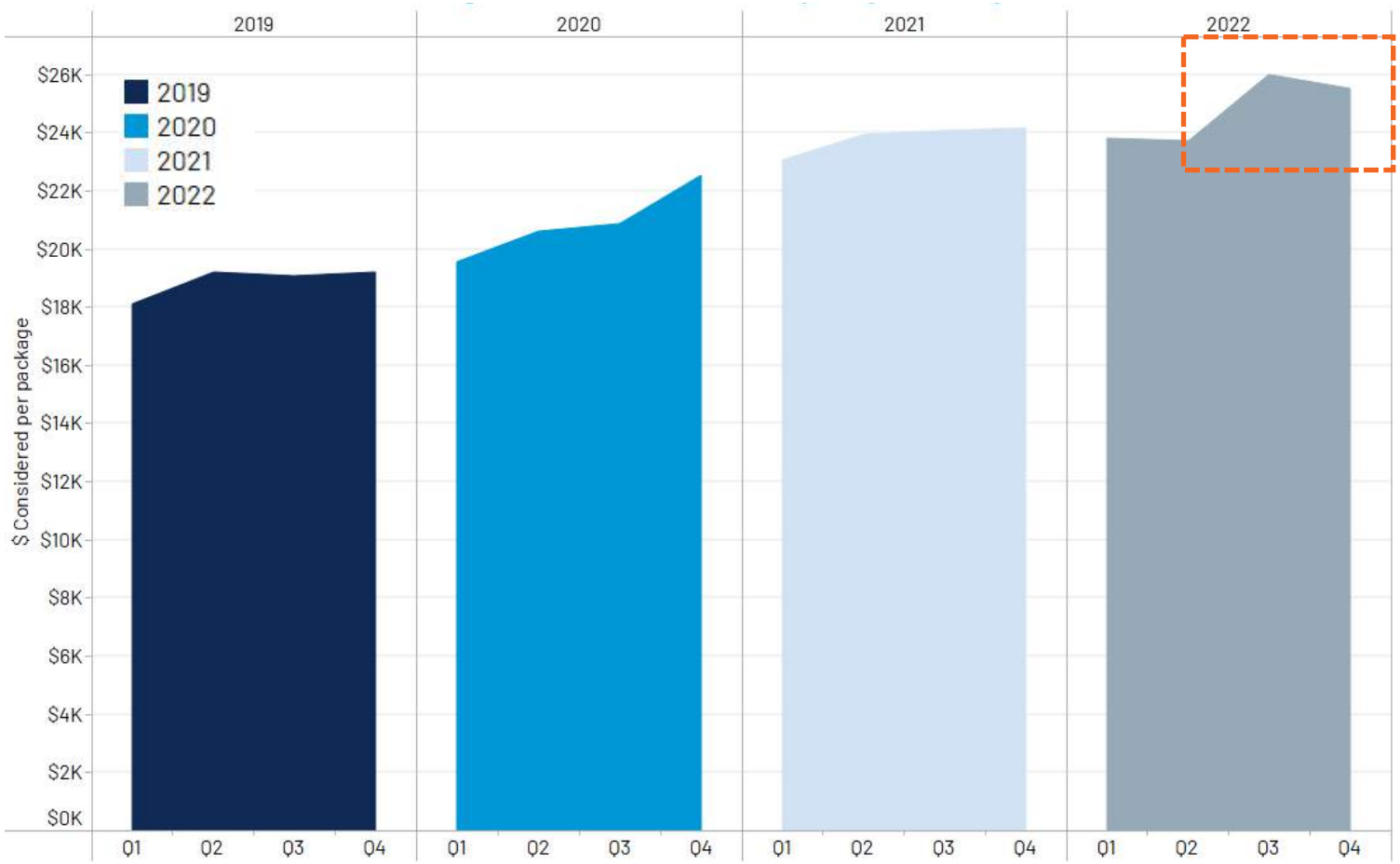
- Pennsylvania
- Virginia
- Washington
- Colorado

3RD PARTY CASUALTY

SEVERITY PER INJURED PARTY ACCELERATE

Average Medical Bill $ Submitted Per Injured Party

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



Average severity per injury party increases have accelerated as of H2 2022.

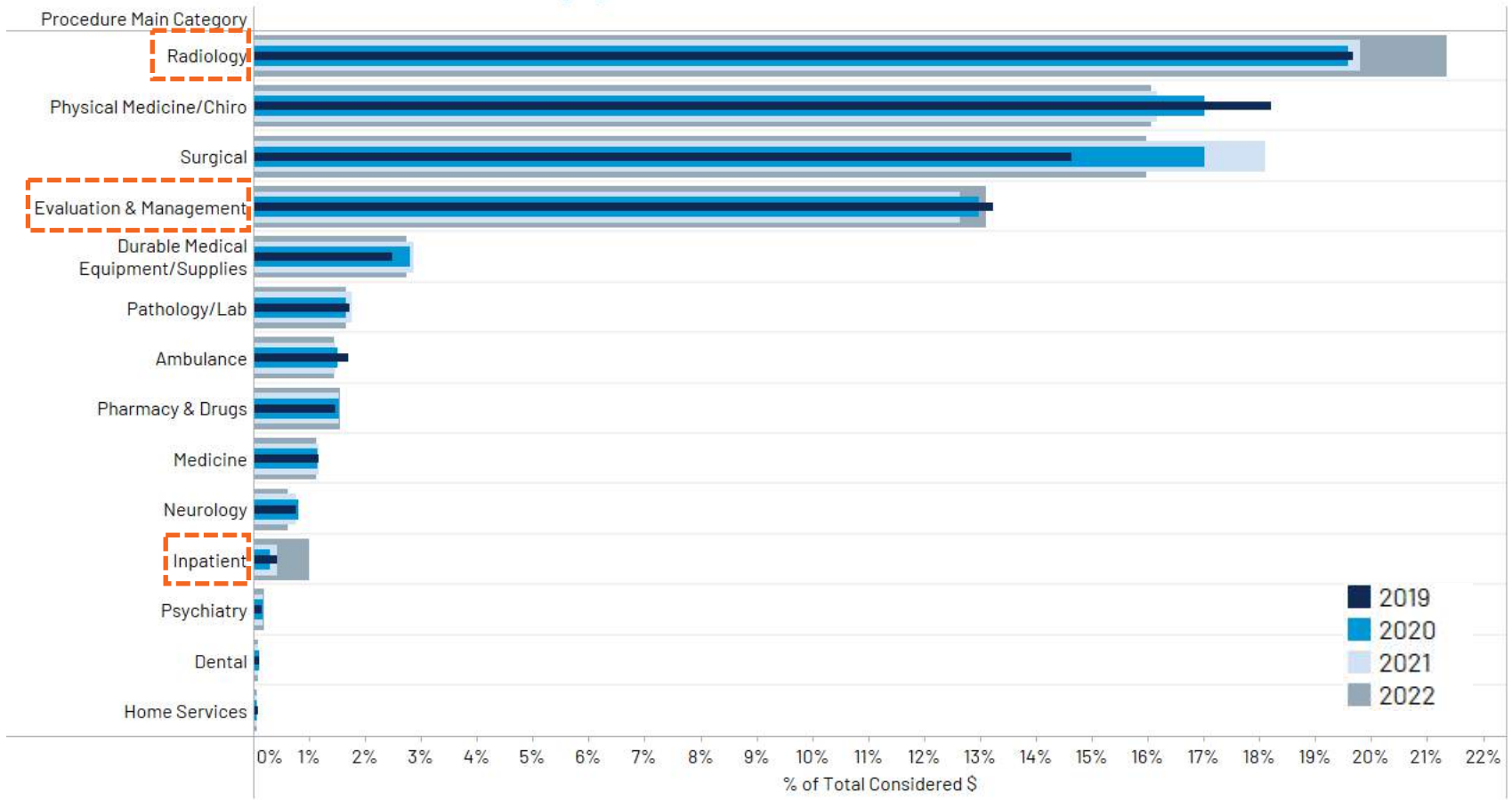
These increases have been partially offset by lower complexity per injured party.

3RD PARTY CASUALTY

PROCEDURES HAVE SHIFTED

Procedure Category: Percentage of Total Med Bill $ Submitted 2019 to 2022

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



Treatment has shifted to an increased percentage of radiology, evaluation and management, and inpatient procedure dollars.

3RD PARTY CASUALTY

PROCEDURE SHIFTS LARGELY DRIVEN BY LINE LEVEL COST INCREASES

Procedures Frequency and Average Med Bill $ Per Line 2021 VS 2022

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.

Procedure Main Catego..	Procedure Sub Category	Avg. Considered $ 2021	Avg. Considered $ 2022	% of Total Bill Lines 2021	% of Total Bill Lines 2022
Evaluation & Management	High Level E&M	$1,033	$1,202	0.94%	0.93%
	Low Level E&M	$165	$185	2.17%	2.05%
	Moderate Level E&M	$331	$379	2.79%	2.73%
	Other Evaluation & Management	$266	$285	1.42%	1.40%
Inpatient	Inpatient DRG	$16,501	$29,882	0.01%	0.01%
	Inpatient Procedure Codes	$1,179	$2,116	0.00%	0.00%
	Other Inpatient Codes	$491	$225	0.00%	0.00%
Physical Medicine/Chiro	Active Physical Medicine/Chiro	$67	$70	26.17%	26.30%
	Other Physical Medicine/Chiro	$184	$203	0.01%	0.01%
	Passive Physical Medicine/Chiro	$41	$42	39.57%	40.79%
Radiology	Computerized Tomography	$1,664	$1,917	1.09%	1.15%
	Magnetic Resonance Imaging	$1,529	$1,603	0.99%	1.07%
	Other Radiology	$608	$654	0.23%	0.19%
	Ultrasound	$371	$422	0.12%	0.11%
	X-Ray	$202	$227	3.03%	3.00%

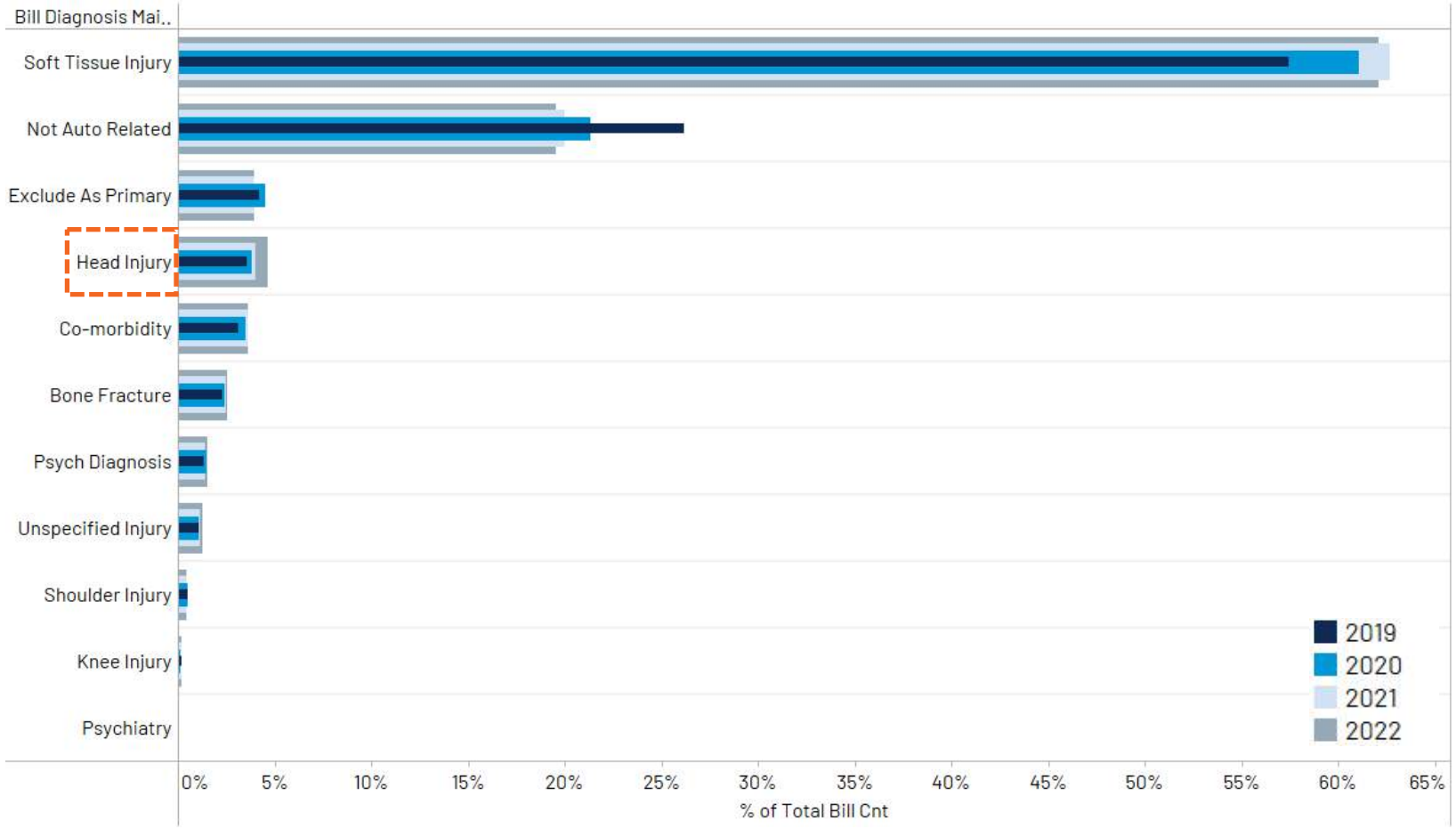
Shifts are largely driven by line level cost increases, although CT scans, MRIs, and physical therapy and chiropractic procedures have also increased in frequency.

3RD PARTY CASUALTY

HEAD INJURY DIAGNOSIS HAVE INCREASED

Primary Diagnosis Categories Percentage of all Bills (Count)

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



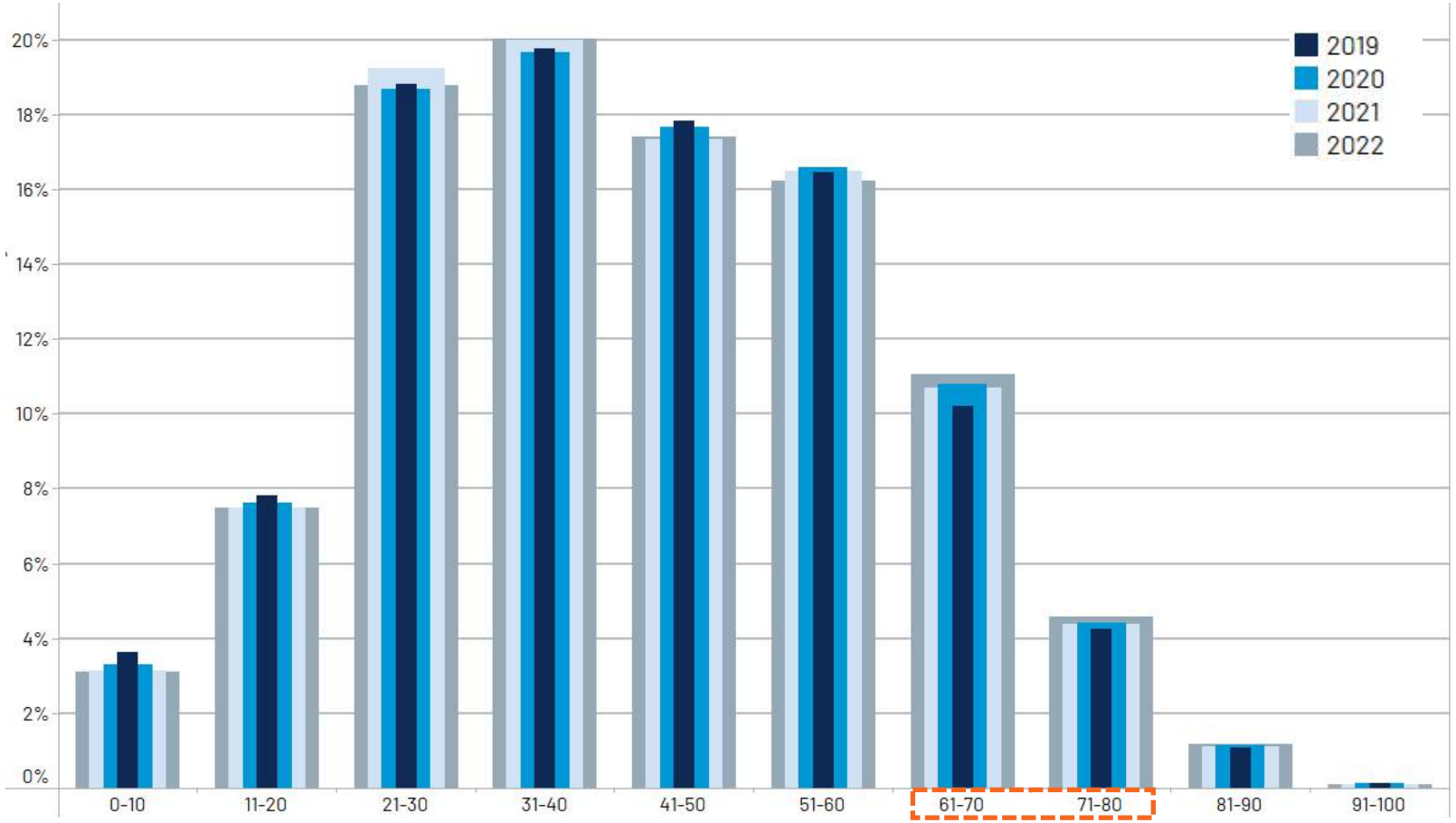
Notable increases in the percentage of claims with primary diagnoses of head injury were observed in 2022.

3RD PARTY CASUALTY

AGING POPULATION DRIVES INCREASE IN OLDER INJURED PARTIES

Injured Party Age Distribution

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



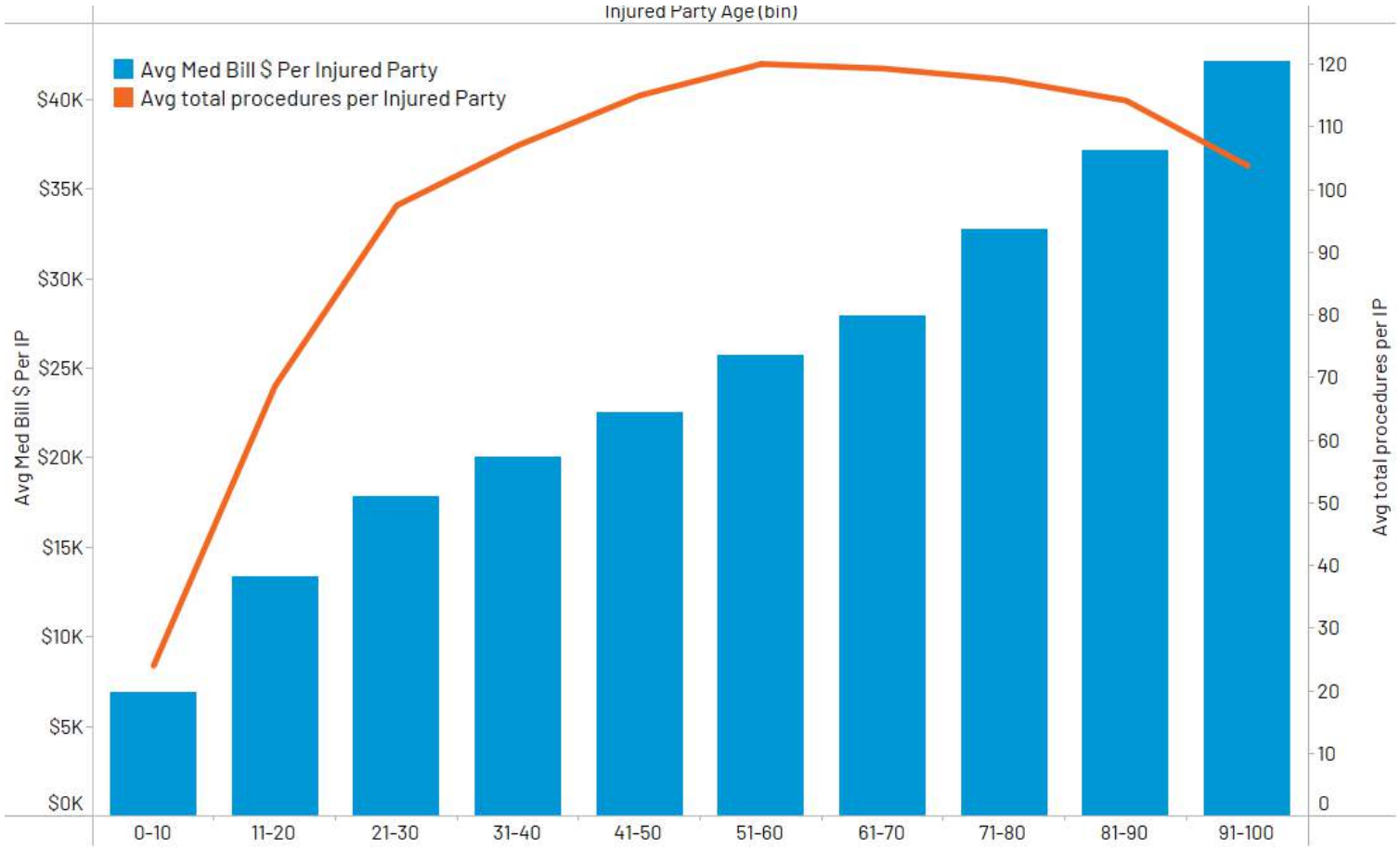
Increases in percentage of injured parties aged 61-80 in 2022 were reflective of U.S. aging population macro trends.

3RD PARTY CASUALTY

BILLING SEVERITY AND COMPLEXITY INCREASE WITH AGE

Average Med Bill $ Treatment Complexity by Patient Age

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



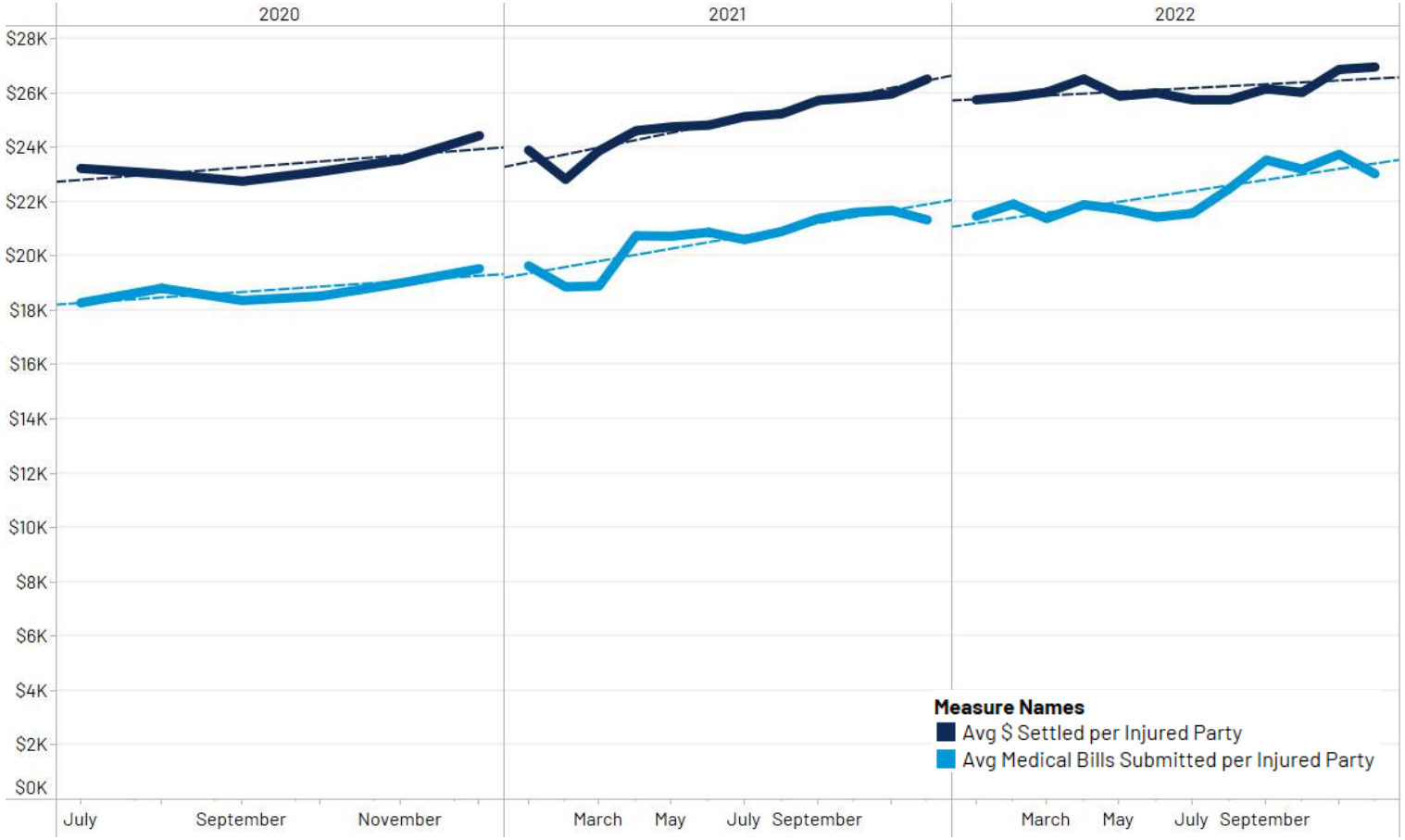
Billing severity increases steadily with injured party age, while complexity peaks at ages 51-60.

3RD PARTY CASUALTY

AVG MEDICAL BILLS & AVG SETTLEMENT INCREASE

Average Settlement and Average Medical Bills Submitted

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



*Features with outcomes of 250K or greater have been excluded

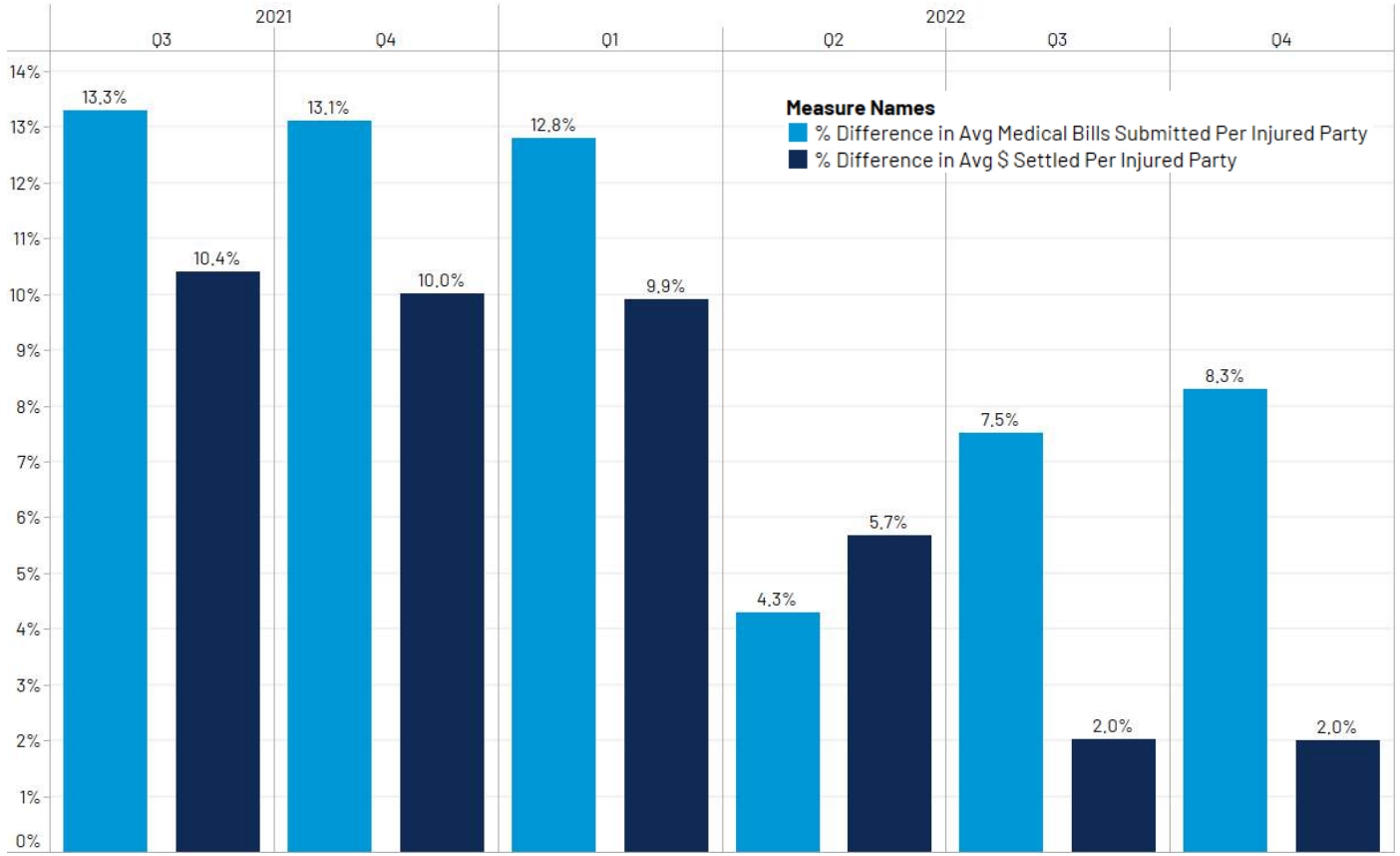
Both the average medical bill $ submitted, and the average $ settlement per injured party have increased year-over-year.

3RD PARTY CASUALTY

INCREASES IN AVG MEDICAL BILLS SUBMITTED OUTPACE INCREASES IN SETTLEMENT OUTCOMES

Average Settlement and Average Medical Bills Submitted Per Injured Party | Percent Change from Prior Year

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



*Features with outcomes of 250K or greater have been excluded

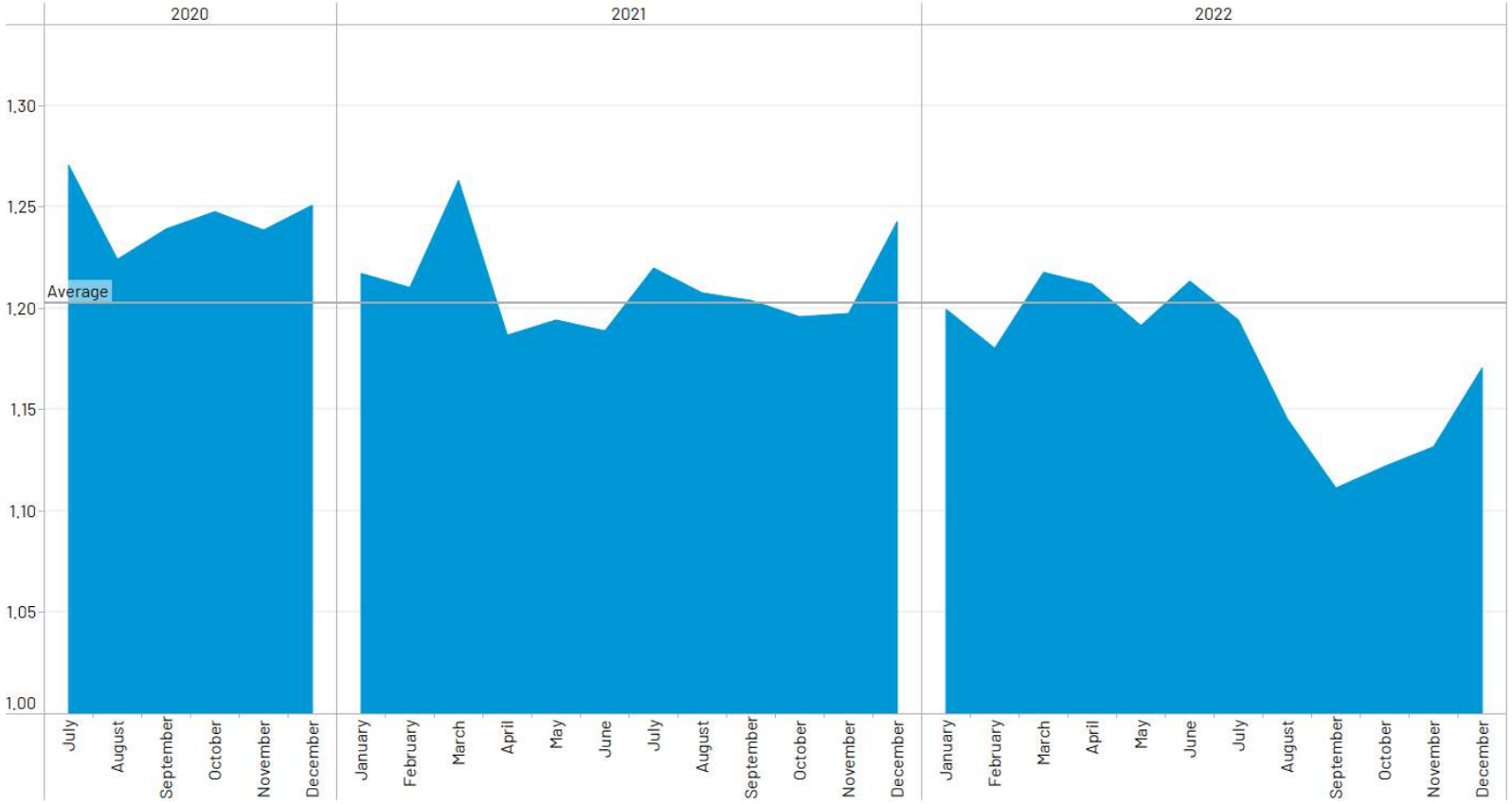
But increases in medical bill $ per injured party have outpaced increases to the average settlement outcome per injured party, especially in H2 2022.

3RD PARTY CASUALTY

SETTLED VERSUS SUBMITTED MEDICAL BILL RATIO DECREASES

Settled Percentage of Med Bills Submitted Trend (Settled/Med Bill Submitted)

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



*Features with outcomes of 250K or greater have been excluded

Multi-year comparison of medical bills submitted to final settlement outcomes indicates increasingly effective use of configurable adjuster tools to efficiently negotiate reasonable and accurate medical specials.

PERFORMANCE: INDUSTRY IMPACT
CASUALTY – SUMMARY

In many ways, the recent outlook for the auto insurance industry has been especially grim. This is understandable in the face of headwinds such as historic price inflation, regulatory challenges, staffing volatility, and social inflation. As a result, margins have tightened considerably, and pricing competition becomes increasingly fierce. Yet, within this sea of uncertainty, the boldest, most resilient insurers will find opportunity. In addition to accurate, competitive pricing, insurers who best optimize customer experience can both retain customers AND gain critical market share.

The latest customer satisfaction research demonstrates that a best-in-class claim experience harnesses a deft combination of technology and "personal" touch by way of omnichannel interface flexibility, reduced touchpoints, proactivity, and speed to resolution/payment.

On the 1st party bill review front, it's all about minimization of high volume – low complexity manual processes, facilitating the shift to exception-based workflow, thereby maximizing operational and adjuster efficiency. Improved customer-facing portals allow injured parties to directly upload medical documentation to the claim file, as well as proactively monitor claim developments, much like portals leveraged by private insurers. Continued focus on expansion and maintenance of PPO networks ensures reasonable indemnity and preservation of policyholder benefits. Lastly, implementation of direct payment solutions will further reduce friction, cycle time, and unnecessary manual touches for the customer, insurer, and medical providers.

CONTINUED NEXT PAGE

KEY **TAKEAWAY**

A best-in-class claim experience harnesses a deft combination of technology and "personal" touch by way of omnichannel interface flexibility, reduced touchpoints, proactivity, and speedy resolution/payment.

PERFORMANCE: INDUSTRY IMPACT
CASUALTY – SUMMARY

On the 3rd party casualty side, technology is best focused on proactivity, efficiency, segmentation, and improved benchmarking, allowing the adjuster to do more with less. With rapid advancements in AI technology, impact severity/Delta-v can be generated directly from photos uploaded to the insurer, as opposed to waiting for an estimate to be written. This helps identify and/or segment "lower impact" injury exposures very early in the life cycle of the claim, before treatment of questionable causation or necessity has occurred. Adjusters can and should interact with injured claimants via phone, email, text, or portal (omnichannel preference) very early in the claim life cycle to gather medical documentation and/or leverage early settlement opportunities.

On the medical bill review front, configurable fee benchmarking tools are must-have as cost inflation lands heaviest on 3rd party auto. In addition, robust analytics based on historical outcomes/indicators can consistently identify and funnel the right claims for professional review. Also, adjusters should have an increasingly small number of platforms to navigate for final evaluation and negotiation strategy, also allowing claim managers to quickly review for feedback and/or pre-settlement authority.

Last but certainly not least, insurers should leverage high-quality analytics to identify improvement opportunities and drive business decisions. The path forward in the next 1-2 years will be rocky, but the insurance industry and the talented people leading it will once again prove their resilience, adaptability, and ingenuity.

KEY **TAKEAWAY**

New medical treatment patterns are emerging, with increased focus on the front end of the treatment cycle. Higher impact severity translates to more head injury diagnoses and increasing concentration of dollars into rapidly inflating diagnostic radiology, evaluation and management, and hospital inpatient procedures.

PERFORMANCE: SUBROGATION

TIM CHRIST

SENIOR SOLUTIONS ENGINEER, CCC

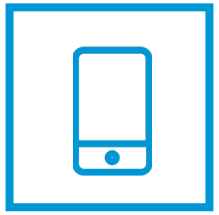
Imagine the fast-approaching digitized world where we have a lot more information available about claim circumstances, allowing us to make faster, smarter decisions throughout the life of the claim.

By creating greater transparency across the industry, we can better realize the carrier's goals of truly automated straight-through processing.

PERFORMANCE: INDUSTRY IMPACT — SUBROGATION

SOARING LOSS COSTS UNDERSCORE THE IMPORTANCE OF SUBROGATION

Significant increases in vehicle repair and replacement costs, labor and medical costs are impacting insurers' financials, underscoring the value of the subrogation process. As loss costs continue to escalate, the need for optimal subrogation recovery is paramount.



THE OPPORTUNITY TO AUTOMATE

While some carriers have experienced tremendous productivity improvement by leveraging predictive models for subrogation, a large part of the industry is still heavily dependent on 1st party adjuster referrals.

Subrogation continues to experience significant administrative costs and highly manual processes. There are opportunities for the industry to automate and straight-through process more claims in subrogation if the industry was provided a greater degree of transparency between both sides.

STAFFING CHALLENGES ARE MAKING OUR JOBS HARDER

Many carriers are short-staffed and/or face challenges from employee turnover. Lengthy training time means it can be months before new employees can take on a full caseload, leaving carriers limited options beyond segmenting claims differently to remain productive.

SUBROGATION RETURNS CHALLENGED

As of CY2021, subrogation and recovery is responsible for 17.2% of total incurred losses, as reported by AM Best.

Historically, salvage has been responsible for about 30% of total recovery; however, as used vehicle prices soared in CY2021-CY2022, salvage is responsible for 35%+ in CY2022.

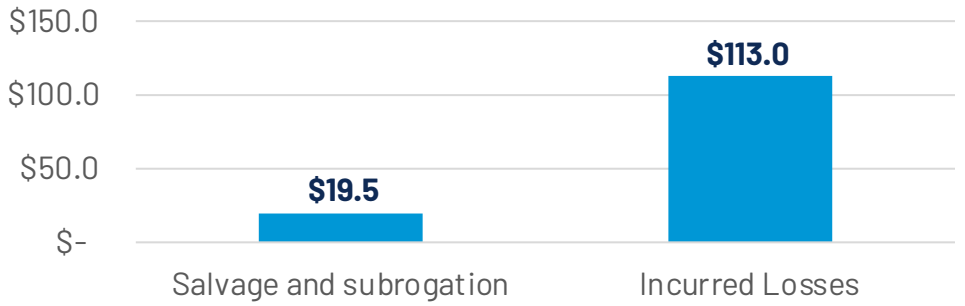
Claims managers will need account for this temporary lift in gross recoveries, and not simply use CY2022 recovery as the basis for their forecast basis for CY2023.

Consider the states of California, Arizona, New York, Florida, and Kentucky. All are pure comparative states, with the best opportunities for auto collision subrogation recovery.

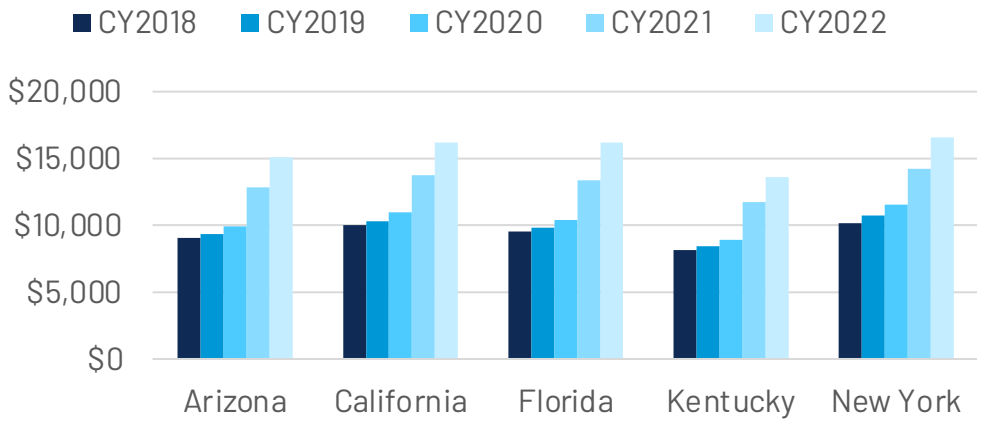
The major variable between these states are the state minimum auto limits: CA ($5K), KY ($25K), NY ($10K), FL ($10K), and AZ ($15K).

With the widening gap between total loss valuation increases and policy limits, per claim settlement statistics will be impacted. With roughly 25% of policies in most U.S. states being minimum limit policies, this can adversely affect recoveries.

Total U.S. PC Industry Incurred Losses and Salvage and Subrogation Recovery CY2021 ($'s in millions)



Average Non-Comprehensive Adjusted Total Loss Vehicle Value By Vehicle Owner State CY2018-CY2022



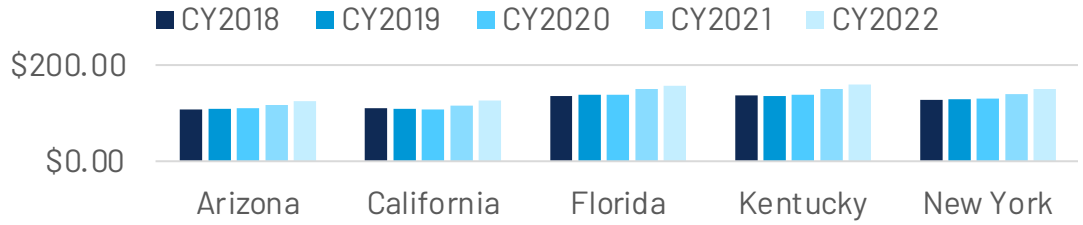
SUBROGATION CHALLENGES – APD

Replacement parts may be a key variable considered during subrogation. The carrier receiving the demand may go through multiple steps to validate that the primary carrier purchased the most cost-effective/available part.

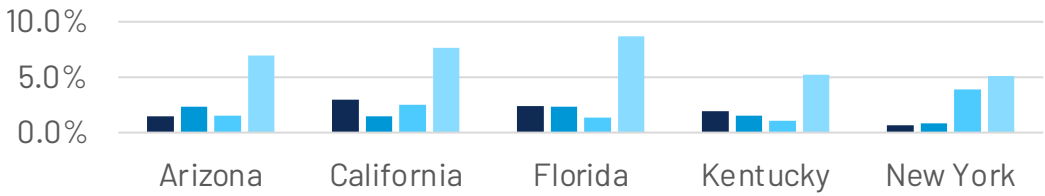
Labor costs may also be a key variable considered during subrogation. Carriers often review the labor rate paid by the primary carrier to determine whether they have different rates negotiated in that market. With labor costs continuing to increase, this may be another key area of focus moving forward.

Finally, vehicle repair times increased nationally to over 16 days in 2022. This translates to on average an additional 6-7 days of rental charges and increased cycle time, and subsequently may be another key line item for subrogation consideration.

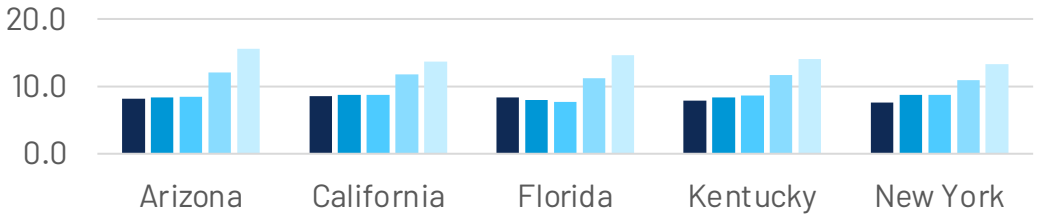
Average Price Per Part Repairable Appraisals by Vehicle Owner State CY2018-CY2022



Average Aggregate Labor Rate – Percent Change from Prior Year



Repair Start to Repair Complete Days Average DRP Repairs by Vehicle Owner State CY2018-CY2022

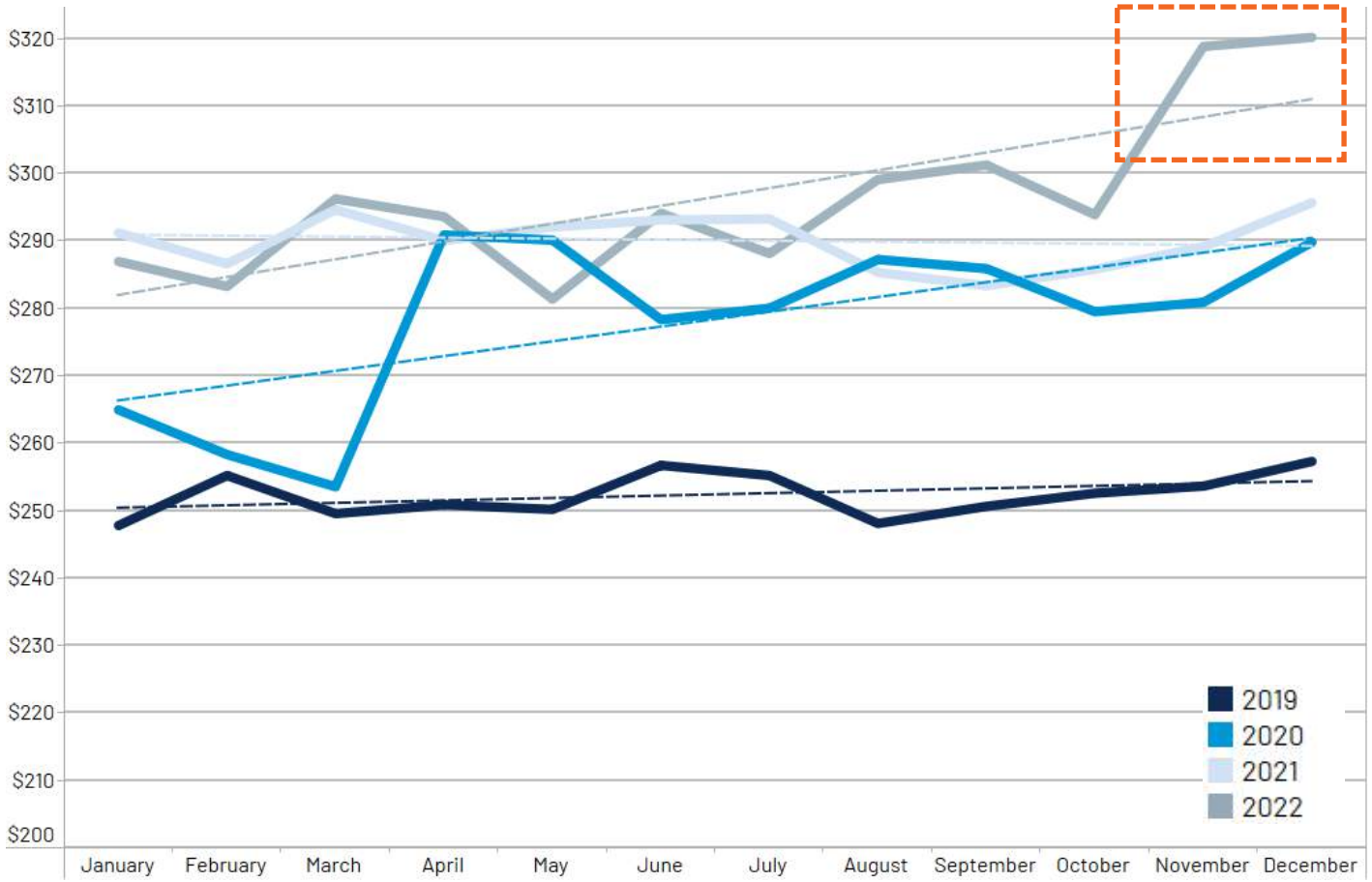


SUBROGATION CHALLENGES – CASUALTY

Auto casualty bill line severity increases continue to climb. There are thirteen states that allow for PIP subrogation recovery opportunities under certain conditions; and a number of those states are where there has been both an increase in frequency and severity of PIP claims.

1st Party Casualty – Bill Line Severity
Average Billed Per Lines Less Dups by Client Received Date

SOURCE: CCC INTELLIGENT SOLUTIONS, INC.



PERFORMANCE: INDUSTRY IMPACT
SUBROGATION — SUMMARY

Insurers will continue to face challenges in the subrogation discipline in coming years.

Among the challenges carriers face?

- Difficulties in consistently identifying claims with subrogation potential;
- Subrogation team sizes may be insufficient to handle the workload;
- There is still a disconnect between 1st party claim processes and subrogation processes;
- Significant administrative costs and inefficiencies remain.

There are opportunities for the industry to incorporate machine learning, automated insurer rules, natural language processing, and more, to identify subrogatable opportunities earlier in the claims lifecycle.

KEY **TAKEAWAY**

Subrogation teams will continue to be challenged by team size, experience, and turnover.

Integration of decisions directly into an insurer's existing workflow can help carriers create a streamlined subrogation process that helps lower cycle times.

POWERING FORWARD: THE ROAD AHEAD

This final section will provide perspective on what's ahead for the P&C insurance and collision repair industries in 2023 and beyond.

ignite EXPERIENCE

CHANGING TECHNOLOGY IS REVOLUTIONIZING PERSONAL MOBILITY AND THE EXPERIENCE OF VEHICLE OWNERSHIP, INSURANCE, AND REPAIR

Prior to the pandemic, numerous experts predicted the demise of the personal vehicle as the primary mode of transportation, with the four "ACES" trends (Autonomous Driving, Connectivity, Electrification, and Shared Mobility) expected to drive this change.

These technologies remain poised to change mobility paradigms as we know them today, but the timeframes for doing so, and the "how" of the change have been largely reset.

Most analysts and technologists, for example, have admitted that the idea of fully autonomous vehicles taking the place of all vehicles on the road today is even harder and farther off. Instead, the focus around autonomy is now largely on technologies that enhance the driving experience for the driver still behind the wheel.

Over the next several pages, we'll assess the status of each of these trends and discuss their impact on our industry to date and anticipated impact in the future.

Four Trends will Change the Way the Auto Industry Develops Cars

4 "ACES" TRENDS

SOURCE: McKinsey & Company

Autonomous Driving

Connectivity

Electrification

Share Mobility

AUTOMAKER CONFORMANCE WITH AEB VOLUNTARY COMMITMENT FOR U.S. VEHICLES REACHES >90%

In their annual reports submitted to the National Highway Traffic Safety Administration (NHTSA), automakers showed just how far they have come toward equipping vehicles with the building blocks for full vehicle autonomy and ADAS.

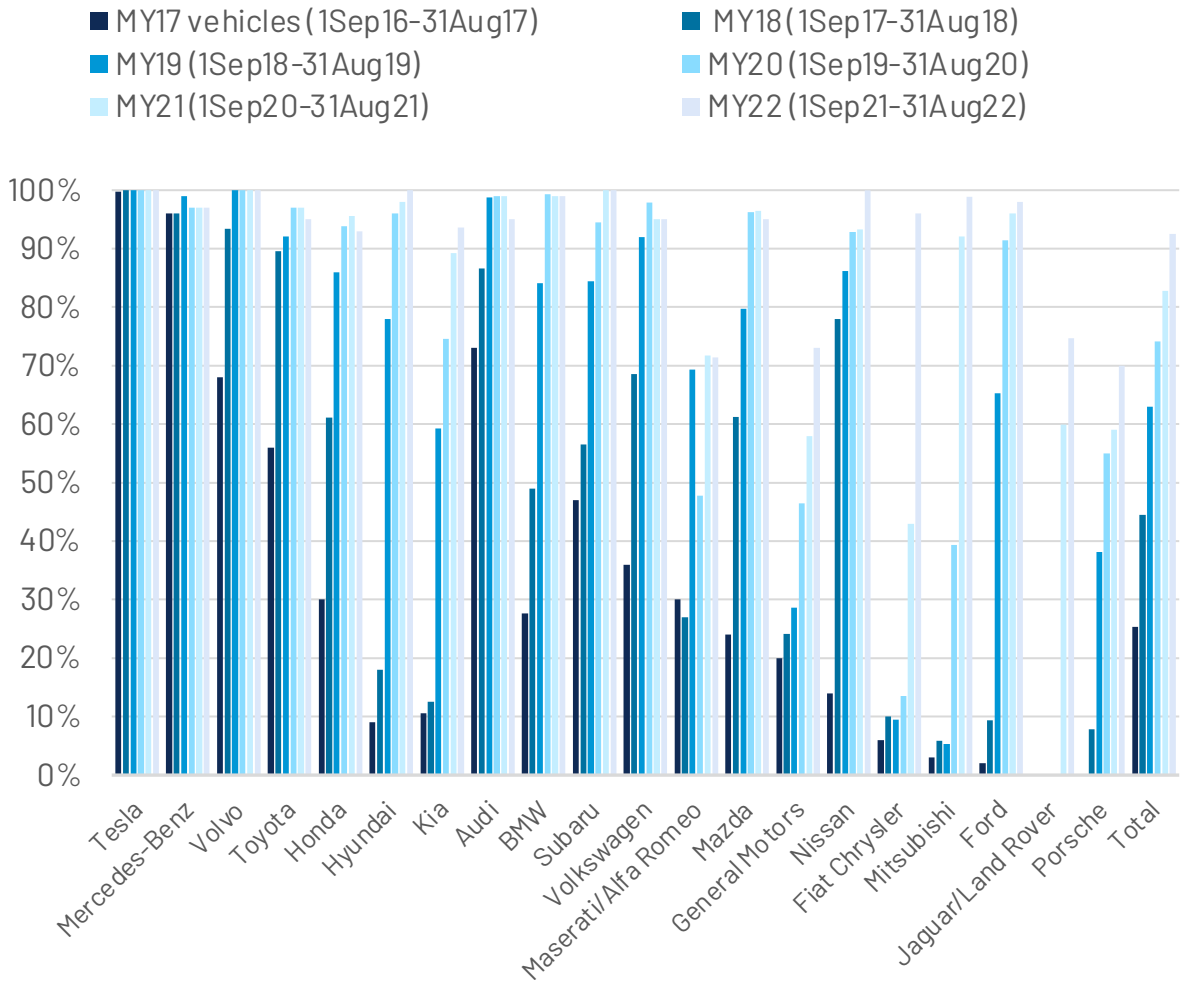
The reports are submitted annually by the 20 manufacturers that pledged to equip at least 95% of their light-duty cars and trucks with a gross vehicle weight of 8,500 pounds or less with the crash avoidance technology by the production year beginning Sep 1, 2022. The commitment was brokered in 2015 by the IIHS and the NHTSA.

Many vehicles on the road in the U.S. today are still at Level 0, with no automated driving functions, but growth among vehicles with Level 1-2 automation is accelerating.

The percentage of vehicles (curb weight 8500 pounds or less) with AEB standard across these 20 automakers grew from about 25% for MY2017 (vehicles manufactured after 1Sep16 and before 31Aug17) to 45% for MY2018, to just over 60% for MY2019, and to an estimated 93% for MY2022 based on those that reported actual volumes of AEB-equipped vehicles.

Percentage of Vehicles that Meet the AEB Voluntary Commitment

SOURCE: NHTSA, CCC INTELLIGENT SOLUTIONS INC.



CRASH AVOIDANCE TECHNOLOGY WORKS, BUT SOME FEATURES ARE MORE EFFECTIVE THAN OTHERS

While adoption rates have grown, there remain a significant number of vehicles on the road in the U.S. that are not yet equipped with any of these technologies.

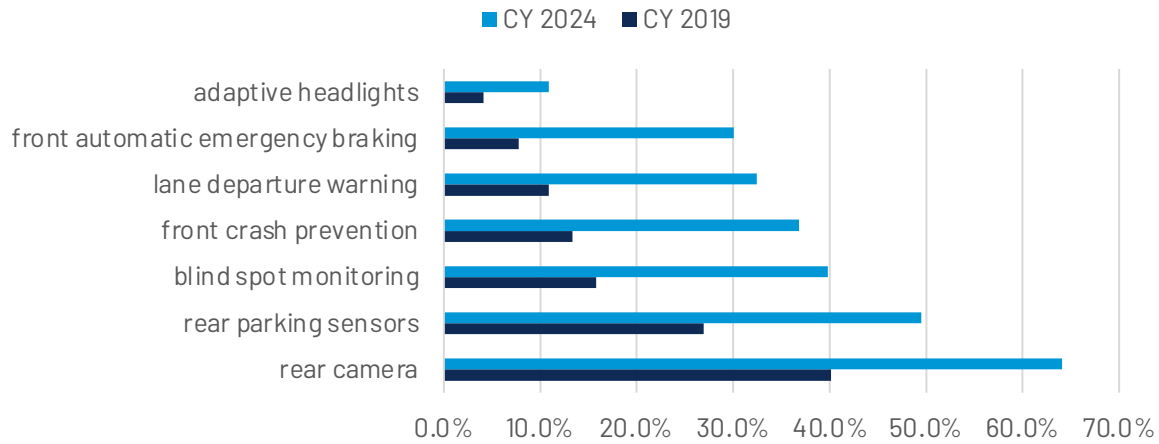
For vehicles already equipped with technology features, the effectiveness of each system to avoid any type of crash altogether varies.

The IIHS and its research division, HLDI, released updated research at the start of CY 2021 around the benefits of individual ADAS features.

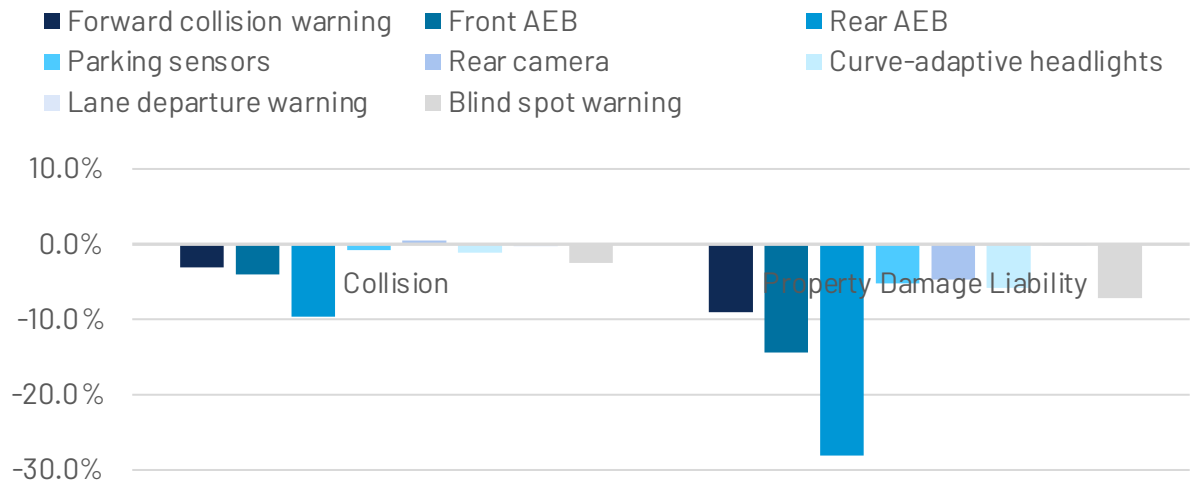
Rear AEB was specifically highlighted, with new research revealing that vehicles equipped with rear AEB had 28% fewer property damage liability claims and 10% fewer collision claims than the same vehicles not equipped with rear AEB.

Both front AEB and rear AEB are automatically deployed for the driver in a crash-imminent situation and have registered larger reductions in claim frequencies than technologies that rely on the driver to respond to warnings. (68)

IIHS/HLDI Predicted registered vehicles equipped with Advanced Driver Assistance Systems (assume no recession)



IIHS/HLDI Effect of crash avoidance features on insurance claim rates



LEVEL 2 AUTONOMY GROWTH AND IMPACTS

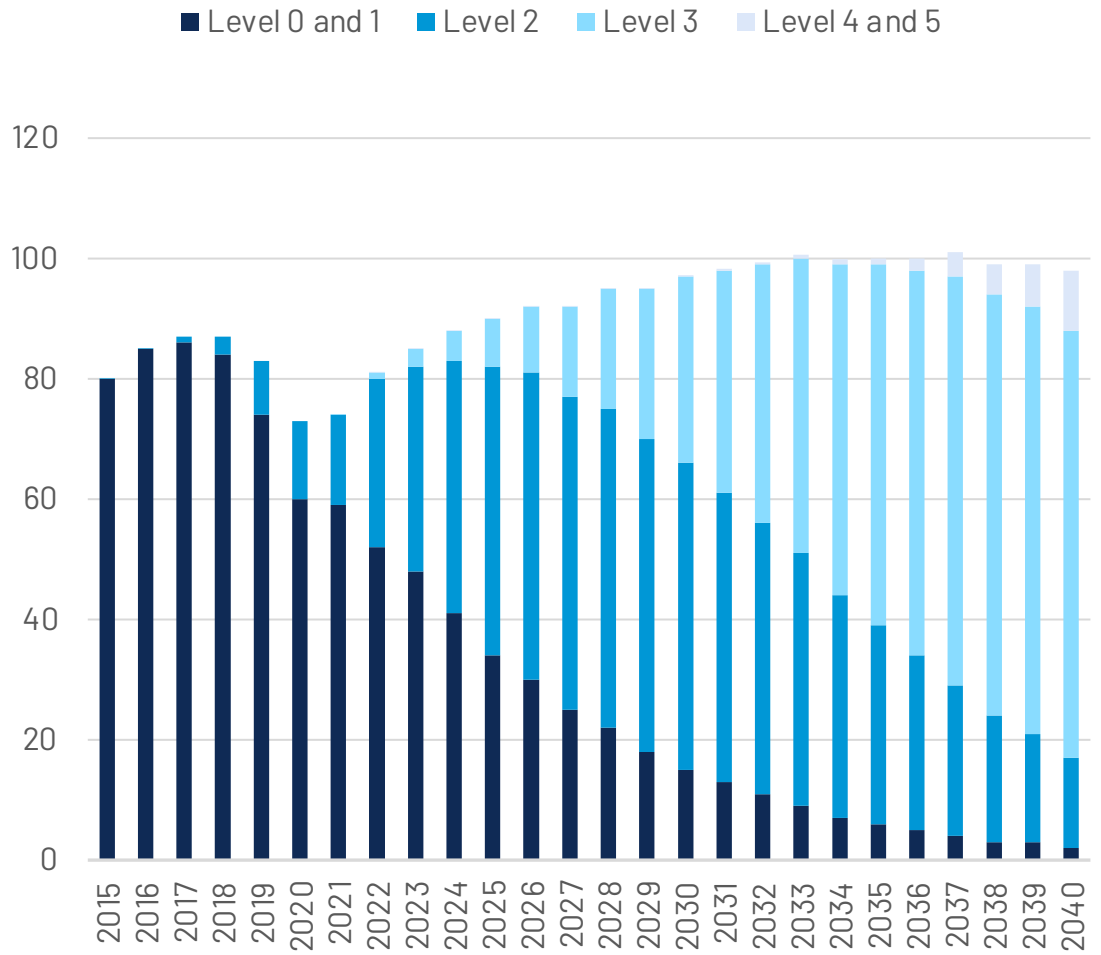
Automakers have begun to roll out Level 2 autonomous features – the combination of adaptive cruise control and lane — keeping assist capabilities — in their mainstream vehicles. While real-world data shows that certain ADAS features such as front and rear AEB and blind-spot warning do help reduce certain types of accidents, it also reveals that Level 2 features may have the reverse effect.

This is because Level 2 features might lessen the effort of driving but are often misperceived or inaccurately advertised as fully autonomous, which can reduce the driver's situational awareness, especially if their experience with the technology is limited.(69)

Most ADAS technology has also been designed to avoid accidents altogether at lower speeds, but as speeds increase, the systems can only mitigate speed before impact. When an accident does occur with an ADAS-equipped vehicle, there's more damage to electronic content and part components, which fuel higher repair costs and complexity.

Of course, shifts in the frequency and cost of motor vehicle crashes in the future are likely to occur, but there are enough countervailing trends with ADAS technology to suggest that changes won't happen overnight.

BloombergNEF Outlook for passenger vehicle sales by level of automation (in millions)(70)



SNAPSHOT OF ADAS FEATURES AND IMPACT ON COLLISIONS AND REPAIR

BENEFITS

- The existence of ADAS will prevent some accidents, particularly those at lower speeds.
- Accidents with ADAS-equipped vehicles in aggregate tend to be less severe.
- Less severe accidents in ADAS-equipped vehicles result in less severe injuries and thus better casualty outcomes.

CONSIDERATIONS

- How quickly fitment rates of ADAS features will grow.
- Capability and packaging of ADAS features varies by OEM, including the human-machine interface design.
- The “mean-shifting” of losses resulting from ADAS will mean more costly repairs.
- The same accident with the same damage will result in higher repair costs for the ADAS-equipped vehicle.
- Some ADAS features have potential to increase driver distraction and risk, such as speeding.
- ADAS cannot help prevent all losses (e.g., hail or losses that occur from ice, low visibility, etc.)
- Consumer acceptance and the driver’s ability and/or desire to disable ADAS features.

MORE OEMS OFFER CONNECTED CAR TECHNOLOGY IN THEIR VEHICLES

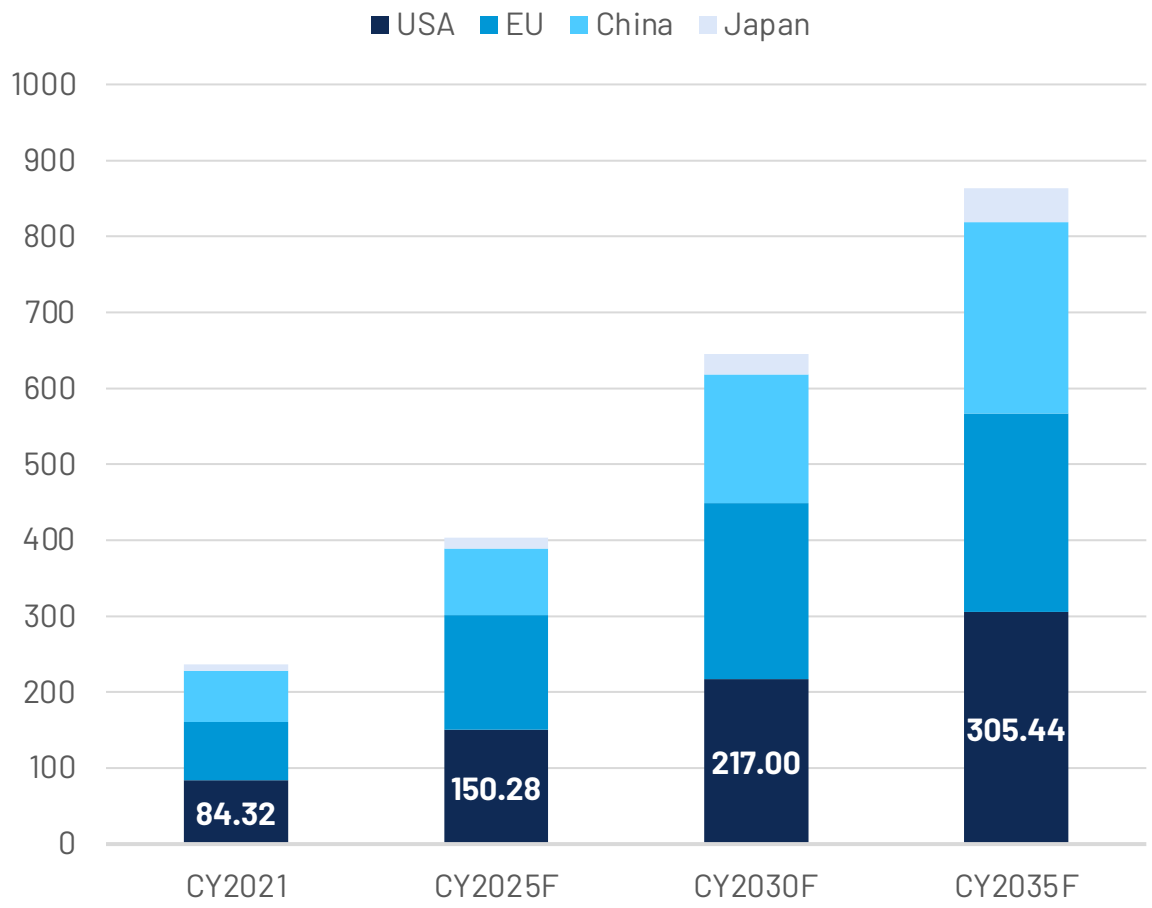
Demand for greater digital capability and wireless connectivity in the vehicle itself has led many automakers to introduce connected vehicle technology into their fleets. Features available through connected car technology include:

- Vehicle performance data sharing to assess vehicle health.
- Leveraging navigation and driving data to assess vehicle acceleration, braking patterns, location and route history.
- Data sharing to facilitate better vehicle-to-vehicle and vehicle-to-infrastructure communication.
- Emergency alerts generated in case of an accident or emergency.
- Numerous additional services like gas price deals that are streamed directly into the vehicle.

Research from SBD Automotive, commissioned by CCC, in Q3' 2021 revealed that between 2014 and 2021, active in-car embedded connections have clocked an impressive compound annual growth rate (CAGR) of 47% to reach the current count of >36M subscribers (Note: not all drivers choose to subscribe even if their vehicle has connected car capability).

Size of the global connected car fleet in 2021, with forecast for 2025, 2030 and 2035 by region (in million units)

SOURCE: HTTPS://WWW.STATISTA.COM/STATISTICS/1155517/GLOBAL-CONNECTED-CAR-FLEET-BY-MARKET/



MORE OEMS OFFER CONNECTED CAR TECHNOLOGY IN THEIR VEHICLES

By 2030, the active 4G/5G car parc as a percentage of total 4G/5G TCU market is expected to reach 62%.

Among the features that OEMs have found consumers value most are crash detection and companion alerts for tasks like first notice of loss (FNOL).

WITH RISING AUTO INSURANCE PREMIUMS, MORE CONSUMERS INTERESTED IN TELEMATICS OR USER-BASED INSURANCE (UBI) POLICIES

Research from the IoT Insurance Observatory has shown that telematics/IoT programs are most successful when customers perceive they are getting a better premium cost but are also receiving other value—added services such as coaching, vehicle maintenance alerts, and accident detection and assistance.(71)

In their May 2021 report "From Risk Transfer to Risk Prevention," the IoT Observatory and The Geneva Association discuss a personal auto telematics program implemented by Generali in the Italian market that uses a patented hardware approach to provide driver feedback.

The results showed that 80% of drivers started in a "red" zone (indicative of more dangerous driving behavior), but eventually moved into the "yellow" or "green" zone based on improved driving skills and habits, as well as fewer accidents and claims.(72)

An October 2022 report from The Geneva Association included results from a survey conducted by YouGov, which showed how respondents ranked the fairness of companies using of various types of data in car insurance decisions fairness on a scale. Data ranked in order from "fairest" to "least fair" was as follows: accident history, speeding tickets, hard braking/sharp turning, credit score, and when a person drives.(73)

MORE CONSUMERS GETTING COMFORTABLE WITH UBI

According to J.D. Power's 2022 U.S. Auto Insurance Study(SM), participation in UBI programs has doubled since 2016, with 16% of auto insurance customers now participating in such programs. Overall customer satisfaction for those UBI customers is 59 points higher than the 834 (on a 1,000-point scale) score for all customers surveyed.(74)

Survey data from Transunion's "Personal Lines Insurance Shopping Report" released in April 2022 shows the number of customers offered a policy where telematics would monitor their driving and help determine their rates rose from 32% to 40% between Nov'21 and Feb'22, and the number who opted in rose from 49% to 65%.(75)

Perhaps not surprisingly, with premiums increasing upwards of 9% nationally in 2022,(76) customers with lower credit tiers reported higher use of UBI than those with "Excellent/Good" credit.(77)

Saving money was the number one reason respondents to a 2021 survey conducted by The Zebra said they would choose a telematics program, more than double the frequency of the next most selected reason: "If the data was secure." (78)

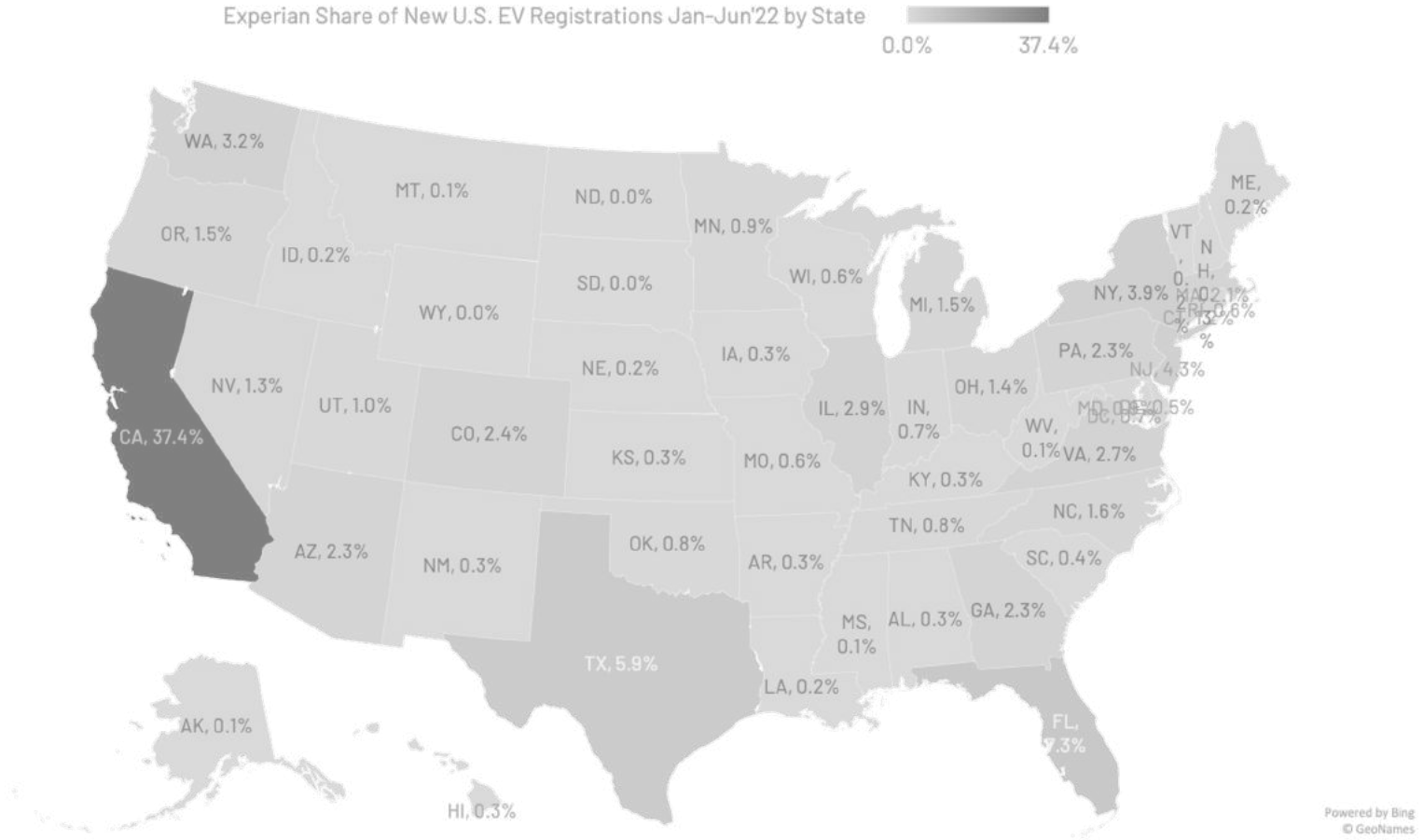
BENEFITS

- Telematics can drive higher levels of engagement through driving scores and gamification.
- Telematics offers ability to track and provide feedback on driving behavior, helping to prevent bad behavior in the first place.
- Telematics may lead to lower auto premiums.
- Telematics can provide faster and better collision data that leads to faster and better decisions to improve and curate the customer experience.

CONSIDERATIONS

- Many consumers remain concerned about data privacy, tempering the pace of adoption.
- Connected car technology offers OEMs the opportunity to monetize connected car data through products like insurance, creating new competition for traditional insurers.

ELECTRIC VEHICLE SALES GREW IN 2022, WITH VAST MAJORITY OF NEW EV REGISTRATIONS IN CALIFORNIA



U.S. EV sales increased nearly 6% to more than 800K in 2022, versus an overall decline of 8% for total U.S. auto sales.(79)

Top EV brands included Tesla with 65% of total EV sales, followed by Ford (7.6%) and Hyundai/Kia (7.1%).(80)

Vehicle registration data from Experian reveals EV buyer demographics skew to younger, professional, white males.(81)

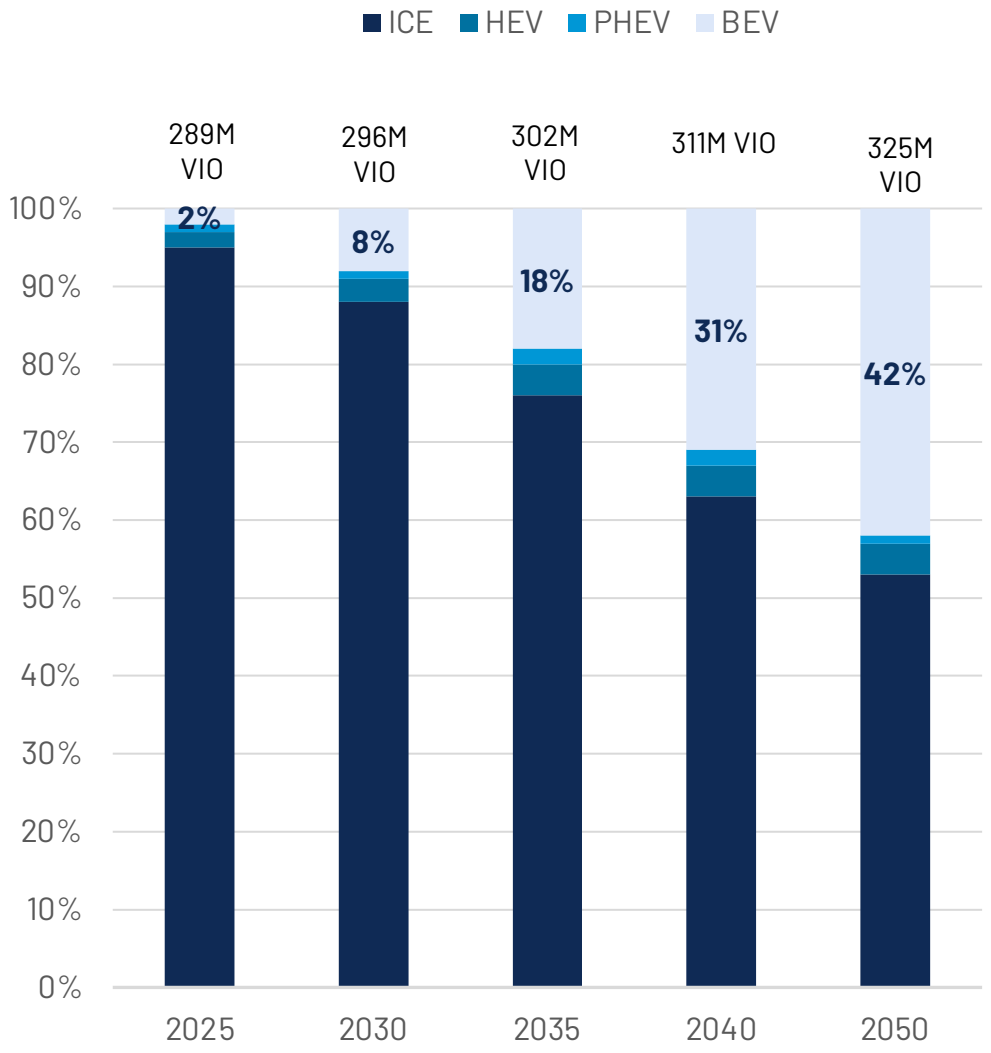
EV SALES EXPECTED TO RAMP UP FURTHER IN THE COMING YEARS, ACCOUNTING FOR A LARGER SHARE OF OVERALL VEHICLES IN OPERATION

In a Deloitte survey, more than 50% of respondents said that lack of affordability was their biggest concern when it comes to EV adoption.[82]

Rising costs of raw materials like lithium used in EV batteries has led automakers to raise EV prices, with the average price paid for an EV nearly $66K in CY2022.

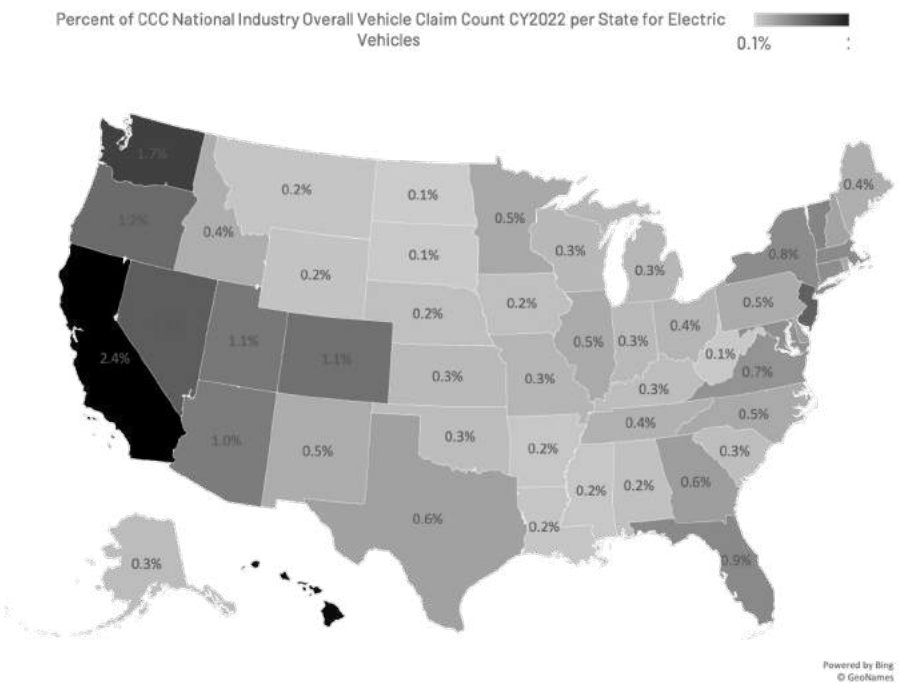
Most analysts do expect improvements in battery technology in coming years that should help bring down their costs, as well as an increased focus on mass market solid-state batteries, broader use of lithium ferrophosphate batteries, and significant improvement in battery recycling, among other initiatives.

CY2025-CY2050 Forecasted of Total Car Parc (vehicles in operation (VIO)) by Vehicle Propulsion System [83]

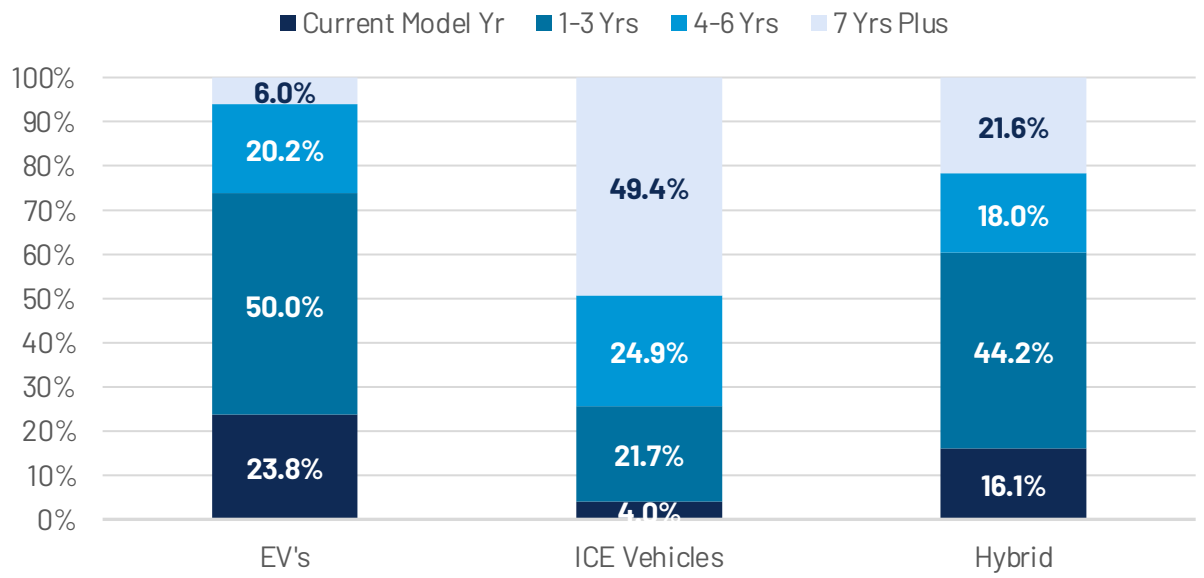


EV CLAIMS ACCOUNTED FOR ABOUT 1% OF NATIONAL INDUSTRY VOLUME IN 2022, WITH 35% OF THOSE LOSSES OCCURRING IN CALIFORNIA

EVs accounted for 0.9% of total industry claim count in CY2022, and hybrids accounted for 2.8%. 35% of the total national volume of EV claims were in California, followed by Texas (5.9%), Florida (5.4%), WA (4%), and NY (4%). EVs and hybrid vehicles skew to newer model years, a factor which often means higher claim costs and longer cycle times.



EV's, Hybrids, and ICE Vehicles' Share of CCC National Industry Overall Claim Count by Vehicle Age Group CY2022



EV'S TORQUE AND ACCELERATION ARE DIFFERENT THAN THAT OF ICE VEHICLES

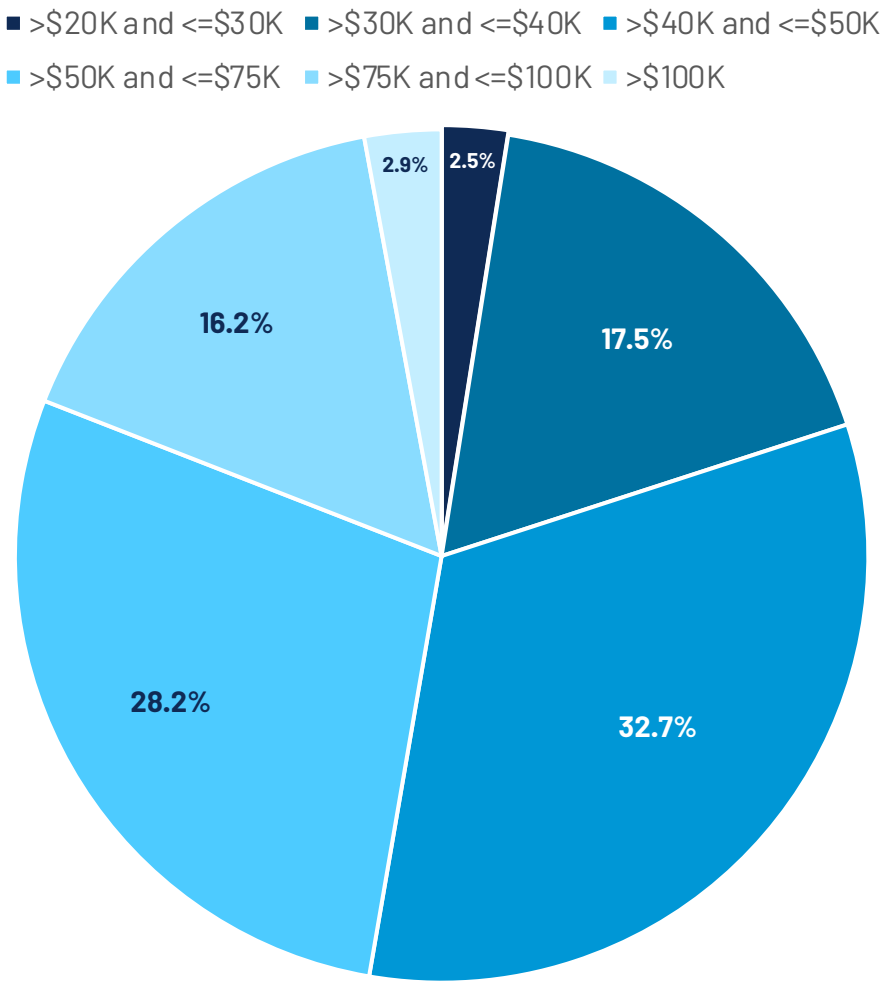
A survey of 1200 EV owners conducted by the French insurer AXA in Belgium revealed drivers of EVs caused 50% more collisions than cars with internal combustion engines.(84)

Drivers switching from an ICE vehicle to EV often unaware of how quickly an EV accelerates. The high, instant torque of electric motors is leading to circumstances in which EV drivers stab the throttle then lift off, sometimes leading to a loss of control and a crash.(85)

Vehicles traveling at higher speeds sustain more damage in a crash, resulting in higher claim costs and longer cycle times.

Higher MSRPs for EVs also translate to higher average EV claims costs. Nearly 50% of EV claim volume in CY2022 were for vehicles with original MSRP greater than $50K.

CCC National Industry EV Claims CY2022
Volume Share by Loss Vehicle's Original MSRP



"Most electric cars, especially the powerful ones, have a very high torque, which is immediately noticeable when you tap the power pedal. This can result in unwanted, jerky acceleration that the driver can no longer control."

Michael Pfaffli
Head of Accident Research, AXA Switzerland

50%

A survey of 1,200 EV owners conducted by the French insurer AXA in Belgium revealed drivers of EVs caused 50% more collisions than cars with internal combustion engines.

SOURCE: HTTPS://WWW.CARSCOOPS.COM/2022/08/ELECTRIC-VEHICLES-CAUSE-MORE-EXPENSIVE-COLLISIONS-DO-MORE-DAMAGE/

EV'S ARE DRIVING COMPLEXITY OF VEHICLES AND REPAIRS

BENEFITS

- IIHS-HLDI data shows the added weight in EV and hybrid vehicles means passengers are less likely to be injured in a crash than people in otherwise similar gas-powered vehicles.(86)
- Many EVs come equipped with ADAS features.
- Nearly 100 traditional ICE components will be eliminated in the shift to EVs, including: fuel system components, engine cooling system, transmission, exhaust components like catalytic converters, and more.

CONSIDERATIONS

- EVs' extra weight can be bad news for other vehicles and their occupants when hit, as the added impact force gets transferred to the other, lighter vehicle.(87)
- Many of the EV models being introduced are high-performance vehicles. Many EVs accelerate as fast as supercars but cost far less, and early data suggests EV drivers have more accidents.
- The average MSRP of all EVs with a claim in CY2022 was over $55K.
- Considerations for repair are different
  - Greater utilization of vehicle light-weighting (i.e., aluminum, ultra-high-strength steel, and carbon fiber).
  - No engine in front means crash energy is managed differently.
  - Safety requirements are different.
  - Time spent in a paint booth may require battery pack removal.
  - Most parts are bonded/riveted to the vehicle structure, which means most must be replaced, leading to greater repair costs.

POWERING FORWARD: WHAT'S NEXT?

Vehicles are transforming from mostly mechanical objects to fully wired, connected electronic machines. The ACES will continue to change how vehicles are purchased, insured, driven, fueled, maintained, damaged, and repaired. And the technology behind the ACES will drive changes to personal mobility, including how vehicles are protected and how recovery is provided in the event of an accident.

- **A**utonomous vehicle technology merges AI, robotics, and sensor technologies.
- **C**onnected vehicle technology is an extension of digitization.
- **E**lectric vehicles are the new frontier for auto manufacturers, and
- **S**hared is an extension of the shift in ownership models.

As the proliferation of data (e.g., how, when, where, and who is driving) and increasing autonomy changes the customer's driving experience, the industry must also change its approach to facilitating richer customer experiences. And as the physical and digital worlds become further intertwined, the industry must strike an ever more careful balance between automation and human touch, where technology like AI augments – not replaces — human processes. This is particularly important given the emotional nature of auto claims, where the policyholder may have experienced a traumatic event and expects empathy.

Transparency, ease of use, and personalized experiences have become essential to today's playing field. Now is the time for companies to evaluate their platforms and how they connect to others within the ecosystem to ensure they are primed to innovate quickly and put the customer experience at the forefront of their objectives

In this final section of Crash Course 2023, two CCC leaders will offer their perspectives on how our industry can power forward to deliver on customer experience.

ignite EXPERIENCE

PERSPECTIVE: THE PHYSICS-SENSITIVE AI OPPORTUNITY FOR AUTO INSURERS

SCOTT PALMER

VICE PRESIDENT & RESEARCH FELLOW, CCC

As leadership teams in auto insurance companies invest in AI to improve their operations and customer service, there is a tried and true, science-based opportunity to consider.

This opportunity is physics-sensitive AI.

This is AI that conforms to the reality of our world, and more specifically, the laws of physics. These laws apply to every legitimate auto collision.

PERSPECTIVE

PHYSICS-SENSITIVE AI FOR AUTO INSURERS

A SHIFT IN MINDSET

Auto insurers are classified and operated as financial institutions, where transactions like claims are viewed as financial transactions that must be managed. Traditional claim cost management objectives have included managing loss costs, reducing operational expenses, reducing cycle times, and improving customer service. Approaches to achieve these objectives have nearly exhausted opportunities to implement supplier discounts and customer self-service options.

The new horizon for claim cost management is digitization of the entire claim process and the strategic use of AI to achieve no-touch or low-touch claim outcomes when possible. Data features traditionally used in the development of AI to achieve these objectives include claim characteristics and cost, transaction duration, and customer feedback.

But what if claim transactions were also viewed as actual physical events governed by the laws of physics? As previously noted, every legitimate auto collision complies with the laws of physics, which describe the real world we drive in. Further, these laws of physics are completely predictable. We have sent people to the moon and back using these laws, which can't be cheated. When the math doesn't add up, you are likely dealing with incomplete information or an element of fraud, both of which are undesirable circumstances.

AN ILLUSTRATIVE EXAMPLE

A big car collides with a little car. What can physics tell us about this? In layman's terms, the collision is going to be more severe in terms of crash energy for the little car because its mass is less than that of the big car. This crash energy is what causes the damage to the vehicle and, if the crash energy is severe enough, any related injuries. Conversely, the big car will experience less crash energy, so logically, the damage to the larger vehicle should be less and the potential for injury less, as well. There is additional physics-related information that also helps explain the expected outcome:

CONTINUED NEXT PAGE

PERSPECTIVE PHYSICS-SENSITIVE AI FOR AUTO INSURERS

- What is the direction of the impact for each vehicle?
- Was there bumper mismatch during the collision causing over-ride or under-ride damage to each vehicle?
- Did airbags deploy in each vehicle?
- Where were the occupants seated?
- Were the vehicle occupants belted?

There are other important data elements to be sure, but the preceding examples illustrate how auto insurers can reframe their thinking and data organization around their claim transactions. Some auto insurers already apply some of these concepts when quoting insurance for an extremely heavy vehicle. Because heavier vehicles can cause more damage to other vehicles in a collision and create more potential for occupant injury, liability premiums are increased. Logically, there is a similar opportunity to consider these factors when segmenting and processing auto physical damage and casualty claims.

AI IMPLICATIONS

How do we integrate physics into our AI for claims? The first important step is the way the data is organized. All vehicles and occupants respond to collision energy according to the laws of physics; however, the physics are better understood in the context of the accident event rather than a single vehicle or occupant. If your data is organized around the accident event, like in the preceding example of a big car versus little car, outcomes can be better understood and, consequently, predicted for future outcomes.

Secondly, casualty data should be linked to auto physical damage outcomes. Remember, the application of collision energy that causes auto physical damage also causes/explains occupant injury if and when it occurs.

Lastly, supplement traditional claim data with data that helps explain the physical event for the vehicle(s) and their occupant(s). These data elements can include, but are not limited to, the following:

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PERSPECTIVE PHYSICS-SENSITIVE AI FOR AUTO INSURERS

- Vehicle physical attributes such as weight, height, width, length, wheelbase, and stiffness coefficients.
- Vehicle safety features – this includes data elements such as airbag locations and ADAS features.
- Occupant restraint system use or non-use.
- Event data for one or both vehicles such as pre-impact speeds, pre-impact braking, impact-related collision energy/accelerations (i.e., often measured as Delta-v, which, as a vector quantity, has a scalar magnitude and a direction), post-impact travel, and collision over-ride/under-ride. These data elements are usually available through event data recorders or some telematics applications.

TIPS FOR SUCCESS

A word of caution: If event data is sourced from mobile-only solutions, critical measures of collision energy such as Delta-V can be highly inaccurate if the mobile device is not securely fixed to the vehicle. Fortunately, this gold standard metric for collision energy can be obtained from technologies that estimate Delta-v from repair appraisals and soon from vehicle damage photos which make its availability nearly ubiquitous. Also, existing photo-based AI can describe damage size and location which further augments the description of physical events.

Occasionally there may be data gaps such as instances when there is a good description of the event for one vehicle but not the other. Physics can help fill these gaps. For example, because of the Conservation of Momentum, when you have the Delta-v for just one vehicle, but have the vehicle weights for both vehicles, the missing Delta-v can be accurately derived.

Another tip: Use physics to assess AI performance. Do your models predict results that are consistent with the laws of physics? If the answer to this test is "yes," your confidence in your solutions should be higher. If "no," do you really want to operationalize something that doesn't conform to the real world?

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CLAIMS IMPLICATIONS

Today, auto insurers are driving more efficiency in their organizations by better segmenting their claims, which means getting the right claim to the right adjuster at the right time or executing a straight through or touchless (or near-touchless) process. Logically, how could an understanding of a physics-based severity assessment (in terms of collision energy and other physical properties of the event) not improve predictions for process segmentation? Consider these segmentation opportunities using physics-sensitive AI:

- High-severity collision with low limits for straight-through processing opportunities
- Likely/unlikely no injury outcomes
- Likely/unlikely severe injury outcomes
- Questionable injury claims
- Likely/unlikely APD audit exceptions
- Subrogation pursuit/resistance opportunities

These segmentation opportunities can be flagged or routed as soon as an accident is reported, and photos of vehicle damage are transmitted.

DIGITAL TWIN OPPORTUNITIES

Physics-sensitive AI positions insurers to implement "Digital Twin" technologies in the future. As published by NASA in 2012, "A Digital Twin is an integrated Multiphysics, multiscale, probabilistic simulation of an as-built vehicle or system that uses the best available physical models, sensor updates, fleet history, etc. to mirror the life of its corresponding flying twin."[88]

More simply stated, "a digital twin is, in essence, a computer program that uses real-world data to create simulations that can predict how a product or process will perform. These programs can integrate the internet of things (Industry 4.0), artificial intelligence, and software analytics to enhance the output."[89]

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PERSPECTIVE

PHYSICS-SENSITIVE AI FOR AUTO INSURERS

The foundations for digital twin technology are already well established. Vehicle telematics provides necessary data to simulate an accident. This data includes pre-accident speeds and braking, impact-related collision energy/accelerations, and post-impact vehicle motions. Vehicle-sourced telematic data may also include occupant seating position(s), restraint system usage, and airbag deployment(s). When coupled with detailed build data for the vehicle, collectively, these data can be used by accident simulation technologies to create a digital twin which can be used by auto insurers to:

- Create a timely and comprehensive first notice of loss (FNOL) data record.
- Coordinate real-time accident responses, which will recognize when towing and ambulance services are needed. Nascent simulation technologies today are predicting if severe injuries are likely so injured parties can be routed to Level 1 trauma centers, which offer higher survivability rates for severely injured occupants.
- Simulate how the accident occurred and resolve questions about liability and subrogation opportunities.
- Simulate actual damage patterns so repair requirements, costs, and timeframes can be accurately predicted. As a result, vehicles can be immediately taken to repair facilities that have the resources to repair the vehicle quickly and accurately and parts can be ordered faster. Predict injury outcomes, treatment requirements, and costs.
- With the prediction of these outcomes, the process of resolving the claims can be optimized through the triage/segmentation of claims, straight-through processing opportunities, low-touch processing opportunities, high-touch requirements, and lastly, flagging of processes that deviate from expected outcomes.

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PERSPECTIVE PHYSICS-SENSITIVE AI FOR AUTO INSURERS

When digital twin technologies in the auto insurance industry become more mature, insurers will be able to evaluate its existing claim inventory and identify the most efficient and accurate resolution paths for all of its claims. The end result? Achievement of greater customer service levels and operational efficiencies previously thought unobtainable.

CONCLUSION

Auto insurers indemnify insureds from the outcomes related to auto accidents. These accidents conform to the laws of physics, which are predictable, and data describing the physics of accident events is now readily available. As leadership looks for opportunities to improve its organization's performance, understanding the physics of accidents at scale offers a new frontier for physics-sensitive AI.

Further in the future, the practice of accumulating data for physics-sensitive AI positions auto insurers to leverage digital twin technology to deliver even higher levels of customer service and operational efficiency.

PERSPECTIVE: 2023 A.D. (AFTER DIGITIZATION)

WHAT COMES NEXT?

KYLE KRUMLAUF

DIRECTOR OF INDUSTRY ANALYTICS, CCC

Imagine the pandemic without access to digital capabilities.

Digital enabled most people to continue working, learning, consuming, and connecting during a time when the world effectively "shut down."

Even tech laggards found their place in the digital age. Now, with the industry well on its path to realize the promise of digital, what comes next?

PERSPECTIVE

2023 A.D. (AFTER DIGITIZATION)

PREPARING FOR THE FUTURE OF PERSONAL MOBILITY

We hear plenty about the ACES — Autonomous, Connected, Electric and Shared vehicles — the sexy half of mobility's future, but not as much about the AEISM — Adoption, Experience, Infrastructure, Safety, and Maintenance — the elements that will ultimately drive just how much change personal mobility will truly experience.

While it's exciting to think about self-driving cars and shared vehicles, what do we need to consider as the ACES make their ascent?

- **Adoption**: Vehicles are changing, from how people interact with them to how they're powered. While adoption of the ACES is ramping up, issues like EV range anxiety, skepticism about vehicle autonomy, and more must be addressed before consumers will accept full-scale change.
- **Experience**: As more technology is embedded in the vehicle itself, the consumer experience of researching, testing, purchasing, and operating the modern automobile will need to adapt. High-pressure sales tactics may become a thing of the past. It's easy to foresee a future where salespeople become automobile experience consultants.
- **Infrastructure**: Supplying, building, selling, powering, and maintaining mobility's future will require coordinated investments and commitments from all corners of the mobility economy. This will also be an opportunity for incumbents and new entrants to seek out new partnerships and control their fate (which is not guaranteed). Everyone from OEMs, parts suppliers, lenders, and dealerships to repair shops, insurance companies, and tow truck operators stand to gain (or lose) depending on how they play their cards.
- **Safety**: Simply put, what are the blind spots that could put others in harm's way? From being electrified to misunderstanding where safety systems end and the human begins, navigating these new risks will require awareness, training, and documentation.
- **Maintenance**: Automobile sophistication will push maintenance squarely to the forefront. Those complexities present endless opportunities for experts prepared to maintain these new machines.

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PERSPECTIVE 2023 A.D. (AFTER DIGITIZATION)

As our industry prepares for the future of personal mobility, there are numerous considerations and challenges ahead.

With all the changes to how, when, where, what and who will be driving discussed earlier, consider these two takeaways as we head into 2023: 1) it will take people and technology working together; and 2) don't let up when it comes to product innovation.

THE CONVERGENCE OF TALENT AND TECHNOLOGY

Parts of the U.S. economy have a mismatch problem — the population of available workers does not align with open positions. This is particularly true within the mobility economy. For example, some auto manufacturers have too many employees, while insurance claims departments and auto repair shops don't have enough. Key drivers range from automation and obsolescence to talent migration and generational retirement.

Reframed and reimagined work in traditional industries, coupled with advanced technology could create a win-win scenario when it is needed the most.

The role of technology in moving talent permeates beyond onboarding and training. How can concepts, such as digital twin, help people imagine their lives in a different role or industry; see how their talents will flourish; and identify how or where they might add value where it is needed most? Similarly, once the work is being done, how can technology enable personal and professional advancement beyond stale day-to-day tasks?

Democratization of robotic process automation (RPA), for example, could empower employees to eliminate low-value work. Yet, balancing advancement with governance and maintenance has proven difficult for over-leveraged technology departments. The proliferation of AI and its underlying capabilities, such as machine learning (ML), could turn tedious tasks into less daunting review and approval work (more akin to human-in-the-loop).

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PERSPECTIVE 2023 A.D. (AFTER DIGITIZATION)

> Fast-paced company seeking tech-savvy individual with proven experience diagnosing and resolving hardware and software issues within state-of-the-art digital systems."*

*If only it was this easy to move someone from an IT help desk to an auto repair shop.

KEEP YOUR FOOT ON THE GAS

Throughout the pandemic, more and more insurance carriers began to test and implement digital, touchless solutions that can expedite the indemnification process and delight customers.

Emerging digital capabilities exhibited the potential to play a role in critical customer interactions, such as first notice of loss (FNOL), claims processing (including straight-through processing), status updates, quoting, underwriting, and digital payments.

With the first wave of insurance industry disruption behind us, lessons from the successes and failures should serve as further transformational guidance to carriers, solutions partners, and future protagonists.

While it seems inevitable that experience-enabling, customer-empowering technologies will become table stakes in delivering value, new market pressures stand to upend the progress that has been made. Current profitability challenges

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PERSPECTIVE

2023 A.D. (AFTER DIGITIZATION)

driven by swelling severity and catastrophic weather events are diverting attention away from testing and perfecting digital tools and processes, thus further prolonging industry modernization.

Labor and supply shortages continue to play a key role in global inflation. And, at a micro level, indemnification cycles are being prolonged, resulting in delays to the timely repairs of customers' vehicles and property.

How is the market responding? With the status quo of hard market economics: price increases and underwriting scrutiny.

Yet given the pace of change in personal mobility, it is important that carriers also continue to focus on the product and its delivery.

POWERING FORWARD

The ACES and the technology behind them will continue to transform personal mobility, how it is protected, and how recovery is provided in cases of an accident. The indemnification product will need to adapt as more autonomy and data about how, when, where, and who is driving becomes available.

As the product changes the industry can adapt by using similar technologies to ensure the product and experience align and that both deliver on evolving consumer demands. The questions of how to price, underwrite, maintain, protect, indemnify, and service this new breed of connected customers and assets remain the key challenges waiting to be solved.

CRASH COURSE **CONCLUSION**

As the P&C insurance, collision repair, and auto manufacturing industries evolve to provide customers with more personalized experiences, so, too, will the technologies that make them possible.

The goal is to strike the right balance between mass automation and manual customization, where technology puts the right data in front of the right customer at the right time to streamline communications and quickly identifies when a customer would be best served by a human.

Advanced AI technologies combined with data-driven intelligence not only enable deeper policyholder engagement — they elevate the business-to-business experience in this vast, connected P&C ecosystem, facilitating many new use cases that optimize operations, augment customer experience, and mitigate risks.

2023 is sure to be a defining year for the role technology plays across the multi-trillion-dollar P&C economy;

The time is now for the industry to ignite **EXPERIENCES** that have the power to transform and ultimately delight customers.

CRASH COURSE 2023
CONTRIBUTORS

ignite EXPERIENCE

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Susanna Gotsch is the author of Crash Course, an annual report now in its 28th year covering the data, trends, and insights impacting the P&C insurance economy. Leaders from across the automotive, claims, repair, and collision industries turn to Crash Course each year for in-depth coverage and comprehensive data on everything from shifts in driving behavior and advances in vehicle technology to the macroeconomic, business, and social shifts driving change. Gotsch has been authoring Crash Course for nearly three decades. She has presented at numerous Industry Conferences and symposiums and is a preeminent thought leader and speaker on industry topics.

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Jason Verlen is CCC's VP of Product Management. He's an industry expert and a sought-after speaker and author, with deep knowledge and historical perspective across the P&C insurance and collision repair industries. Jason has extensive experience in the software industry with specific expertise in product management, big data, and analytics. Before joining CCC, Jason spent five years at IBM where he was Vice President of Big Data Analytics, and prior to that, he was Vice President of Product Management for SPSS, a predictive analytics software company. Jason earned a B.S. degree in Computer Science from Northwestern University and an MBA from the University of Chicago.

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Erik Bahnsen has spent 20 years in the insurance industry, first holding several auto and casualty-focused claim roles on the insurer side before moving into the technology side. Erik joined CCC in 2012 where he has held numerous roles in account management, leadership, and product innovation, with a focus on casualty. Erik also participates in the ongoing development of CCC's industry-leading analytics and AI products. Since joining the industry analyst team in early 2022, Erik's industry analysis and thought leadership content has been presented and/or featured in numerous industry meetings and influential publications.

KYLE KRUMLAUF

Director of Industry Analytics, CCC

Kyle Krumlauf brings more than 20 years of industry experience to his new role at CCC, having served in a variety of management and individual contributor positions at Nationwide and Grange Insurance. He was awarded a CEO Award at Nationwide in 2014 for Innovation & Continuous Improvement, and an Accolade Award at Grange in 2019 for his work in Innovation. Kyle earned a BA in Political Science and History from Ashland University and an MBA from Ohio Dominican University. He also holds the CPCU and ARM designations.

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VP and Research Fellow, CCC

Scott Palmer, Vice President and Research Fellow at CCC, has worked in the field of injury causation since 1987 and pioneered the use of Delta-v in claims technologies. Prior to CCC, Scott founded Injury Sciences where he architected science-based auto claim evaluation technologies that leverage both vehicle repair estimate and "black box" data to evaluate liability and injury causation. Prior to Injury Sciences, Scott was the President and CEO of Biodynamic Research Corporation, an internationally recognized firm in the field of impact biomechanics and injury causation.

TIM CHRIST

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Tim Christ brings 20+ years of insurance claims, forensic engineering, management consulting, and insurtech advisory work to CCC. He is a regular contributor to PC360 magazine and has been a public speaker for multiple national claims conferences like Connected Claims, Combined Claims, NAMIC Claims, PLRB, IRMI Energy Risk, University Risk Managers Association, over 25 CPCU chapters, and more. Tim has authored several books, including *Becoming a World-Class Expert: The Business of Forensic Engineering*, and *Outgrowing QuickBooks: Engineering Real Profit in Companies $10 Million-$50 Million Annual Revenue*.

ENDNOTES

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ENDNOTES

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