Payden&Rygel

POINT of VIEW

Vol. 2, 2025

Our Perspective on Issues Affecting Global Financial Markets

Pg 1 **DRONE DELIVERY: BRINGING THE CITY TO THE SUBURBS**

Urbanites revel in the hustle and bustle of city life, where dense housing enables the creation of convenient and walkable neighborhoods filled with restaurants and stores. But, what if drone-delivery-on-demand could give suburbanites the amenities that urbanites have? We explore.

Pg 5 **DECIPHERING THE CBO: OBSCURE SCOREKEEPER OF THE U.S. BUDGET GAME**

We often hear policymakers refer to the Congressional Budget Office (CBO) in Capitol Hill debates, but what role does this obscure government agency play in the federal budget process in America? We unravel how the CBO came to be and how it fits into the U.S. budget process.

Pg 7 **SLICING THE U.S. FEDERAL BUDGET: UNDERSTANDING THE REVENUES AND OUTLAYS OF THE MOST IMPORTANT GOVERNMENT BUDGET IN THE WORLD**

The U.S. federal government's budget has a significant impact on the global economy, as it determines the level of Treasury debt, which serves as the international reserve asset. We slice the federal budget and examine the factors that truly drive U.S. debt growth.

Pg 11 **VAR SHOCK: REFEREE REVIEWS AND LIVE SPORTS: RUINATION OR REVOLUTION?**

Many investors are familiar with the term "VaR" (value-at-risk), which has become a key metric for gauging portfolio risk among portfolio managers. The general public is likely more familiar with “VAR” as either a savior or a sin in live sports. Where does the Payden Economics Team stand on this important issue?

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Drone Delivery

Bringing The City To The Suburbs

Is it a bird? A plane? Or...Superman?[1]

Nope. It turns out it's just piping-hot coffee being delivered *by a drone*.

«DRONE DELIVERY IS NO LONGER A SCIENCE FICTION FANTASY»

If you live in suburban Dublin, you might already be familiar with the above questions, as drone delivery is no longer a science fiction fantasy!

City dwellers often tout the many urban amenities they enjoy, especially the abundance of dining options within walking distance. But, historically, you needed to live *in* the city to take advantage of the amenities.

Now, at least on the outskirts of Dublin and in a few other locales, all you have to do is pull out a food-delivery app, choose "drone delivery" rather than "road delivery," and drop a pin on the map where you want the item delivered.

Voilà, you're all set. Less than three minutes later, you will have your cup of hot joe.[2]

Below, we explore the process and economics of drone delivery, as well as the possibilities that the success of drone delivery in Dublin is unlocking for the global delivery and freight market.

«DRONES MAY SOON BUZZ BY TO DELIVER GOODS IN YOUR NEIGHBORHOOD. AND, BELIEVE IT OR NOT, THE TEST CASE IS... COFFEE?»

AIRDROPS

Drones may soon buzz by to deliver goods in your neighborhood. And, believe it or not, the test case is...*coffee?* For Manna Air Delivery, a drone delivery service started in Dublin, Ireland, it takes a mere 60 seconds for a human to load the coffee order in the drone before it zips off to its destination.[3]

The Manna service makes 25 to 30 deliveries per hour, with the autonomous drone "driving" in a straight line, avoiding buildings at an elevation of 250 feet (~80 meters). In abnormal situations, a "pilot" can "drive" the drone out of trouble.

With only light turbulence involved in low-level flights, there's little risk of spilling your caffeinated beverage, though you might lose two to three degrees Celsius of temperature en route. A small price to pay for a delicious morning beverage?

Once the drone is hovering over your garden, the bay doors open, and the delivery falls four meters per second toward the ground on a string.

Again, your coffee won't spill. You can even order fresh eggs that don't break (*see Did You Know? The Physics Of An Egg Drop*).

«ASIDE FROM CONVENIENCE, THE MOST SIGNIFICANT POSITIVE IS THE RELIABILITY OF THE DELIVERY TIME.»

Aside from convenience, the most significant positive is the *reliability* of the delivery time. Drone delivery beats road delivery with impressively quick and precise delivery times.

For example, the average delivery time for Manna is two to three minutes per order, covering an average distance of 1.2 miles. In contrast, a regular "road delivery" over the same distance to Payden & Rygel's downtown Los Angeles Office took 35 minutes to deliver two coffees! Worse, in suburban Los Angeles, drivers can spend over an hour navigating through traffic. "By the way, the delivery driver is eating your fries!"[5] Even if driverless delivery becomes ubiquitous, computer-controlled cars cannot avoid traffic, meaning the drone remains the superior choice.

DELIVERING HIGH TECH

Several key factors have laid the groundwork for Manna's success, including the availability of technology, ease of integration, the popularity of the delivery product, and the optimal operating location.

First, the technology required for this "manna from heaven" already existed: GPS tracking, computer vision, drone parts, and batteries. Drone delivery began operating as early as 2013. Since then, advancements in phone technology have made batteries cheaper and lighter. The push for self-driving cars has also led to improved autonomous "driving" algorithms.

Second, integration or consumer adaptation was also easy since the average consumer is already accustomed to ordering delivery through a phone app.

Third, for a drone delivery company like Manna that wants to leverage its high fixed-cost and low variable-cost business model, there's no better product than Ireland's most frequent purchase, coffee (more on this below).

«DRONES TRAVEL QUICKLY AT LOW ALTITUDES, MAKING THEM IDEAL FOR WIDESPREAD SUBURBAN NEIGHBORHOODS WITH LOW-STORY SINGLE-FAMILY HOMES.»

Fourth, location matters. Suburbs are ideal for drone delivery. Drones travel quickly (on average, 50 miles per hour) at low altitudes, making them ideal for widespread suburban neighborhoods with low-story single-family homes, which enables almost all drone routes to be straight-line deliveries.

UNIT ECONOMICS

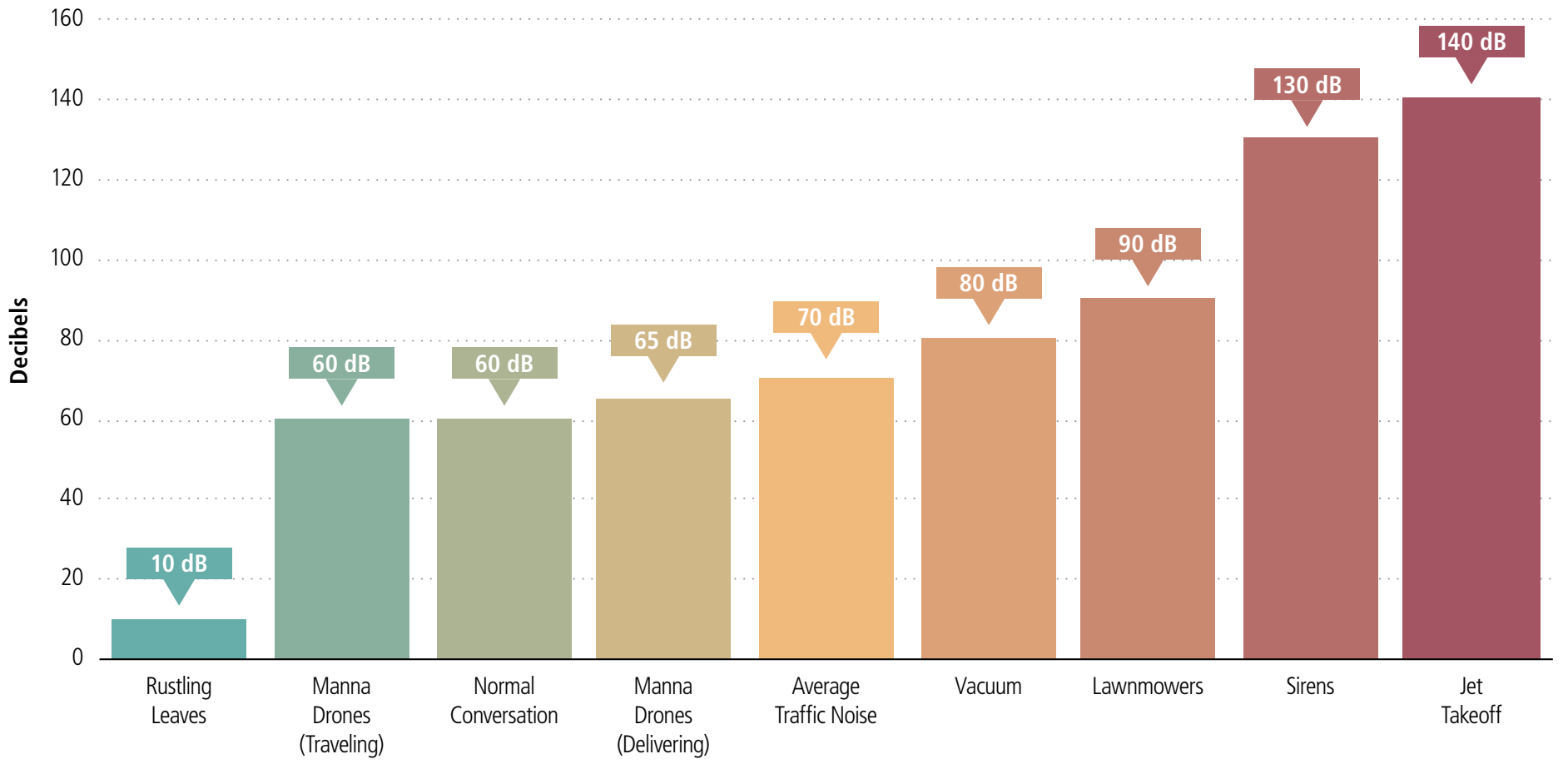
But we're an investment management publication, so we must ask: How does drone delivery make money?

DID YOU KNOW?

THE PHYSICS OF AN EGG DROP

You might sometimes come across eggs dropping from the sky. But it doesn't mean the world is ending. It's because either Manna's drones are delivering fresh eggs or someone is trying out an egg drop challenge—a common physics experiment exploring how to protect a raw egg from breaking when dropped from the sky (or a drone). Common ways of preventing the egg from breaking include cushioning and parachuting—that's how they land rockets back on Earth. More creative solutions include orienting the egg so it lands on the sturdiest part of its shell, i.e., vertically! In the case of Manna, they cushion their eggs and drop their deliveries slowly. But the physics behind an egg drop proves a point: As Manna's CEO Bobby Healy has said, "We deliver fresh eggs, so we can deliver literally anything."[4]

fig 1. NEIGHBORHOOD NUISANCES:
DECIBEL SCALE OF TYPICAL NOISE LEVELS*



Sources: California Department of Transportation, Manna, Decibel Pro
*Decibel (dB) is measured on a logarithmic scale, meaning a 10 dB increase makes the sound about ten times more intense

Easy: at least in the case of Manna, buyers pay a fixed fee per delivery (EUR 4 or $4.60), but the unit economics built on the abovementioned four key factors of success enable the average delivery cost to be $4.27 and lower—so it's a cash flow-positive business.

Of the $4.27, labor costs are $1.93, fixed overhead costs are $0.71, and consumables and depreciation are $1.63.[6]

In a world where labor costs hinder new businesses, one Manna dispatcher could monitor 20 autonomous drones *simultaneously*. Compared to the average labor cost in Europe of $18 per hour, $1.93 per order is unbeatable by any road delivery.[7]

Overhead costs are low since the space requirements for loading, take-off, and landing are also minimal: an area covering 12 car parking spaces, for example, can accommodate two shipping containers and support five drones simultaneously.[8]

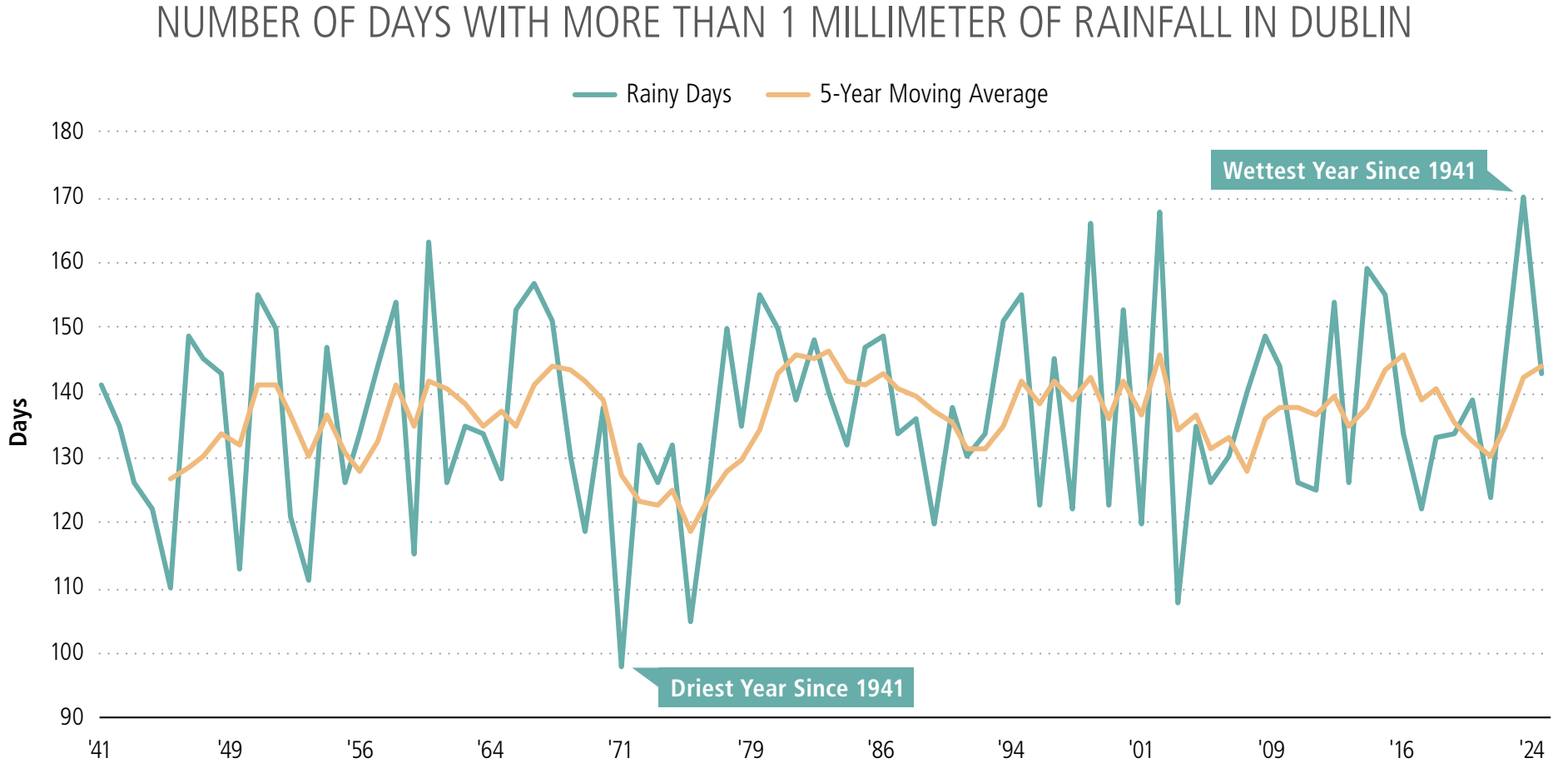
Further, since the overhead costs are fixed, the more deliveries are made, the lower the cost of each delivery becomes. Manna's CEO, Bobby Healy, estimated that the price per delivery could soon "be closer to $3 and even $3.50."[9]

DRONE DERANGEMENT SYNDROME (DDS)

We can already hear the critics' objections. In 2019, we wrote fondly about "micro mobility," and heard "electric scooters would never be allowed in *London*" in response. Ha! Readers may now be pleased (or annoyed) that scooters and e-bikes dominate the City of London, zipping along dedicated bike lanes.

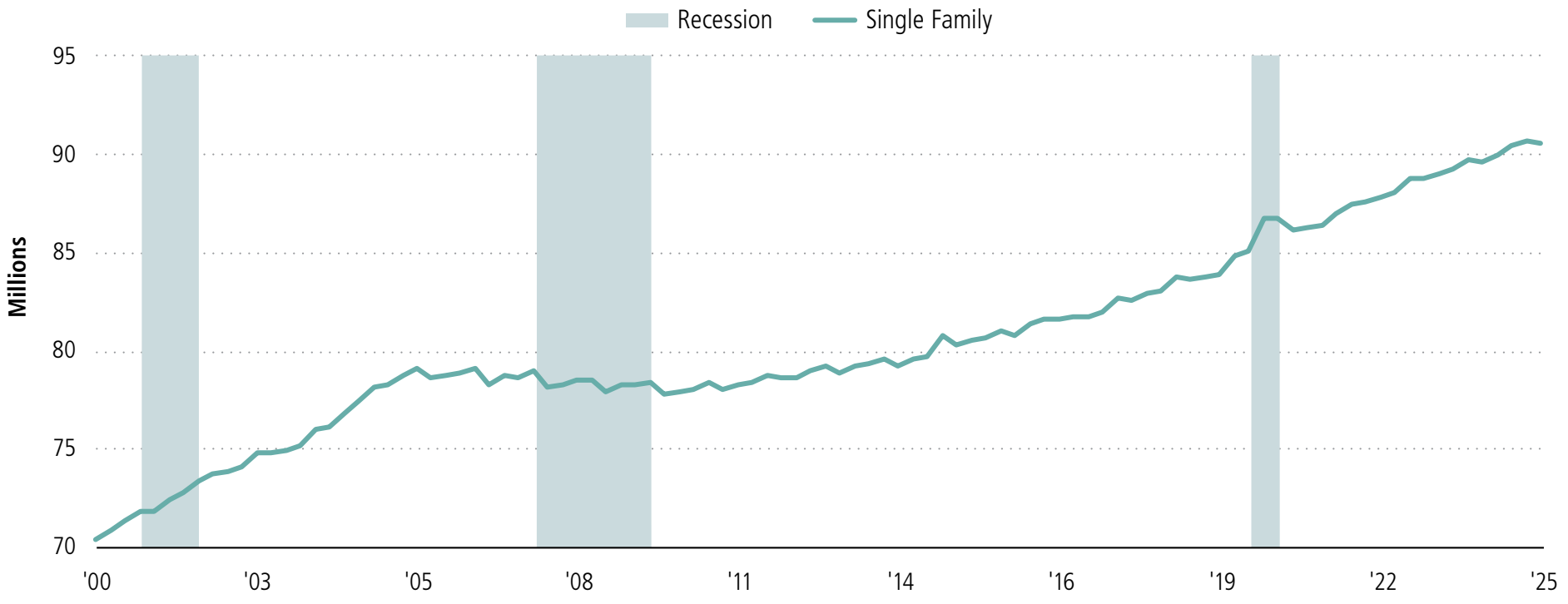
So, we're ready for the drone pushback: "This is different; I don't want thousands of drones buzzing overhead, ruining the countryside or at least the neighborhood."

fig 2. A DAMP TRADITION:
NUMBER OF DAYS WITH MORE THAN 1 MILLIMETER OF RAINFALL IN DUBLIN



Source: Met Éireann, Gridded Daily Rainfall Dataset

fig 3. SUBURBS FOR SUCCESS:
OCCUPIED SINGLE-FAMILY HOUSING UNITS* (DETACHED AND ATTACHED) IN THE U.S.



Sources: U.S. Census Bureau, Energy Information Administration (EIA)
*Single-family housing unit is computed by multiplying the total owner and renter-occupied housing inventory by the share of single-family units from the EIA

Well, do you know what's *worse* than a drone? The noise of regular street traffic or neighbors' lawn mowers every morning (*see Figure 1 on page 2*).

«EVEN WITH AN IMPAIRED VISUAL LINE OF SIGHT, DRONES CAN STILL RELY ON GPS TO MAKE DELIVERIES.»

The other critique we expect: "Drones can't fly in the weather where I live." Well, Dublin is as great a testing ground as any city. A typical day in Dublin features average cloud cover of 70–80%, sustained winds of 20–30 kilometers per hour (or 12–18 miles per hour) with gusts exceeding 50 km/h (30+ miles per hour), and persistent rainfall over 190 days per year (*see Figure 2 on page 2*). Even with an impaired visual line of sight, drones can still rely on GPS to make deliveries.

Further, Manna began testing on the outskirts of Helsinki, Finland, in January 2025, and has been making, on average, 100 deliveries a day in extremely cold temperatures and the snowiest weather.[10]

WHAT TAM IS IT?

With the hurdles and objections out of the way, we can return to the opportunity set: How big is the total addressable market (TAM) for drones? Our short answer is that it could be massive.

First, the largest consumer market exists in the U.S., a country that also happens to have almost 70% of its housing units in suburbs, making it ideal for drone delivery such as Manna's (*see Figure 3*).

Second, the food delivery market in the U.S. is already huge, with 5.2 billion orders annually.[11]

«THE FOOD DELIVERY MARKET IN THE U.S. IS ALREADY HUGE, WITH 5.2 BILLION ORDERS ANNUALLY.»

Drone delivery can unlock many hidden food delivery demands that were previously hindered by delivery times and costs. For example, how many people would prefer their ice cream delivered before it melts? Estimates suggest that the food delivery market could expand to 16 billion orders per year.[12]

Third, we can easily imagine the case for drone delivery expanding to packages (*see Did You Know? The "Last Meter" Of Drone Delivery*). A growing share of online purchases as a share of retail sales is a perfect proxy for real-time market size (*see Figure 4 on page 4*). Manna drones can already deliver up to five pounds in cargo weight—just picture how many items sold online weigh five pounds or less!

Fourth, drones could supplant freight trucking for high-value, low-weight freight. In addition to consumer use, drones could be used to transfer packages from airports, seaports, and train stations to local warehouses and logistics hubs, or from wholesalers to retailers.

What about second-order effects, as with any economic upheaval?

«THE INNOVATION SHOULD MAKE SUPPLY CHAINS MORE RESILIENT AND PREVENT SUPPLY-CHAIN CRISES LIKE THOSE EXPERIENCED DURING THE COVID-19 PANDEMIC.»

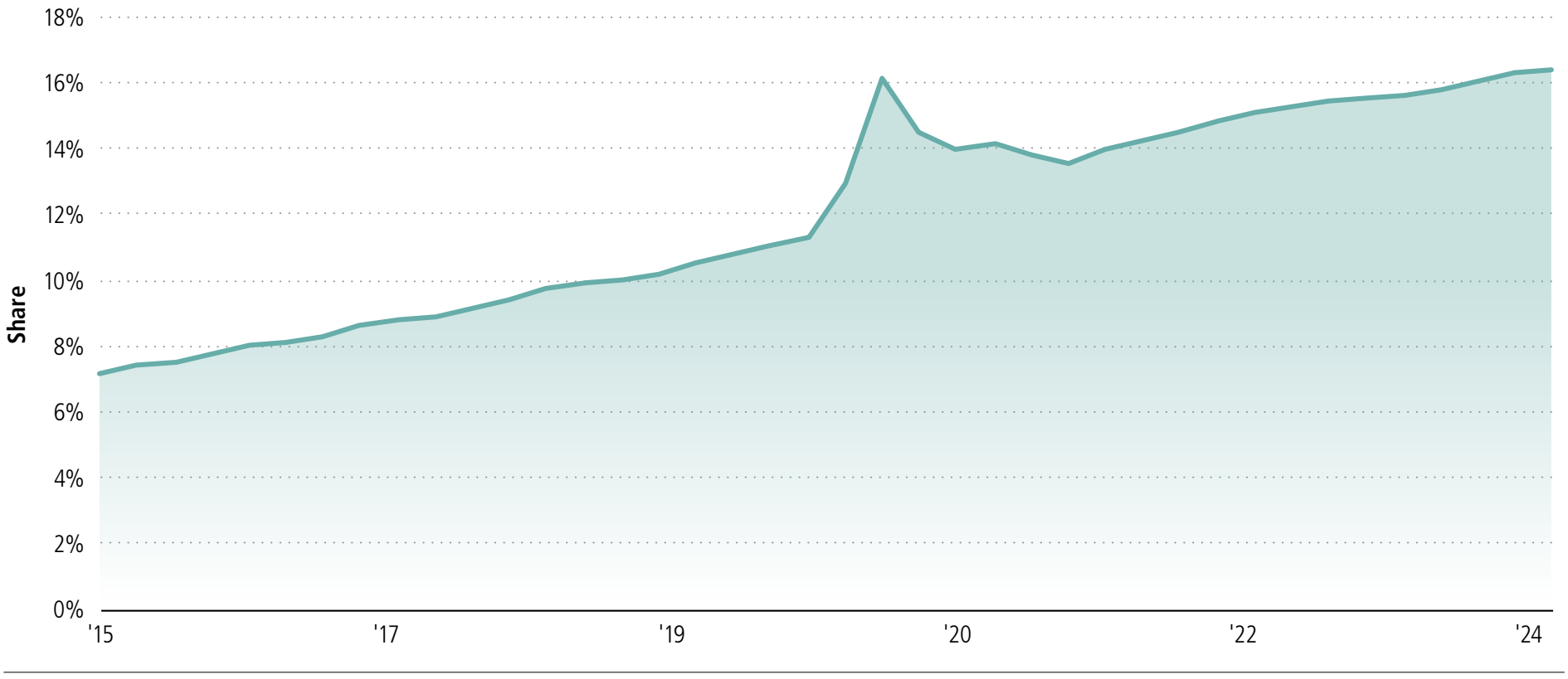
If living 30 miles from downtown LA is suddenly as tasty as living around the corner from your favorite grocer, drone delivery could open up more housing preferences. Further, as drones replace road deliveries, they will reduce road traffic,

DID YOU KNOW?

THE "LAST METER" OF DRONE DELIVERY

The last mile of delivery, defined as the movement of packages from the final distribution center to individual consumers, is typically the most expensive and challenging part of the traditional goods delivery chain. Integrating drone delivery may reduce the cost of traditional last-mile delivery, which is still dominated by road deliveries. However, the next step (or opportunity?) for drones might be a "last meter" delivery challenge: What's the best way to "land" packages? As of 2022, approximately 46% of drone deliveries, such as Manna's, utilized the tether (string) method, which is the most precise method but requires drones to descend to lower altitudes, thus increasing the risk of tangling. Another 35% of drone deliveries use parachutes, which is less precise but allows for longer vertical range deliveries. Less commonly used methods include loading packages at docking stations.[13]

fig 4. RELENTLESS RISE:
E-COMMERCE SALES AS A SHARE OF TOTAL SALES IN THE U.S.



Source: U.S. Census Bureau

accident rates, and greenhouse gas emissions. And long-range drone fleets across seas may be able to bypass port bottlenecks. At the very least, the innovation should make supply chains more resilient and prevent supply-chain crises like those experienced during the Covid-19 pandemic.

THE FLIGHT FORWARD

It took more than four years for drones to be approved to fly over populated areas legally in Dublin.

Further, Europe's proactive stance on regulating emerging technologies already sets up a framework of regulations for drones. Contrary to common belief, the fragmented regulation landscape in Europe has allowed drones to be approved more easily, depending on the country.

Meanwhile, the free market-loving and allegedly regulatory-light U.S. still faces legal concerns surrounding low airspace privacy issues above homes. Perhaps Manna's example could push for friendlier U.S. drone delivery regulations to replace the current rules that restrict existing drone infrastructure like "Amazon Prime Air" to only a few localities.

«MANNA'S SUCCESS SUGGESTS THAT A FUTURE WITH DRONE DELIVERY HAS ALREADY TAKEN OFF.»

While we wait for U.S. drone regulations, Manna's success suggests that a future with drone delivery has already taken off—and we are buckling up for the ride.

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Deciphering The CBO

Obscure Scorekeeper Of The U.S. Budget Game

For those who have been following news on Capitol Hill lately, the Congressional Budget Office (CBO) has been in the hot seat.

Policymakers say, "We're not buying the CBO's estimates," or "[It's] notorious for getting things wrong."[1]

The current U.S. Treasury Secretary, Scott Bessent, called the recent CBO scoring "not real [and] a lot like Enron accounting."[2] He went on to criticize the CBO for using "nonsensical rules."[3]

Well, it's not the first time that policymakers have attacked the CBO. Back in 1980, President Reagan called the CBO estimates "phony" when the CBO scored his tax cuts conservatively.[4]

But why so much fuss with what seems to be a quirky government think tank? It turns out that this unelected office in Congress wields surprising influence in the federal budget process.

Let's unpack the CBO's importance.

FOUNDATIONS

According to the U.S. Constitution, out of the three branches of the U.S. government, the legislative branch, or Congress, has "the power of the purse." However, Congress has not always had control over the budget. Analysis shows that the President was in the budgetary "driver's seat" before 1974.[5]

Before 1974, when Congress passed spending bills, it was then the Executive Branch's authority to execute the actual funding. Further, the President was responsible for planning the federal budget by submitting annual budget proposals through the Executive Branch's Bureau of the Budget (later renamed the Office of Management and Budget, or OMB).

In other words, Congress lacked the power to ensure that the President followed through on funding bills and the capacity to develop budget estimates independently of the President's.

The situation escalated in 1974 when the Nixon administration threatened to ignore or withhold (also known as "impound") Congress's approved expenditures to fund government programs that President Nixon opposed (*see Did You Know? Impoundment Aficionado Nixon on page 9*).[6]

As a result, Congress overwhelmingly passed the *Budget and Impoundment Control Act of 1974*, also known as the Budget Act, to reassert Congress's authority over spending.

The Budget Act established budget committees in the House and the Senate, formalizing the congressional budget process we know today. Among a host of reforms, the Budget Act established the CBO to provide nonpartisan budget analysis for Congress and serve as the new guidepost for the federal budget process.

«THE CBO CRUNCHES THE BUDGET NUMBERS FOR CONGRESS WITH ITS 275 STAFF MEMBERS, CONSISTING OF ECONOMISTS, PUBLIC POLICY ANALYSTS, LAWYERS, INFORMATION TECHNOLOGISTS, AND EDITORS.»

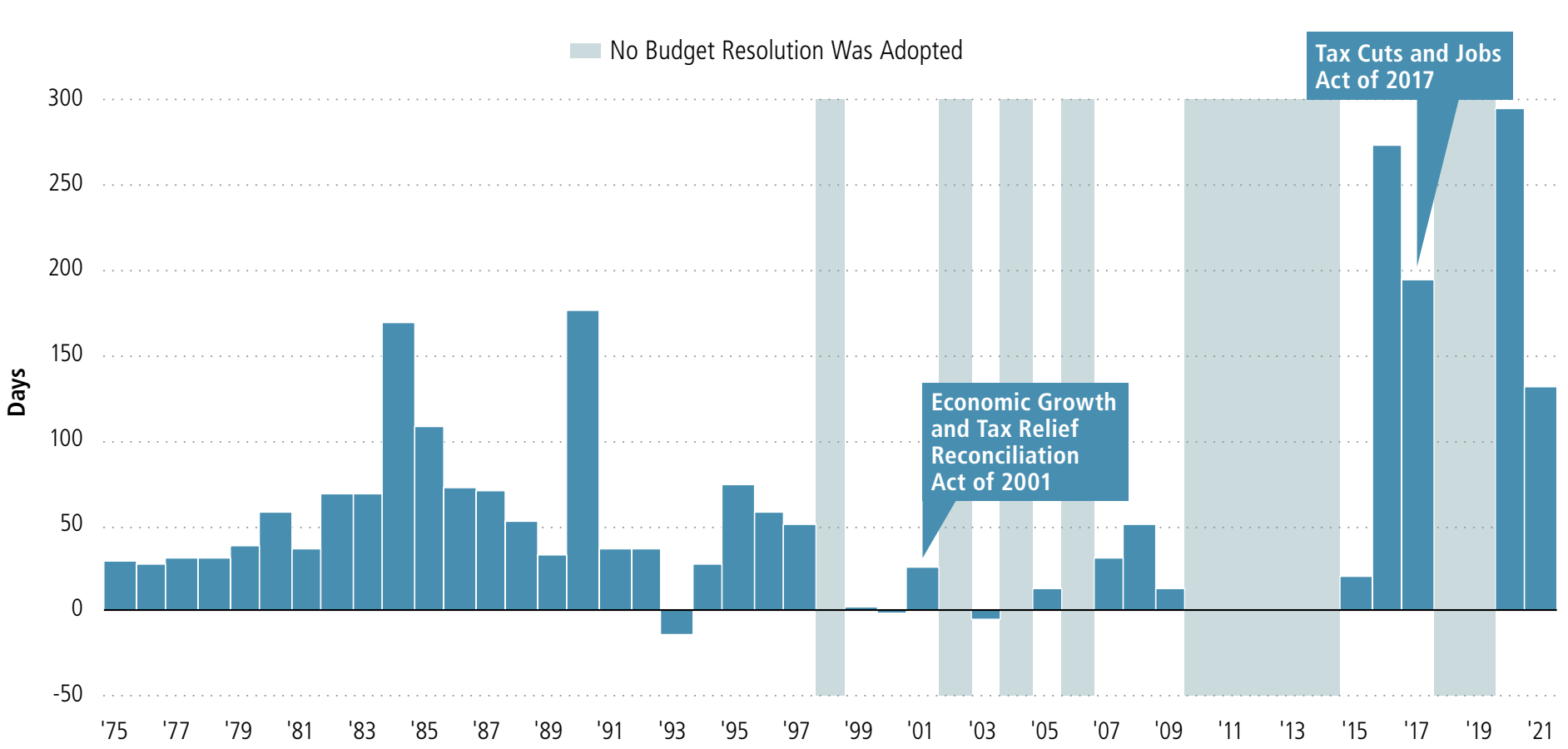
A NEW ORDER

Simply put, the CBO crunches the budget numbers for Congress with its 275 staff members, consisting of economists, public policy analysts, lawyers, information technologists, and editors. It might not sound like much at first, but the CBO's math is integral to almost all stages of the budget process, from baseline budget forecasts to "scoring" new legislation.

First, the 1974 Budget Act requires the CBO to produce annual budget reviews and outlooks assuming the continuation of current law for the next 10 fiscal years, also commonly referred to as baseline forecasts.

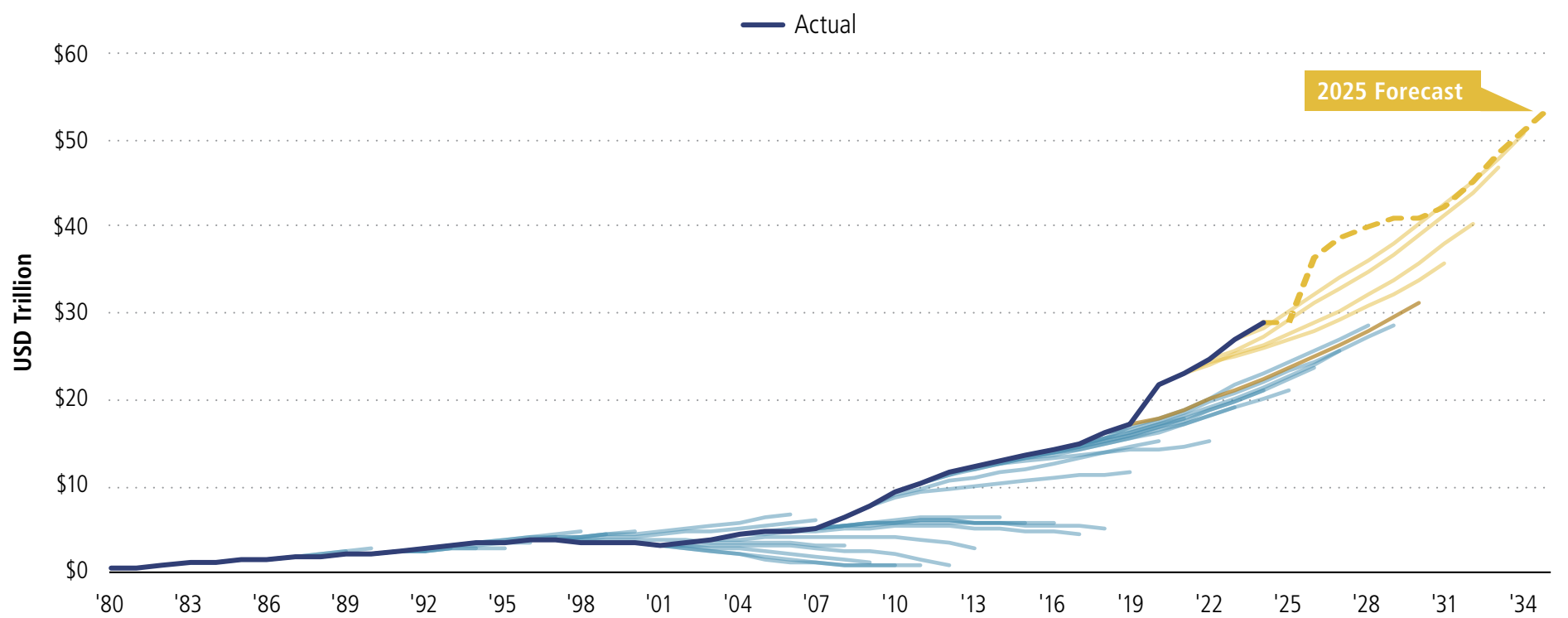
Although similar to what the OMB was doing before 1974, the CBO's forecasts are considered more neutral, as they assist members of Congress

fig 1. TOO MANY BUT NOT TOO TIMELY:
CALENDAR DAYS BUDGET RESOLUTIONS ARE ADOPTED AFTER APRIL 15 TARGET DEADLINE



Source: Congress.gov

fig 2. INFLECTION LAG:
CBO PROJECTIONS—TOTAL DEBT OUTSTANDING TO PUBLIC, ACTUAL VERSUS FORECASTS



Sources: U.S. Treasury, Congressional Budget Office

from both political parties. As a result, since 1974, the CBO's annual outlooks became the preferred "baseline" for any policymaking, while the President's budget has simply become a "wishlist," sometimes referred to as "dead on arrival."[7]

Second, the Budget Act "requires that *each bill* ordered by a Congressional committee to the House or Senate include a CBO cost estimate."[8] In other words, all proposed legislation needs to be "scored" by the CBO. By "scoring," it means that the CBO will estimate how much the new bill adds to or subtracts from the current projected deficit under existing law.

Since its creation, the CBO has published approximately 600 to 800 cost estimates each year for bills that have passed through congressional committees and are scheduled for a vote on the House or Senate floor.[9]

In recent decades, the CBO has also been increasingly involved in crafting stages of legislation and helps analyze the cost impact of amendments to existing bills.

CONGRESSIONAL GUIDEPOST

In addition to providing baselines and individual bill scoring, the CBO also serves as the guidepost for Congress in budget resolutions—that's usually when the CBO attracts the most attention.

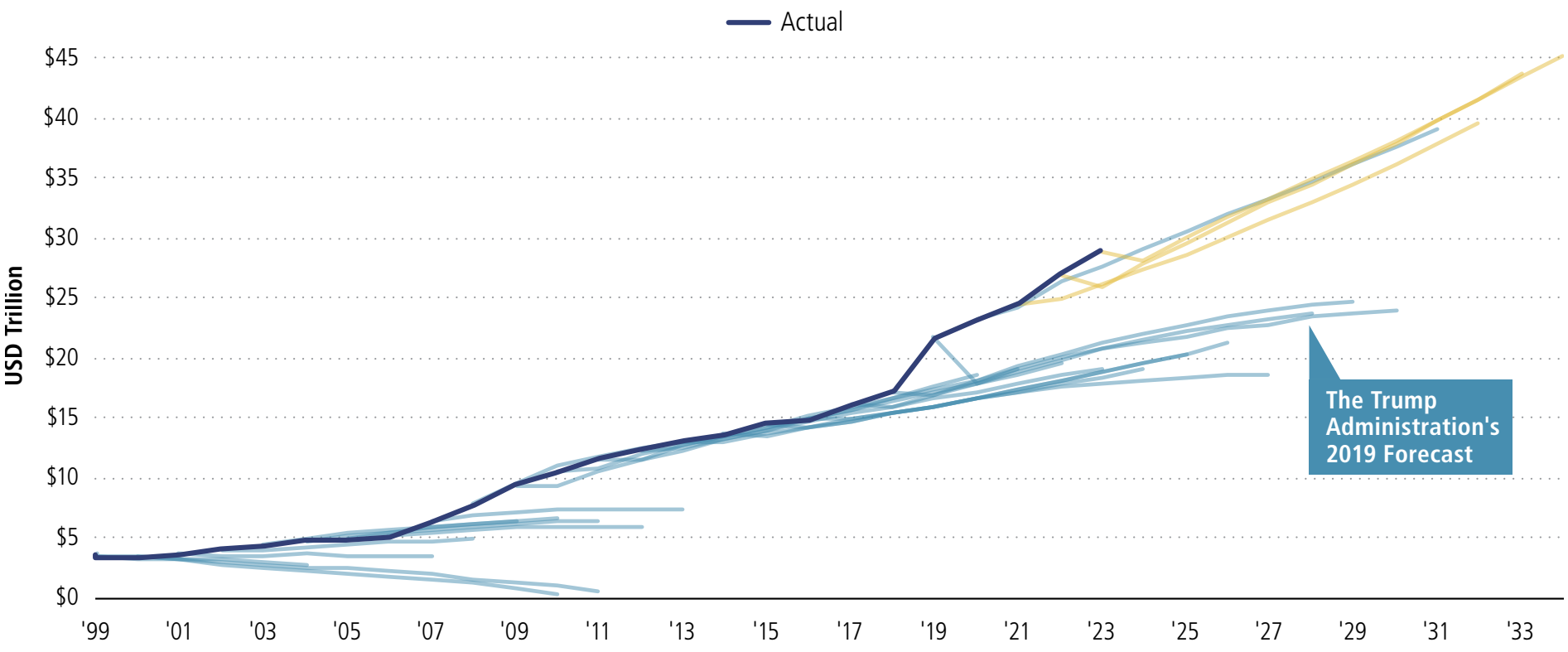
Specifically, Congress can initiate budget resolutions to plan for the next fiscal year's budget, which includes funding adjustments and the addition or amendment of legislation.[10] The resolution sets a "target" budget level, and policymakers need to ensure that all new and existing legislation matches the target numbers.[11]

That's when the math becomes complicated. After all, one doesn't simply add up all the costs and savings of hundreds of bills to arrive at a total cost estimate, as budget bills have second-order economic impacts and may amplify or reduce the effects of other pieces of legislation.

«WITHOUT THE CBO, IT WOULD BE IMPOSSIBLE TO TRACK ALL EXISTING LEGISLATION AND ENFORCE BUDGET TARGETS.»

But don't worry—the CBO is here to crunch out all the dynamic impacts and make sure that the net scoring of individual bills doesn't violate

fig 3. CONSISTENT UNDERSHOOT:
OMB PROJECTIONS—TOTAL DEBT OUTSTANDING TO PUBLIC, ACTUAL VERSUS FORECASTS



Sources: Office of Management and Budget, Payden Calculations

Continued on page 9

UNDERSTANDING THE REVENUES AND OUTLAYS OF THE MOST IMPORTANT GOVERNMENT BUDGET IN THE WORLD

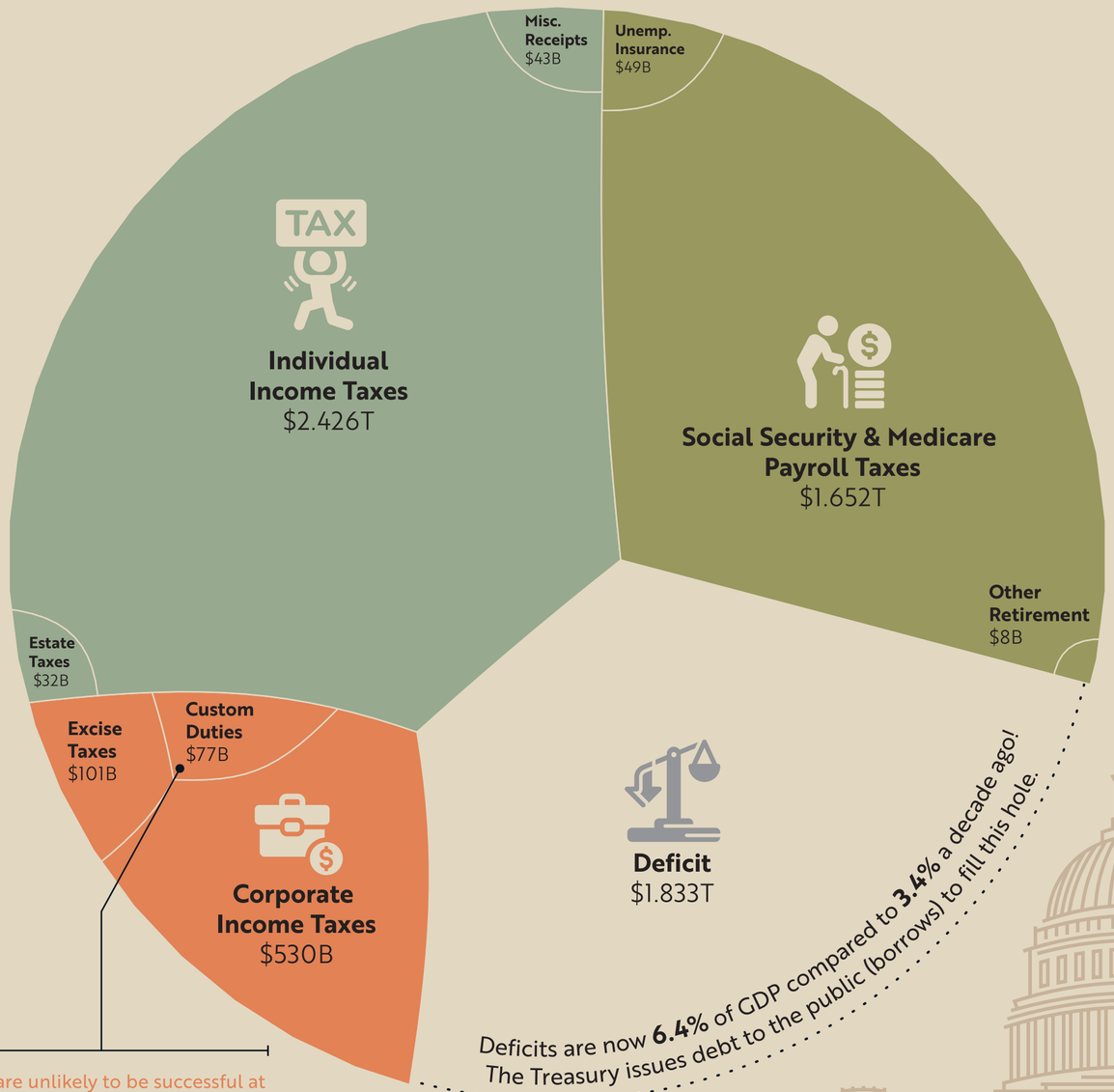
SLICING THE U.S. FEDERAL BUDGET

The U.S. federal government's budget has a significant impact on the global economy. Treasury debt serves as the international reserve asset and fills the hole in the federal budget. While headlines focus on tariffs, the federal government raises most of its money from taxes.

Federal government outlays are split between discretionary spending (27%) appropriated by Congress each year and mandatory programs (73%) run on "autopilot." The annual budget process may result in minor changes to discretionary spending. Still, policymakers are unlikely to adjust Social Security spending and are unable to change net interest expense, which is a function of interest rates.

REVENUES = Where The Money Comes From (Fiscal Year† 2024)

$4,918,736,000,000



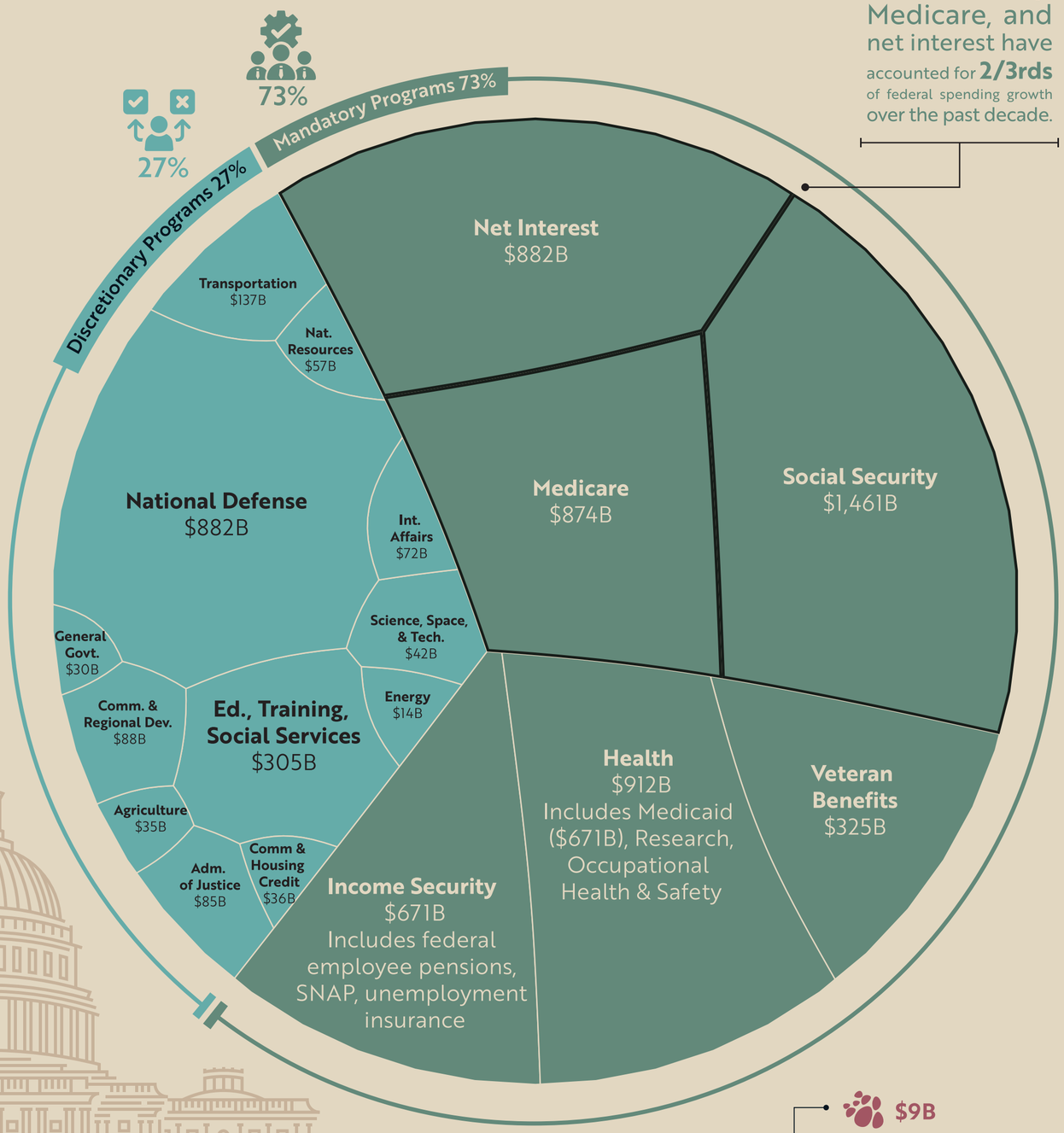
Tariffs are unlikely to be successful at generating enough revenues to fix the deficit. Still, the government has already raised $165B in tariff revenues as of August 2025, eleven months into the 2025 fiscal year.

Deficits are now **6.4%** of GDP compared to **3.4%** a decade ago! The Treasury issues debt to the public (borrows) to fill this hole.

OUTLAYS = What We Spend It On (Fiscal Year† 2024)

$6,751,552,000,000

Social Security, Medicare, and net interest have accounted for **2/3rds** of federal spending growth over the past decade.



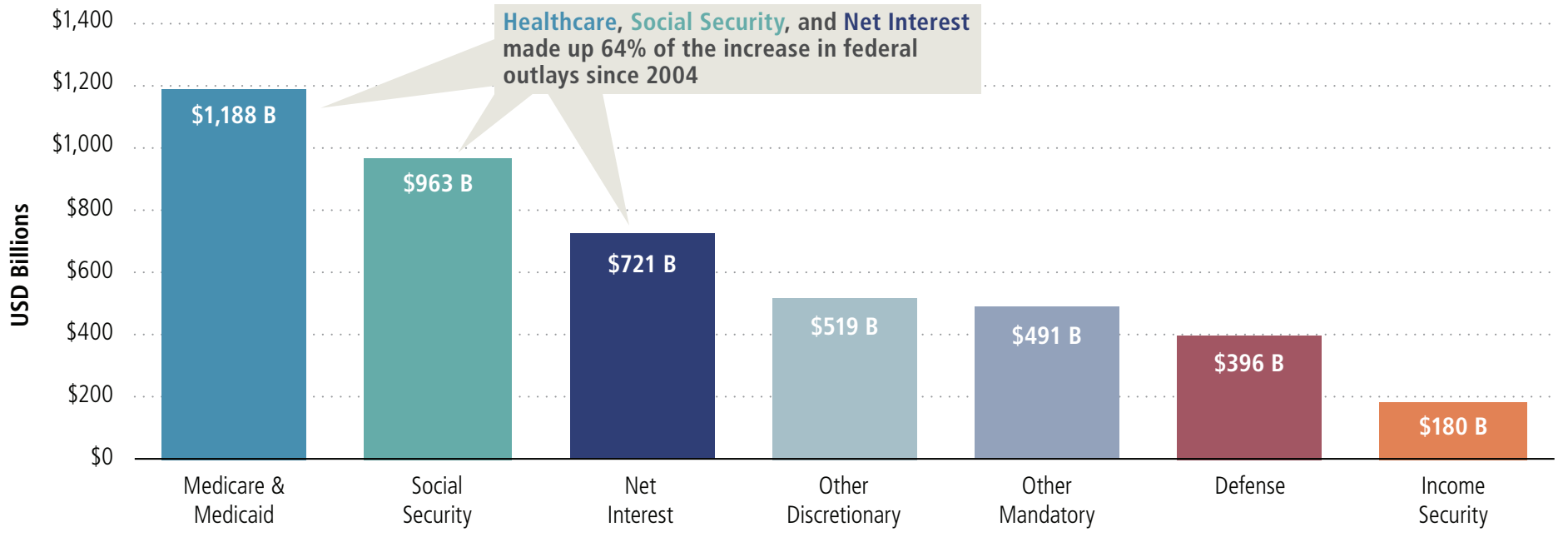
$9B
DOGE's rescission package passed by Congress to cut spending*

Sources: U.S. Treasury Oct. 2024 Monthly Treasury Statement, Congressional Budget Office, Congressional Research Service, Payden Calculations

*A rescission package is submitted to Congress to pull back previously appropriated funds; †Fiscal year 2024 was from 10/1/2023-9/30/2024

Continued from page 6

fig 4. STRUCTURAL SPENDING RISE:
FEDERAL GOVERNMENT OUTLAYS CUMULATIVE CHANGE BY CATEGORY, FROM 2004 TO 2024



Source: Congressional Budget Office

the top-line number specified by the budget resolution. Since 1975, Congress has adopted 32 budget resolutions out of the 41 fiscal years—think of your 2001 and 2003 Bush tax cuts, the Tax Cuts and Jobs Act of 2017, and the American Rescue Act—none of those could have passed without the technical analysis from the CBO (*see Figure 1 on page 5*).[12]

Finally, after budget resolutions and new pieces of legislation have passed, the CBO also works together with the Congressional Budget Committees and the OMB in keeping track of "approximately 1,200 spending accounts from the time bills are reported out of committee" to their enactment. Without the CBO, it would be impossible to track all existing legislation and enforce budget targets.

BIPARTISAN NONPARTISANSHIP

Now, skeptical readers might ask: What makes the CBO so trusted in the budget process?

Well, the reliability of the CBO's estimates compared to those of its Executive Branch counterpart (the OMB) stems from the fact that it provides "nonpartisan analysis" to "perhaps [the] most partisan institution imaginable—the U.S. Congress."[13]

For example, the CBO's director is appointed by the House and the Senate, not the President, for four-year terms, whereas the President directly selects the head of the OMB.

In its early years, the CBO established its reputation as it was critical of both President Ford's (Republican) and President Carter's (Democrat) budgets, despite the founding director, Alice Rivlin, having a long history of serving under Democratic administrations. Rivlin once said that she was happy that the CBO was attacked "both from the right and from the left."[14]

Even to this day, the political affiliation of the director does not prevent either party in control of Congress from criticizing the CBO. The current director, Philip Swagel, is registered as a Republican but was initially appointed during the Trump administration and reappointed during the Biden administration. Much like the current Federal Reserve Chair Jerome Powell, his Republican affiliation has not prevented members of his party from criticizing his agency's analysis recently. All is fair in love…and politics?

THE ULTIMATE GOLD STANDARD?

Critics of the CBO point to its erroneous forecasts. Indeed, being neutral does not mean that the CBO's estimates are always accurate.

The CBO's deficit forecasts have an average absolute error of 1.1% of GDP, or $330 billion in today's dollars in the short run and $750 billion over the medium and long term (six years and beyond).[15] Further, the CBO estimates often lag major "turning points" in the deficit (*see Figure 2 on page 6*).

However, as the previous CBO director Rudolph Penner explained, making assumptions for the next 10 years is "much more challenging than predicting the weather or the outcome of sports events."[16] We economists are well aware of data surprises and how differing assumptions can yield widely divergent forecasts.

«IT IS ALSO WORTH NOTING THAT JUST BECAUSE FORECASTS ARE NOT PERFECTLY ACCURATE DOESN'T MEAN THEY'RE NOT HELPFUL.»

It is also worth noting that just because forecasts are not perfectly accurate doesn't mean they're not helpful. The CBO is tasked with analyzing proposed legislation, not with predicting wars, recessions, and election outcomes, which often prove to be the most significant source of error rather than the budget forecasts themselves.

Further, there are no alternative government bodies that serve the same purpose as the CBO and possess the capacity to analyze the complex federal budget. For example, other government forecasts, such as the OMB's, are even more

DID YOU KNOW?

IMPOUNDMENT AFICIONADO NIXON

Nixon was not the only president who impounded funds appropriated by Congress. Presidential impoundment powers date back to Jefferson, who was the first to refuse spending funds that Congress had approved in 1803 for the purchase of gunboats. Nixon's more recent predecessors, including Truman, Eisenhower, Kennedy, and Johnson, have all exercised impoundments. So what makes Nixon's impoundment so agitating to Congress? After World War II, impoundments were smaller, well justified, and generally used to reduce war funding that was no longer necessary. Nixon's impoundment was larger and was for domestic social and educational programs that he disapproved of, which, to Congress, was a clear violation of the balance of power. Coincidentally, when Congress passed the 1974 Budget Act, Nixon signed the bill under pressure from the Watergate scandal and resigned a month later. So is it all Nixon's fault (or is it to his credit?) that we have the lengthy and inefficient budget process today?

inaccurate than the CBO's, aside from the early 2010 period (*see Figure 3 on page 6*).[17] Historically, the OMB has forecast lower deficits and faster GDP growth, which makes sense given that the OMB's mission is to promote the President's budget, rather than taking a neutral approach like the CBO.

THE LONG GAME

The goal of the Budget Act of 1974 was to return the "power of the purse" to Congress. Since then, we have seen the power of Congress in the U.S. budget process in real-time, with the CBO as the guidepost.

That said, the federal deficit has been rising on an unsustainable path. Has the CBO failed its mission?

We'd argue otherwise.

«MUCH OF THE GROWTH IN THE U.S. DEFICIT IS ALSO INHERENTLY STRUCTURAL DUE TO THE COUNTRY'S AGING POPULATION.»

Much of the growth in the U.S. deficit is also inherently structural due to the country's aging population. For example, from fiscal year 2004 to 2024, federal outlays increased by $4.5 trillion, half of which is attributed to Social Security and healthcare, including Medicaid and Medicare (*see Figure 4 on page 9*). Moreover, as structural deficits increase, the cost of carrying all that debt, or the net interest cost, also adds a substantial amount to the spending pile (*also see our Centerpiece: Slicing The Federal Budget on page 7*).

Further, without the CBO as Congress's most nonpartisan (and arguably the best) number cruncher, the deficit situation could be even worse.

«"NEUTRALLY ANALYZED AND PRESENTED INFORMATION CANNOT SUBSTITUTE FOR—OR COMPENSATE FOR THE ABSENCE OF—POLITICAL WILL."»

In the end, the CBO only provides guidance and assistance for policymakers, but "neutrally analyzed and presented information cannot substitute for—or compensate for the absence of—political will."[18] It will be up to policymakers to address U.S. fiscal concerns, and the CBO, as always, will continue to conduct objective analysis to assist the process.

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VAR Shock

Referee Reviews And Live Sports: Ruination or Revolution?

More data is *always* better, right?

Right?

More information enables investors to make better-informed decisions.

Or, does more information overwhelm decision-making, creating analysis paralysis?

Attend a live sporting event, and you've undoubtedly encountered the problem.

Standing shoulder-to-shoulder with your fellow fans in a boisterous section of a packed stadium, the adrenaline is pumping, the noise is deafening, and the pints of beer are flowing.

Suddenly, the action stops on the pitch.[1]

Confusion reigns in the stadium. Fans exchange quizzical glances and mutter with profanity-laced questions. The pause sometimes lasts for seconds or even minutes.

Then, the referee jogs off the pitch. Unless the official-in-charge requires immediate medical attention, it's likely the VAR, or video-assistant referee, is killing the on-field action. During the VAR pause, the referee is reviewing a slow-motion replay to see if he has made a "clear and obvious error" when awarding a goal, penalty, or red card.

But by the time the decision is confirmed (or overturned), the crowd's excitement has already worn off. Worse, it leaves the fans puzzled—even angry—as their eyes saw something else.

«HOW MUCH TECHNOLOGY CAN BE IMPLEMENTED IN SPORTS GAMES WITHOUT COMPROMISING THE FUN IS A JUDGMENT CALL.»

The intent of using VAR is to enhance referee accuracy and promote fair play. However, how much technology can be implemented in sports games without compromising the fun is a judgment call. We can never get everything perfectly right, whether in sports or investing, and attempts at perfection can be futile, frustrating, and even dangerous.

HISTORY OF VAR

Arguably the greatest footballer of all time and certainly of his generation, Diego Maradona committed one of the most blatant rule violations in sporting history, which led to a goal during the most prestigious and important sporting tournament on the planet.

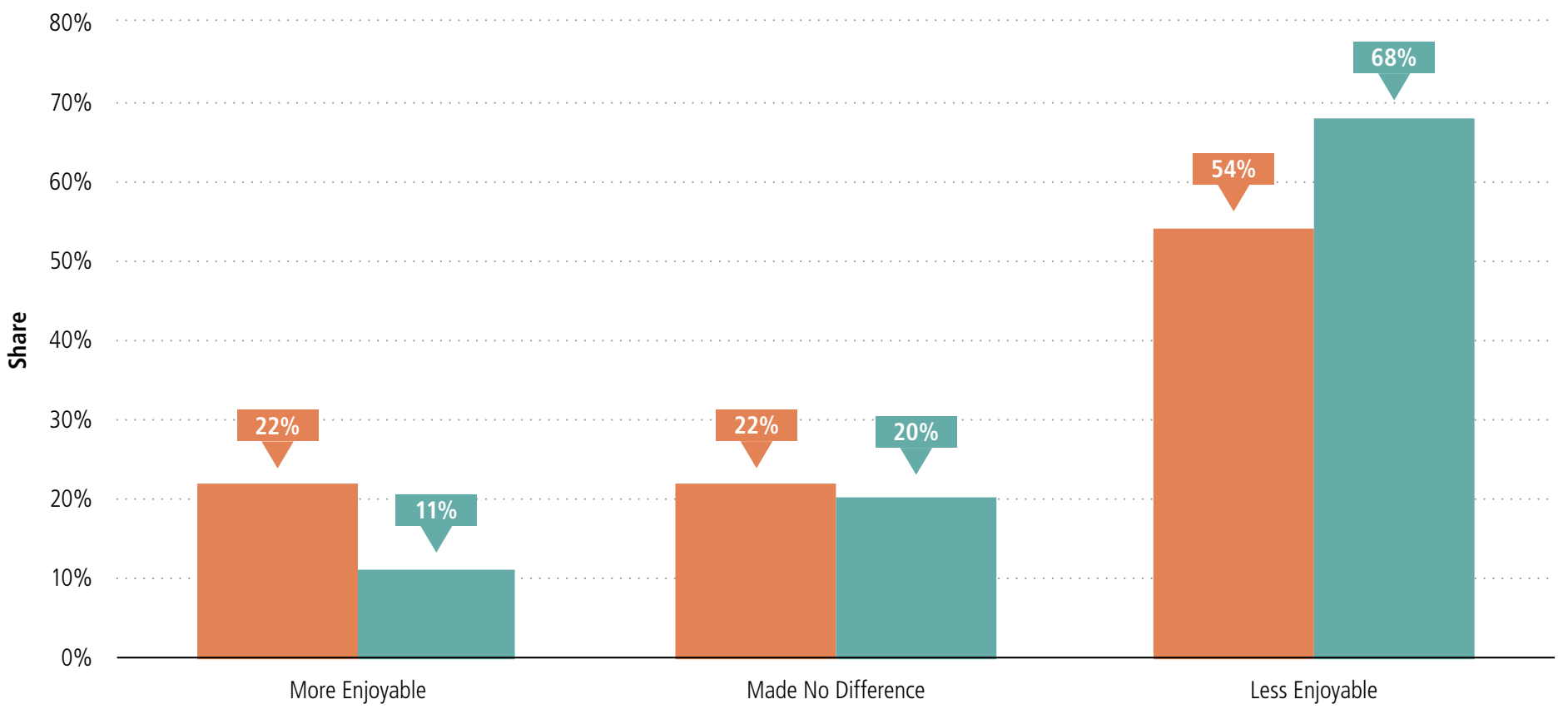
During the 1986 World Cup, in the so-called "Hand of God" goal, Maradona handled the ball in mid-air and scored en route to a 2-1 Argentine victory over England, securing a spot in the World Cup Semi-Final (*although it* does not necessarily mean England would have won *without* the Maradona goal).

Would a video review have solved the problem and imposed justice? So goes the argument in favor of VAR. It was *so* obvious!

With good intentions, VAR was finally adopted by the World Cup in 2018 and subsequently introduced to UEFA in 2019. During a match, the VAR sends alerts to the referee when an "obvious" mistake has been observed, and the referee has the option to verify their decision with the VAR (or not).

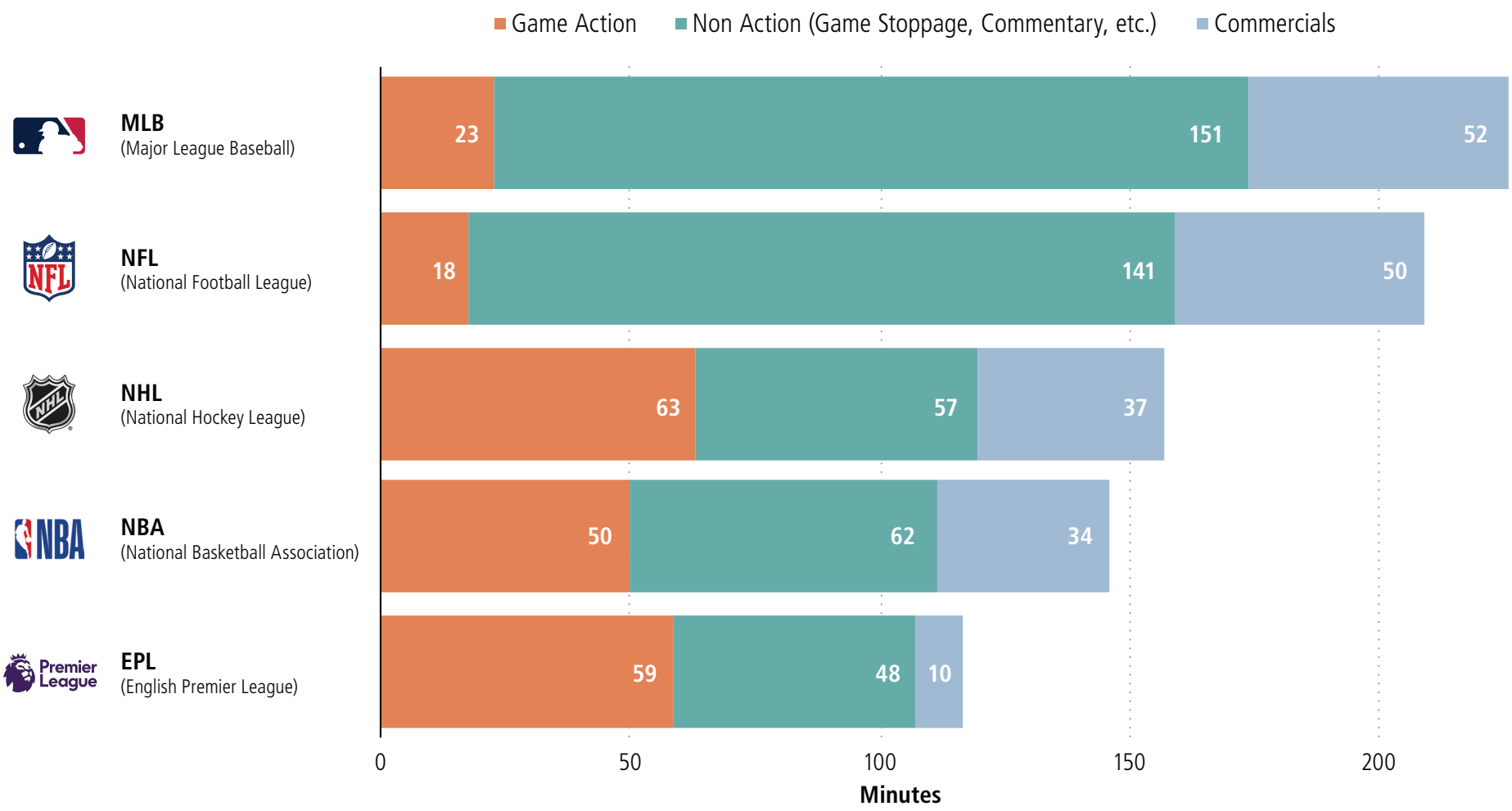
Indeed, studies have shown an improvement in accuracy since the implementation of VAR. For example, during the 2018 World Cup, the adoption of VAR improved the accuracy rate of referees from 95.6% to 99.34%.[2]

fig 1. NOT A FAN FAVORITE:
SURVEY* ON ENJOYABILITY OF GAMES WITH VAR IMPLEMENTED



Source: YouGov
*531 Regular Or Frequent Adult Viewers Of Premier League

fig 2. PASS ME THE NACHOS:
BROADCAST SCREEN TIME BY TYPE ACROSS FIVE MAJOR SPORTS LEAGUES



Sources: University of Texas at Austin-Sports Analytics Course, FiveThirtyEight

«IN SPORTS, ACCURACY IS NOT EVERYTHING.»

WHAT'S THE CONTROVERSY?

So what's the problem? The VAR controversy hinges on the fact that, in sports, accuracy is not everything.

At home, VAR "breaks" are filled by watching replays from various angles or listening to commentary, making the gap less interruptive.

But, *in person*, at a *live* sporting event, the interlude disrupts the game and the players' momentum, often with few updates for the fans on why decisions were made one way or the other, as all they see is the referee peering at a screen. Or worse, the "Jumbotron" video screens often show only *one* angle of the replay—the *most* favorable angle for the home team, which can incite pandemonium if the on-field review differs from what the fan consensus believes with their own eyes.

It's not just us. A large majority of regular attendees of English Premier League games find that VAR makes the games less enjoyable, and this perception has become even more pronounced over time (*see Figure 1 on page 11*).

«VAR MIGHT HAVE ENDED UP COMPLICATING THE GAME RATHER THAN SIMPLIFYING IT. »

REGULATORY RED TAPE

More than an inconvenience for fans, VAR might have ended up complicating the game rather than simplifying it.

The original handball rule before VAR read like this:

> *Handling the ball involves a deliberate act of a player making contact with the ball with the hand or arm.*[3]

Twenty words. One sentence. Pretty straightforward. Right?

By the 2019/2020 season, a new handball law and a new VAR system were introduced into the Premier League at the same time, and the handball rule is now 11 times longer in terms of word count![4]

Given the complexity of the new wording, it wouldn't be possible to enforce the new rule *without* VAR, because an on-field referee simply wouldn't be able to analyze the situation in real-time.

Now, with video review, referees have begun identifying "incredibly marginal accidental handballs that occurred at the very start of a chain of events that led to a goal,"—say, when a player far upfield in the sequence accidentally touched the ball before several subsequent passes led to a goal. Goal overturned.

«WORSE, VAR IS CHANGING THE WAY THE GAME IS PLAYED. »

Worse, VAR is changing the way the game is played.

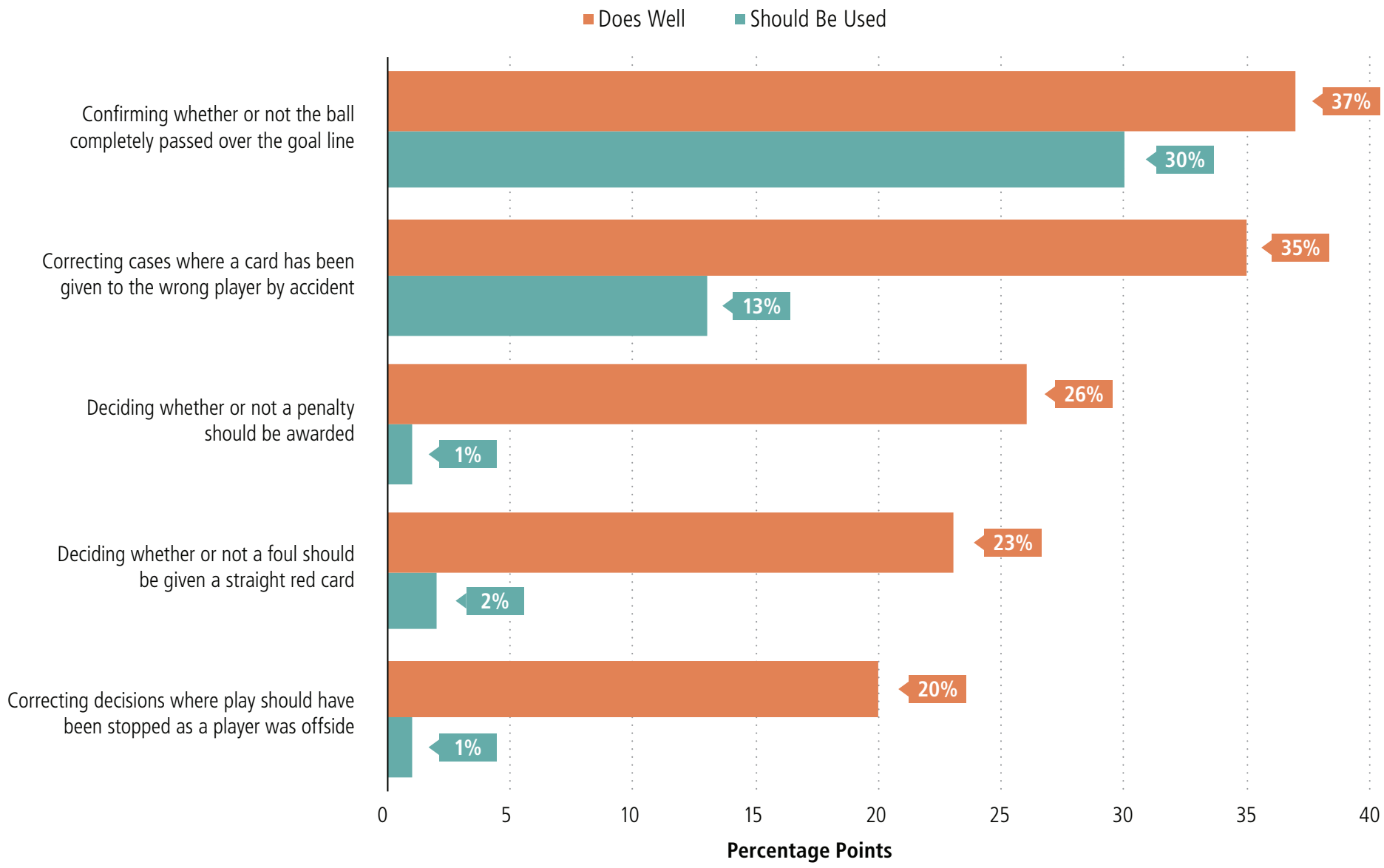
For example, players comically run with their hands behind their backs to prevent even the

DID YOU KNOW?

MARKETING SCHEME

Cynical readers may have long ago spotted another VAR angle: controversial VAR decisions generate a huge amount of interest, especially on social media. Headlines with "the most controversial VAR decision" and "the most sterile game" attract many clicks and tweets. What's more, the implementation of VAR in top leagues might have fueled new opportunities in football betting, where gamblers often bet on match outcomes and specific events in a game. VAR adds more betting options and creates additional uncertainty of outcomes due to VAR reviews. Furthermore, more bettors prefer leagues with VAR, as the referee has less influence on the final result.[5] Perhaps counterintuitively, then, in an entertainment-driven era, do leagues actively benefit from VAR controversy to fuel clicks and attract eyeballs?

fig 3. WISDOM OF THE CROWD:
RATIO OF RESPONDENTS* WHO THINK VAR SHOULD BE USED (OR DOES WELL) TO RATIO OF THOSE WHO THINK VAR SHOULDN'T BE USED (OR DOESN'T DO WELL)



Source: YouGov
*Respondents are 531 regular or frequent adult viewers of Premier League

possibility of incidental contact with the ball when in the penalty box. Why so careful? Well, handling the ball in the penalty box results in an automatic penalty kick—and the conversion rate of a penalty kick, or the rate at which penalty kicks are converted into a goal, is 82%.[6] In other words, since so few goals get scored in a football game, a penalty kick can easily alter the outcome of the game.

BEYOND FOOTBALL

Action in football (soccer for our American readers) is fairly continuous. Taking a break—even for 60 seconds—disrupts the flow of play, making the implementation of VAR difficult.

However, the technology itself is not useless. There are sports where video reviews can be integrated much more effectively.

For example, cameras have been used extensively in track and field races for a long time. As early as 1912, the Stockholm Olympics utilized a camera system for the men's 1500-meter race.[7]

Other sports, like basketball or American football, have frequent breaks in the action, making video review more palatable—even desirable. Why? VAR gives the announcers *something* to talk about, filling time between advertisements, and provides the audience with something to discuss on social media. In the average NFL game broadcast, only 18 minutes are devoted to actual playing time (*see Figure 2 on page 12*).[8]

Nonetheless, leagues were initially resistant to delegating authority to an official not on the field of play (i.e., sitting in a booth above the field). As a result, the VAR rollout was slow. The United States Football League (USFL) began using Instant Replay in 1985, and the NHL followed suit in 1991. The NBA didn't follow until 2002, and the MLB joined the club in 2008 (*see Did You Know? Marketing Scheme on Page 12*).[9]

Tennis might have been one of the first ball sports to adopt VAR. But even in tennis, where it seems most straightforward, the devil is in the details. Research shows that the "Hawk-Eye" software used to monitor whether a tennis ball is in or out has a margin of error (*see Did You Know? History of Hawk-Eye*). Players have encountered cases where the physical ball mark on the field shows that the ball is "out," but the "Hawk-Eye" system counted it as "in."[10]

DID YOU KNOW?

HISTORY OF HAWK-EYE

Developed by Paul Hawkins, the Hawk-Eye system was designed to provide additional insight into the broadcast of cricket and add visually engaging elements that the audience can enjoy. Further, unlike the VAR in football, the Hawk-Eye system doesn't just record a video of the ball and replay it in slow motion. Hawk-Eye develops models that forecast the path of the ball based on the angle and position from which the player hits it. Interestingly, during the 2004 U.S. Open, the chair umpire (referee in tennis) ruled several balls hit by Serena Williams as "out," while the Hawk-Eye model displayed on the audience's screen showed the balls as "in," creating a huge controversy.[11] As a result, in the following U.S. Open, Hawk-Eye was integrated with the umpire's decision-making. Fast forward to today, Hawk-Eye has completely replaced human line judges in prominent tennis tournaments, but it still generates controversy among tennis fans.

«BUT WHAT DOES "GETTING IT RIGHT" MEAN? BEYOND THE HANDBALL RULE IN FOOTBALL, INTEGRATING VAR MAKES "GETTING IT RIGHT" HARDER, NOT EASIER.»

THE WAY FORWARD: DISPERSED KNOWLEDGE?

Sure, critics might say, "We can all agree, let's just get it right." That makes sports better, right?

But what does "getting it right" mean? Beyond the handball rule in football, integrating VAR makes "getting it right" harder, not easier.

We can spend several minutes in every match trying to "just get it right," but the trade-off is that it has become painful to watch sports, ruining the entertainment.

One solution is to limit in-game VAR to very few key decisions, thereby reducing disruptions. Football fans have a consensus on the types of referee decisions they believe VAR is effective in addressing (*see Figure 3 on page 13*).

Or, we can rely on the "wisdom of the crowds." Allow the audience in the stadium or at home to vote, or use a panel of experts (former players, referees, coaches, and managers), since, with most infractions, "you know it when you see it." Fooling the referee, diving in football, flopping in basketball, players trying to kick the ball off the defender's hands to draw a penalty—once fans see it on screen, they will realize it's wrong.

Alternatively, modern techniques, such as AI algorithms, may be significantly more effective if trained on thousands of past correct and incorrect referee decisions or calls.

«JUST LIVE WITH IMPERFECTION—AS WE DO WITH WEATHER FORECASTS, AND FAMILY VACATIONS.»

Best of all, perhaps we just live with imperfection—as we do with weather forecasts and family vacations.

In sports, the unexpected (and imperfection) is thrilling. In markets, we need to be comfortable with the unpredictable and not fool ourselves into thinking that with just a bit more data, or just the right metric, we'll cover all our bases (and risks).

Because we won't.

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