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Editorial Note

The November 2026 issue of the *Journal of International Business Disciplines (JIBD)* has been the result of a rigorous process of blind reviews, and in the end, the reviewers recommended three articles for publication in this issue of *JIBD*.

JIBD is committed to maintaining high standard of quality in all its publications.

Ahmad Tootoonchi, Chief Editor
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THE MOST POPULAR SPORTS IN THE WORLD

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ABSTRACT

This paper examines the multifaceted role of sports in contemporary society, emphasizing their social, cultural, and economic significance while identifying the components that contribute to the global popularity of specific sports. The analysis begins by exploring the importance of sports. It then outlines the wide-ranging benefits of sports participation and spectatorship (physical health, psychological well-being, cultivation of social skills, civic engagement, community belonging). Building on this foundation, the paper delves into the economics of sports and the dynamics supporting global commercialization. Linked together, these interconnected dimensions provide the context for assessing which sports have become globally popular and why. Findings indicate that the most popular sports are the ones that are the simplest in terms of equipment and overall accessibility. The paper concludes by emphasizing the interconnected nature of sport popularity and economic growth, underscoring the need for continued research into the evolving global sports landscape.

INTRODUCTION

Sports occupy a uniquely influential position in societies around the world, functioning not only as a source of entertainment but also as a powerful social, cultural, and economic institution. Their importance extends far beyond the playing field. Scholars consistently highlight that sports contribute to physical health, psychological well-being, community identity, and social cohesion, making them a central component of public life (Coakley, 2015; Wann, 2006). Participation in sports fosters teamwork, discipline, resilience, and social connection, while spectatorship creates shared experiences that bind communities together across lines of class, race, and geography. At an international level sporting events have become powerful occasions through which nations project images of unity, identity, and cultural distinctiveness (Tomlinson & Young, 2006). Because of these wide-ranging benefits, sports have become deeply embedded in educational systems, public policy, and global media cultures, reflecting their enduring significance in modern society.

Understanding why certain sports become widely popular while others remain niche requires examining the complex set of factors that shape public interest and engagement. Popularity is

rarely accidental; instead, it emerges from the interaction of cultural traditions, accessibility, media visibility, economic investment, and technological innovation. These components illustrate that sport popularity is not simply a matter of participation rates or tradition, but a dynamic outcome shaped by social forces, economic structures, and evolving patterns of global media consumption.

This study seeks to integrate the various social, cultural, economic, and technological factors identified in the literature to determine which sports can be considered the most popular worldwide. In doing so, the research not only ranks global sports based on participation, viewership, and commercial impact but also examines the underlying forces that contribute to their widespread appeal. To provide a comprehensive understanding, the study offers detailed descriptions of each sport, including its historical origins, core rules, patterns of global diffusion, and the specific attributes that have enabled it to achieve and sustain international popularity. By combining empirical data with contextual analysis, this study aims to illuminate why certain sports resonate across cultures and generations.

THE IMPORTANCE OF SPORTS

Sports have long been recognized for their physical and psychological benefits, but their influence extends far beyond individual well-being. Increasingly, sports are recognized as a powerful mechanism for community development, social cohesion, and the creation of social capital. Sports function as a social institution that shapes relationships, strengthens civic engagement, and fosters collective identity. These community-level benefits extend to participants and non-participants alike, making sports a uniquely influential force in modern society.

One of the most significant benefits of organized sports is the strengthening of community identity and social cohesion. Sporting events create shared experiences that bring people together, fostering a sense of belonging and collective pride. Sports serve as a social anchor, providing opportunities for interaction among diverse groups and enhancing community connectedness. Warner and Dixon (2011) found that community sports environments promote social capital by encouraging trust, cooperation, and shared identity among residents. These shared experiences help build a unified community culture. Local leagues, school teams, and recreational sports programs serve as gathering points where families and neighbors interact, reinforcing social networks and enhancing community engagement.

Organized sports also function as a public health asset. Communities with strong sports cultures tend to promote active lifestyles more broadly, encouraging healthier behaviors among residents. Exposure to sports environments increases awareness of physical activity, wellness habits, and the importance of movement. Families who support children or relatives in sports often become more informed about nutrition, exercise, and general well-being. The American Academy of Pediatrics (2019) emphasizes that sports participation supports lifelong health benefits for the developing body and brain, and these benefits extend indirectly to family members who engage in supportive roles. Additionally, public health researchers note that communities with robust sports programs often experience higher overall physical activity levels, due to increased access to facilities, walkable environments, and health-promoting social norms (Eime et al., 2015).

Economic and community development represent another important dimension of the impact of organized sports. The sports industry continues to expand rapidly, generating revenue that supports local businesses, recreation centers, tourism, and employment opportunities. Eime et al. (2015) highlight that community sports organizations contribute to local economies by stimulating spending, creating jobs, and supporting infrastructure development. These investments enhance the overall quality of life for residents and contribute to long-term community development. In many communities, sports facilities double as multipurpose spaces for events, meetings, and recreational activities, further extending their value.

Organized sports also provide cultural and entertainment value. Spectators enjoy the excitement of games, tournaments, and community events, which serve as sources of enjoyment and shared tradition. These experiences strengthen social ties and create lasting memories that enrich community life. Researchers have noted that sports spectatorship contributes to emotional well-being by offering opportunities for leisure, stress relief, and social bonding (Inoue et al., 2017).

THE ECONOMICS OF SPORTS

The global sports industry has transformed into one of the world's most influential and rapidly expanding economic sectors. Once viewed primarily as a cultural pastime, sport has evolved into a multitrillion-dollar global marketplace that spans media, technology, tourism, apparel, betting, and infrastructure. Andreff (2011) describes the contemporary sports economy as a highly dynamic global industry, deeply integrated into international trade, investment flows, and innovation processes. This evolution reflects the increasing commercialization, digitization, and globalization of sport, as well as the growing integration of sports into national economic strategies.

This transformation underscores the extent to which sports have moved beyond the boundaries of entertainment and into the realm of global economic strategy. Sports leagues, mega-events, and international competitions now operate as transnational enterprises, generating revenue streams that rival those of major industries such as energy, technology, and finance. The integration of sports into global markets has been accelerated by digital platforms, international broadcasting networks, and the rise of global fan communities that transcend national borders.

A key driver of this evolution is the rapid digitization of sports consumption. Advances in streaming technology, social media, data analytics, and mobile connectivity have fundamentally altered how fans engage with sports. Digital platforms have expanded the reach of leagues and teams, enabling them to cultivate global audiences and monetize content in new ways. As Hutchins and Rowe (2012) argue, the digital era has fundamentally reshaped the global sports media ecosystem, creating new economic opportunities while intensifying competition among broadcasters, technology firms, and sports organizations. This digital transformation has also fueled the growth of emerging sectors such as esports, virtual fan experiences, and AI-driven performance analytics, further expanding the economic footprint of the global sports industry.

Globalization has also played a central role in reshaping the sports economy. International player migration, cross-border investment, and the global circulation of sports media have created a highly interconnected marketplace. The integration of sports into national and global economic planning has led to significant public-private partnerships, particularly in the areas of stadium construction, tourism development, and urban revitalization. Governments increasingly view sports infrastructure as a catalyst for economic development, job creation, and international visibility. Mega-events such as the Olympics and the FIFA World Cup are often justified on the grounds that they stimulate tourism, attract foreign investment, and enhance a nation's global profile. While the long-term economic benefits of such events remain debated, their role in shaping national economic agendas is undeniable.

WHAT MAKES A SPORT POPULAR

The popularity of a particular sport is shaped by a complex interplay of cultural, economic, social, and technological forces. No single factor explains why one sport becomes globally dominant while another remains regionally confined; instead, popularity emerges from the convergence of historical traditions, accessibility, media visibility, star power, community identity, and broader structural conditions. Sport popularity is best understood as a dynamic social process shaped by both long-standing cultural patterns and rapidly evolving global trends.

Cultural embeddedness as one of the most enduring determinants of sport popularity. Sports that align with a society's historical experiences, national identity, or cultural values tend to achieve deep and lasting resonance. Tomlinson and Young (2006) note that sports attain cultural significance when they resonate with the narratives through which nations understand themselves, becoming symbolic sites where collective identity and shared historical memory are expressed

Accessibility also plays a central role in determining which sports gain widespread participation and viewership. Sports requiring minimal equipment, low financial investment, and simple rules tend to spread more rapidly across diverse populations. Coakley (2015) emphasizes that accessibility is especially important for youth participation, which often predicts long-term fandom and intergenerational transmission of interest. Global dominance is frequently attributed to low barriers to entry. Sports with high costs or limited facility access tend to remain niche or regionally concentrated Eime et al. (2015).

Media exposure has become one of the most influential determinants of sport popularity in the modern era. The expansion of television broadcasting in the mid-20th century dramatically increased the visibility of certain sports, creating national and global audiences. Boyle and Haynes (2009) argue that media institutions play a central role in constructing sport popularity by determining which sports receive coverage, how narratives are framed, and which athletes are elevated to celebrity status. With the rise of digital platforms, streaming services, and social media, the relationship between media and sport has intensified. Hutchins and Rowe (2012) contend that digital media has fundamentally reshaped the global sports media ecosystem, enabling fans to follow leagues and athletes across borders and time zones. Sports with strong media partnerships

benefit from consistent exposure, high production values, and global distribution networks, all of which reinforce their popularity and commercial appeal.

The presence of charismatic, high-performing athletes is another key factor influencing sport popularity. Star athletes serve as cultural icons who attract new audiences, shape fan identities, and elevate the visibility of their sport. Pegoraro (2010) notes that athlete celebrity is driven by the convergence of sports performance, media representation, and digital engagement. Star power creates compelling narratives, rivalries, dynasties, and personal journeys draw in casual viewers and deepen emotional investment.

Entertainment value and competitive structure also shape the popularity of sports. Fans are drawn to sports that offer excitement, unpredictability, and aesthetic appreciation of athletic skill. Trail and James (2001) found that spectators are motivated by factors such as drama, suspense, and the quality of competition. Sports that are fast-paced, high-scoring, or visually dynamic tend to attract larger audiences, particularly in global markets where attention spans are shaped by digital consumption patterns. Leagues that structure their competitions to maximize drama—through playoff systems, rivalry scheduling, or competitive balance, often see higher viewership and fan engagement.

Community identity and social influence also contribute to sport popularity. Sports often serve as vehicles for social cohesion, providing shared rituals, collective pride, and opportunities for interpersonal connection. Wann (2006) describes sports as anchors that reinforce group identity and belonging. Local clubs, school teams, and community leagues create pathways for participation and fandom, embedding sports into the social fabric of everyday life. Social influence plays a role as well: individuals are more likely to adopt sports that are valued by peers, family members, or local communities. This socialization process helps explain why certain sports remain dominant within specific regions despite the availability of global alternatives.

Globalization has expanded the reach of many sports, enabling them to transcend cultural and geographic boundaries. Maguire (2011) maintains that global sports migration, international broadcasting, and multinational sponsorships have created a global sport space in which certain sports achieve worldwide prominence. Globalization allows fans to follow international leagues and athletes, thus reinforcing the popularity of specific sports.

Technological innovation is another determinant of sport popularity in the 21st century. Digital platforms enable fans to engage with sports through streaming, social media, fantasy leagues, and interactive content. Ratten (2020) reasons that technology has revolutionized fan engagement by making sports more accessible, personalized, and immersive. Wearable technologies, virtual reality, and data analytics also enhance participation and spectator experience. Sports that embrace technological innovation tend to attract younger, digitally native audiences, contributing to sustained popularity.

METHODOLOGY

This study employs a multi-dimensional comparative analysis to rank global sports popularity for the 2025–2026 period. Recognizing that popularity is a polysemic term, this research utilizes a Composite Ranking Model (CRM). This model aggregates data across four primary pillars: total viewership/fandom, active participation, geographic density, and commercial revenue. Data was harvested from a secondary analysis of primary industry reports and global databases:

- Commercial/Revenue Data: Financial figures for professional leagues were sourced from annual fiscal reports, Statista data sets (2026), and Deloitte (2026).
- Fandom and Viewership: Estimates for the global fan base were derived from TopendSports (2025) and WorldAtlas (2025) demographic studies, which utilize survey-based sampling and digital engagement metrics.
- Participation Rates: Statistics on active players were synthesized from the "Global Participation Report" (2025) issued by the International Olympic Committee (IOC) and individual international federations.

Variable Definitions and Weighting

To maintain consistency across diverse sporting structures, variables were defined as follows:

1. Global Fan Base: Defined as individuals who consume sports content via broadcast, streaming, or social media at least once per month.
2. Participation: Defined as individuals who engage in the sport in an organized or recreational capacity at least twice per month.
3. Annual Revenue: Defined as the total "top-line" revenue generated by the sport's highest-earning professional league (inclusive of media rights, gate receipts, and sponsorships) within the 2025–2026 fiscal cycle.

Standardizing Economic Figures

All financial data originally reported in local currencies (e.g., Indian Rupee for the IPL, Euro for European Football) were converted to United States Dollars (USD) using the average exchange rates for the 2025 fiscal year to ensure comparability. In instances where "Field" and "Ice" varieties of a sport (e.g., Hockey) shared significant historical or administrative overlap, figures were aggregated to reflect the sport's total cultural footprint, while league revenue focused specifically on the dominant professional entity (the NHL).

Method

Our analysis draws on global sport-industry metrics published between 2019 and 2025. Priority was given to primary sources, including international sport federations and major event organizers such as FIFA and the International Olympic Committee. We also incorporated data from established measurement organizations and supplemented these with audited financial disclosures when available.

The methodological process proceeded in several stages. First, we reviewed widely circulated "fans by sport" baseline rankings to identify preliminary candidate lists. We then validated these claims against federation reports and documentation from major international events. Subsequently, we compared global event reach across competitions such as the FIFA World Cup, the Olympic Games, and sport specific world championships. Economic indicators were then integrated, including reported club and league revenue figures. Sports wagering was included as a contextual variable, given its documented influence on audience engagement and media valuation.

We also documented key limitations. Estimates of sport popularity vary substantially across sources and depend on differing operational definitions. Informal blog-based rankings were excluded unless corroborated by a credible primary or industry source. Additionally, we noted that large markets, particularly China and India, can distort cross-sport comparisons due to inconsistent measurement of "fans" and "active participants" across various surveys and reporting systems.

The final output is a consensus top-ten ranking supported by multiple converging indicators for each sport.

RESULTS

Table 1 summarizes the world's most popular sports based on fan base, region, leagues, and revenue.

TABLE 1. WORLD'S MOST POPULAR SPORTS: 2025-2026 COMPREHENSIVE DATA

Rank	Sport	Estimated Global Fan Base	Estimated Global Participation	Dominant Global Region(s)	Primary Professional League (Revenue)	League Annual Revenue (Approx. USD)
1	Football (Soccer)	3.5 - 4.0 Billion	265 Million	Europe, Africa, LatAm, Asia	English Premier League	$8.2 Billion
2	Cricket	2.5 Billion	35 Million	South Asia, Australia, UK	Indian Premier League (IPL)	$10.5 Billion
3	Basketball	2.4 Billion	450 Million	North America, China, Europe	NBA	$13.1 Billion
4	Hockey (Field/Ice)	2.1 Billion	30 Million	Europe, N. America, South Asia	NHL (Ice Hockey)	$6.8 Billion
5	Tennis	1 Billion	87 Million	Global	ATP / WTA Tours	$1.1 Billion (Combined)
6	Volleyball	900 Million	800 Million	Asia, Europe, Americas	Italian SuperLega / VNL	N/A (Distributed)
7	Table Tennis	850 Million	300 Million	China, East Asia, Europe	CTTSL (China)	N/A (State-supported)
8	Baseball	500 Million	65 Million	USA, Japan, Caribbean	Major League Baseball (MLB)	$12.8 Billion
9	Rugby	480 Million	10 Million	Oceania, UK, France, SA	Top 14 / Gallagher Prem	$0.95 Billion (Top 14)
10	Golf	450 Million	67 Million	N. America, Europe, East Asia	PGA Tour / LIV Golf	$2.1 Billion (PGA)
11	American Football	410 Million	5 Million	United States, Canada	National Football League	$20.5 - $23 Billion

RULES, ORIGIN & APPEAL

Football

International football, or soccer, is a globally played team sport in which two sides of eleven players compete to score goals by moving the ball into the opponent's net without using their hands or arms, except for the goalkeeper. The modern game took shape in England in the mid-19th century when the Football Association standardized the rules in 1863, although earlier forms of ball games existed in China, Japan, and medieval Europe (Goldblatt, 2006; Murray, 1998).

Cricket

Cricket is a bat-and-ball sport played between two teams of eleven players on an oval field, with a 22-yard pitch at the center where most of the action occurs. One team bats to score runs while the other bowls and fields to restrict scoring and dismiss batters. Cricket originated in 16th-century England and evolved into an organized sport by the 18th century, eventually spreading across the British Empire to regions such as South Asia, Australia, the Caribbean, and southern Africa (Birley, 1999; Wynne-Thomas, 1997).

Basketball

A fast-paced team sport played between two teams of five players who compete to score points by shooting a ball through the opponent's hoop while preventing the opposing team from scoring. Invented in 1891 by Dr. James Naismith as an indoor activity that relied on skill rather than physical force, basketball quickly spread through YMCA networks across the United States and internationally (Naismith, 1996).

Hockey (Field & Ice)

Field hockey and ice hockey are sports in which two teams compete to score goals by directing a ball or puck into the opponent's net. Field hockey is played on turf with curved sticks and a hard ball, while ice hockey is played on an ice rink with skates, sticks, and a rubber puck. Field hockey developed into its modern form in 19th-century England, while ice hockey originated in Canada in the late 1800s, influenced by European stick-and-ball traditions (Gruneau & Whitson, 1993).

Tennis

A global racket sport played in singles or doubles formats, where players use strung rackets to strike a felt-covered ball over a net into the opponent's court. A point is won when the opponent fails to return the ball within the designated boundaries. Matches are structured around games, sets, and points following the distinctive 15-30-40 scoring system. It is played on a variety of surfaces—grass, clay, and hard courts—each influencing ball speed and playing style (International Tennis Federation, 2026).

Tennis traces its origins to 12th-century France, where an early hand-ball game known as *jeu de paume* laid the foundation for racket-based play. Modern lawn tennis emerged in 19th-century England, particularly in Birmingham, where standardized rules and equipment shaped the contemporary game (Gillmeister, 1998).

Volleyball

A globally played team sport in which two teams of six players compete to send a ball over a net and ground it on the opponent's court while preventing the opposing team from doing the same. Invented in 1895 by William G. Morgan as a less physically demanding alternative to basketball, volleyball (originally named mintonette*)* blended elements of tennis, handball, and basketball and quickly spread through YMCA networks across the United States and internationally (Reeser & Bahr, 2003).

Table Tennis

A high-speed indoor racquet sport in which players use small paddles to strike a lightweight plastic ball across a net on a rectangular table. Modern gameplay follows standardized rules, including 11-point games, alternating serves every two points, and matches typically structured as best-of-five or best-of-seven. Originating in late 19th-century England as an after-dinner parlor game, early versions of table tennis used improvised equipment and were known by names such as "Whiff-Waff" and "Ping-Pong" (Crayden & Mbe, 1995).

Baseball

A bat-and-ball sport played between two teams of nine players on a field arranged around four bases in a diamond configuration. The objective is to score runs by hitting a pitched ball and advancing safely around the bases to home plate. Modern baseball follows the Official Baseball Rules, which outline core elements such as three strikes constituting a strikeout, four balls

awarding a walk, and three outs ending a half-inning. Games typically last nine innings, with teams alternating between offense and defense (Major League Baseball, 2025).

Baseball's origins trace back to mid-19th-century America, where it evolved from earlier bat-and-ball games such as rounders and cricket. Over time, baseball became deeply embedded in American culture, earning the title "America's pastime" (Riess, 1999).

Rugby

A high-intensity, full-contact team sport played with an oval ball on a rectangular field, most commonly in the rugby union format featuring 15 players per side. Scoring occurs through tries, conversions, penalty kicks, and drop goals, with teams advancing the ball primarily by running or kicking, as forward passing is prohibited (World Rugby, 2023).

Rugby traces its origins to early 19th-century England, with tradition attributing its symbolic beginning to 1823, when Rugby School student William Webb Ellis allegedly picked up the ball during a football match and ran with it. Although historians debate the accuracy of this anecdote, Rugby School remains recognized as the birthplace of the sport (Collins, 2015).

Golf

A precision-oriented outdoor sport in which players use a variety of clubs to strike a small ball into a sequence of holes on a course in as few strokes as possible. Unlike most sports played on standardized fields, golf takes place on expansive natural terrain, with each course featuring unique layouts, hazards, and environmental conditions that influence strategy and performance. Standard play consists of 18 holes, with scoring based on the total number of strokes taken (The Royal and Ancient Golf Club of St Andrews & United States Golf Association, 2023).

Golf's origins trace back to 15th-century Scotland, where early forms of the game were played on coastal linksland. The first documented reference appears in 1457, when King James II banned golf because it distracted soldiers from archery practice.

American Football

American football (often referred to as gridiron football) is a full-contact team sport characterized by strategic play-calling, specialized player roles, and territorial advancement of an oval-shaped ball. Played on a 100-yard field with goalposts at each end, the game centers on alternating offensive and defensive possessions, with teams attempting to score through touchdowns, field goals, and safeties. Core rules include a four-down system requiring teams to advance the ball ten

yards to retain possession, as well as structured play beginning with a snap from the line of scrimmage (National Football League, 2025).

The origins of American football trace back to the late 19th century, emerging from earlier forms of rugby and association football brought to American colleges. A pivotal figure in shaping the modern game was Walter Camp, whose rule innovations - such as the line of scrimmage, the snap, and the system of downs - distinguished American football from its rugby roots and established its foundational structure.

Table 2 highlights the seminal reason why these sports are popular.

TABLE 2. CORE APPEAL

Football (Soccer)	Global accessibility, simple rules, massive international culture
Cricket	Deep tradition in Commonwealth nations, long-form and short-form formats
Basketball	Fast pace, urban accessibility, global NBA influence
Hockey (Field/Ice)	Field - Strong school/club systems, Olympic presence Ice – High-speed physicality, strong North American & European leagues
Tennis	Global tournaments, individual star power, lifelong accessibility
Volleyball	Low equipment needs, school and beach popularity
Table Tennis	Space-efficient, low cost, extremely fast and skill-based
Baseball	Cultural traditions, strategic depth, MLB visibility
Rugby	Physically, national identity in my countries, Rugby World Cup
Golf	Lifelong playability, prestige events, social and business culture
American Football	Tactical complexity, spectacle, NFL dominance in U.S.

DISCUSSION

The primary limitation of this study is the inherent transparency gap in non-publicly traded sports organizations. While North American leagues (NFL, MLB) provide robust financial disclosures, revenue figures for state-supported leagues in East Asia or decentralized associations in Africa are based on high-confidence estimations from sports economists and market intelligence firms.

The findings of this study demonstrate a clear divergence between cultural reach and financial concentration. While traditional field sports maintain the largest global footprints, North American

commercial models and emerging markets in South Asia represent the peak of economic efficiency.

The data also confirms that Association Football (Soccer) remains the undisputed global leader, with an estimated fan base of 3.5 to 4.0 billion people. It is the only sport in this study to maintain a top-three ranking in every category: fans, participation, and revenue.

For participation, Volleyball and Table Tennis exhibit the highest ratio of participants to viewers. Volleyball leads the world in recreational participation with approximately 800 million active players, yet it ranks significantly lower in professional revenue, suggesting it is a sport primarily played rather than paid.

Cricket maintains the second-largest fan base (2.5 billion) but exhibits the highest regional density, with over 90% of its followers concentrated in the Indian subcontinent, Australasia, and the United Kingdom.

The most striking result is the disconnect between the number of fans and the revenue generated per fan. The National Football League (NFL) generates the highest annual revenue of any single sports entity, reaching $23 billion for the 2025–2026 cycle. Despite ranking 11th in global fan numbers, its ability to monetize the domestic U.S. market is unparalleled.

CONCLUSION

Sports today achieve widespread popularity through a combination of accessibility, media visibility, cultural relevance, and economic investment. Sports with simple rules, minimal equipment needs, and low participation costs tend to spread more easily, making them appeal to both players and spectators. Their reach is amplified by extensive media exposure, including global broadcasting, streaming platforms, and social media engagement, all of which help sustain constant visibility. International competitions and globalized leagues further expand fanbases by creating shared cultural experiences across borders, allowing sports to transcend national boundaries and develop worldwide following.

Cultural traditions, national identity, and strong youth development systems reinforce participation across generations, ensuring that certain sports remain deeply embedded within communities. These social and cultural foundations interact closely with economic forces, emphasizing the interconnected nature of sport popularity and economic growth. As sports attract larger audiences, they generate greater commercial investment, which in turn enhances infrastructure, media coverage, and global reach—creating a reinforcing cycle that helps the most accessible and culturally resonant sports rise to the top of global popularity.

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GENERATIVE AI ADOPTION AND USE BY FINANCIAL SERVICES PROFESSIONALS: EVIDENCE FROM A MULTI-INDUSTRY SURVEY

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ABSTRACT

Artificial intelligence (AI), particularly generative AI (GenAI), is rapidly transforming the way organizations operate, creating new opportunities to improve productivity, decision-making, and organizational effectiveness. However, adoption and usage vary considerably across industries, highlighting the need to better understand how businesses are integrating these technologies into the workplace. This research note examines GenAI adoption and usage among professionals in the financial services industry and compares these patterns with those in other industries. Using descriptive statistics from a survey of business professionals, the study analyzes adoption rates, usage frequency, and organizational measures related to AI in the workplace. Although the findings are not generalizable, they suggest that professionals in the financial services industry exhibit higher levels of GenAI adoption and usage than those in many other industries. In contrast, adoption of agentic AI appears to be relatively similar across industries, suggesting that this emerging technology remains in the early stages of organizational implementation.

INTRODUCTION

In today's technological landscape, artificial intelligence (AI) is becoming one of the most impactful technologies in recent history. The recent advances in AI, generative AI, and agentic AI have come on quite suddenly. While most agree that there is a lot of potential for AI in business, its true potential and impact have yet to be determined. The most recent advancements have made AI easier to access and more user-friendly, which have helped to significantly expand its reach into a wide range of industries. Many of these advancements can help businesses to improve efficiency and effectiveness. While there are a lot of opportunities for AI to help improve many aspects of business, the landscape for AI adoption and usage is quite murky. The rapid nature of AI technological advancements has resulted in varied levels of adoption and usage among different industries. This research note seeks to examine the variation in adoption and usage rates of GenAI in the financial services industry and to provide insight into how this compares to other industries.

Background

In the past, much of AI was focused on algorithms. More recently, there have been significant advancements associated with GenAI and there are expected to be even more with the advent of agentic AI. These technologies have proven to be powerful tools with the potential to help businesses improve overall competitiveness, decision-making, organizational effectiveness, and profitability. But the landscape is unclear among different industries and suggests that AI is not yet fully maximized, as adoption and usage rates remain fragmented. A 2025 study conducted by McKinsey found that 55% of larger companies had some level of adoption, while smaller businesses had adoption rates of 22% (Mayer et al., 2025). Furthermore, this study found that 55% of the respondents indicated that there was a dedicated AI team to drive AI adoption, while smaller organizations had a rate of 23% (Mayer et al., 2025). While there is a plethora of research for AI adoption and usage at the company level, there is significantly less research that provides insight into how companies are actually using AI. Given this variation among different organizations and within organizations, the aim of this research note is to better understand how GenAI adoption and usage rates are impacting companies, specifically, the financial services industry and how these rates compare to other industries.

Financial Services Overview

The financial services industry is a major contributor to the economy, as it accounts for 8.1% of US GDP (U.S. Bureau of Economic Analysis, 2026). In addition, this industry is expected to continue to grow at a compound annual growth rate of 7.3% over the next five years, reaching an estimated $51.1 trillion globally by 2030 (The Business Research Company, 2026). While some industries have been struggling, in general, the financial service industry has seen growth. One of the main reasons that this industry is so impactful is because it is comprised of six different financial sectors, including banking, insurance, credit cards, mortgages, fintech, and investment services (Hatzakis et al., 2010).

Like many industries, AI is a driving force in the financial services industry. For many companies in this industry, the integration of AI is the major theme for 2026 (Brewer & Rhoads, 2025). At the organizational level, there is a lot of research that supports the adoption and use of AI. According to a 2026 survey conducted by the Cambridge Centre for Alternative Finance, 81% of surveyed financial services firms indicated that they were adopting AI at some level, with 40% of industry respondents reporting advanced AI adoption. Since many of the sectors in the financial services industry tend to embrace technology at a higher rate, it is not surprising that many businesses have actively embraced technology. The central driver of future corporate earnings and overall market sentiment remains the disruptive force of artificial intelligence. As the technology moves beyond its infancy and into later developmental and adoptive stages, its impact on efficiency and business models will deepen (Brewer & Rhoads, 2025). With the ability to analyze vast amounts of data, make predictions, and automate decision-making, AI is being used to improve fraud detection, credit scoring, investment management, customer service, and risk management in the finance industry (Bhatnagar & Mahant, 2024). While the financial services

industry is well entrenched into technology and AI, it is important to understand how this industry compares to other industries.

The financial services industry has pretty high rates of GenAI adoption and usage. However, to better understand what this means, it is important to compare these rates to other industries in the marketplace. This can help to determine whether or not these rates are unique to financial services, identify performance gaps versus other industries, and understand how AI is being operationalized versus other industries.

Regarding research, there is significantly less available when it comes to comparing GenAI rates of adoption and usage in the financial services industry to other industries. In that same vein, there is even less research on how companies are operationalizing GenAI. The Cambridge Centre for Alternative Finance (2026) argues that in the financial services industry, GenAI is primarily being used to improve execution, not reconfigure business models. In addition, much of the research captures broad adoption and usage at the organizational level, but not the employee level which can provide better insight into how GenAI is being operationalized. Looking at adoption and usage from the employee level can be quite insightful and help to better understand how financial services compare to other industries when looking at how GenAI is being operationalized by employees in the workplace.

There is a gap in the research that compares GenAI adoption and how it is being operationalized in financial services and other industries. This research note seeks to provide insight to better understand this gap. Specifically, the following analysis uses descriptive statistics to provide insight into GenAI adoption and usage in financial services and compares this data to other industries. In addition, to better understand the future of AI, there is also data on agentic AI adoption in financial services versus other industries.

METHODOLOGY

The purpose of this research note is to provide a snapshot of adoption and use of GenAI in the financial services industry. Furthermore, to better understand the real impact of adoption and usage of GenAI, the financial services data is also compared to other industries. To understand how this data was generated, the following discussion provides a review of the methodology for this research, which includes the research questions, survey design, and analytical approach.

Survey Design

Data for this study were collected online via Qualtrics from March to June 2026. The authors designed and fielded an anonymous survey to examine generative and agentic AI adoption and usage patterns among professionals across US industries. Notably, no personally identifiable information was collected. Respondents were asked about GenAI adoption and usage, frequency of use, project breadth, and task penetration. They also indicated whether they used agentic AI for

work, how frequently they used it, and whether their organization had a formal GenAI policy. Employment levels were captured as entry-level, mid-level, senior-level, or executive.

Analytical Approach

In this analysis, the study uses descriptive statistics to examine frequency distributions with counts and percentages, cross-tabulations comparing subgroups defined by industry, employment level, and formal GenAI policies. No causal claims are made. In terms of employment levels, the only comparison was between senior-level and mid-level respondents, as entry-level and executive respondents had low sample sizes ($n < 7$) in financial services. Two industries, healthcare and nonprofits, were excluded because of low response rates ($n = 25$). The Other category ($n = 72$) was also excluded because it did not represent a defined industry sector. The study addresses five research questions organized around four findings.

RESULTS

After data cleaning, the final sample included 424 respondents. A subset of 321 respondents was used, comprising those from financial services, technology, professional services, manufacturing, retail, education, and government. The respondent's education and income are consistent with industry norms for financial services professionals. The gender distribution is approximately balanced (52% male, 44% female), and 64% of the respondents are between 25–44.

Generative AI Adoption and Usage

Table 1 indicates that 98% of financial service professionals have adopted GenAI and 82% have used it at least 5 times over the past 30 days. Similarly, 63% have used it at least 7 times over the same period.

TABLE 1. GENAI USAGE FREQUENCY IN THE PAST 30 DAYS

Times used GenAI for work	n	%
0 times	1	2.3%
1–2 times	2	4.5%
3–4 times	5	11.4%
5–6 times	8	18.2%
7+ times	28	63.6%
Total	44	100.0%

Generative AI Usage by Employment Level

GenAI adoption for senior managers is 100% and for middle managers is 94% (Table 2). The usage frequency distribution of respondents in financial services indicates that 72% of senior-level respondents report using GenAI at 7+ times over the past 30 days, while 59% of middle managers report using it at least 5 times, a difference of 13 percentage points. Similarly, 22% of senior-level respondents reported using it 5-6 times compared with 12% of mid-level managers using it 5-6 times or more over the past 30 days, a difference of 10%.

TABLE 2. GENAI USAGE FREQUENCY BY EMPLOYMENT LEVEL: FINANCIAL SERVICES

Frequency	Mid-level %	Senior-level %	Senior Advantage (% pts)
0 times	6%	0.0%	−6%
1–2 times	6%	0.0%	−6%
3–4 times	18%	6%	−12%
5–6 times	12%	22%	+10%
7+ times	59%	72%	+13%
Total	**100.0%**	**100.0%**	—

Note. Mid-level n = 17, senior-level n = 18. Entry-level and executive respondents excluded.

Generative AI Project Use Industry Comparison

Table 3 presents GenAI project use across seven industries. 48% of financial services professionals reported using GenAI for at least 7 projects over the past 30 days, which was similar to rates by professional services, technology, and retail. Manufacturing and government had a project usage rate of 30% and 29%, respectively.

TABLE 3. PERCENT OF PROJECTS USING GENAI IN THE PAST 30 DAYS BY INDUSTRY

Industry	7+ Projects %	Relative to Financial Services (% pts)
Financial Services	**48%**	—
Professional Services	47%	-1%
Technology	47%	-1%
Retail	42%	-6%
Education	32%	-16%
Manufacturing	30%	-18%
Government	29%	-19%

Note. 7+ projects = seven or more distinct work projects involving GenAI in the past 30 days. Relative to Financial Services = industry % minus Financial Services 47.7%. Financial Services n = 44, Professional Services n = 55, Technology n = 94, Retail n = 33, Education n = 37, Manufacturing n = 30, Government n = 28. Rows sorted by 7+ projects rate in descending order. N = 321.

Generative AI Work Tasks by Industry

Table 4 presents the percent of tasks that professionals use GenAI to conduct more than fifty percent of their tasks. Financial services professionals had 32% followed by education at 27%, technology at 25%, and manufacturing at 13% with the lowest rates.

TABLE 4. PERCENTAGE REPORTING GENAI INVOLVEMENT IN MORE THAN HALF THEIR WORK TASKS BY INDUSTRY

Industry	51%+ of Tasks %	Relative to Financial Services (% pts)
Financial Services	**32%**	—
Education	27%	-5%
Technology	25%	-7%
Retail	21%	-11%
Professional Services	20%	-12%
Government	18%	-14%
Manufacturing	13%	-19%

Note. 51%+ of tasks = GenAI involved in more than half of work tasks in the past 30 days. Relative to Financial Services = industry % minus Financial Services 31.8%. Financial Services n = 44, Education n = 37, Technology n = 94, Retail n = 33, Professional Services n = 55, Government n = 28, Manufacturing n = 30. Rows sorted by 51%+ rate in descending order. N = 321.

Generative AI Governance Across Industries

Table 5 presents formal GenAI policy coverage across all seven industries. The financial services industry is among the leaders with 80% having a formal GenAI policy. With similar rates of GenAI policy adoption, government had 77%, manufacturing had 75%, and technology had 75%.

TABLE 5. FORMAL GENAI POLICY BY INDUSTRY

Industry	Formal Policy Present %	Relative to Financial Services (% pts)
Financial Services	**80%**	—
Government	77%	-3%
Manufacturing	75%	-5%
Technology	75%	-5%
Retail	71%	-9%
Education	67%	-13%
Professional Services	49%	-31%

Note. Formal policy present % based on respondents who answered Q9. Financial Services n = 40, Government n = 26, Manufacturing n = 24, Technology n = 87, Retail n = 31, Education n = 24, Professional Services n = 51. Relative to Financial Services = industry % minus Financial Services 80.0%. Rows sorted by policy coverage rate in descending order. N = 321.

Agentic AI Adoption by Industry

Table 6 presents agentic AI adoption across all seven industries. The data indicates that financial services have an adoption rate of 43%, which is below some of the other industries. Technology, manufacturing, professional services, and education have adoption rates between 51-54%. 11% of financial service professionals were unsure if they had used agentic AI, and other industries such as retail had a 15% unsure adoption rate.

TABLE 6. AGENTIC AI ADOPTION BY INDUSTRY

Industry	Yes %	No %	Unsure %
Technology	54%	42%	4%
Manufacturing	53%	33%	13%
Professional Services	53%	40%	7%
Education	51%	35%	14%
Financial Services	43%	46%	11%
Retail	39%	46%	15%
Government	29%	61%	11%

Note. Agentic AI was defined for respondents as systems capable of executing multi-step tasks and taking actions across tools or workflows, often with human approval. Rows sorted by Yes % in descending order. Technology n = 94, Manufacturing n = 30, Professional Services n = 55, Education n = 37, Financial Services n = 44, Retail n = 33, Government n = 28. N = 321.

DISCUSSION

This study provides descriptive evidence that GenAI has been universally adopted by financial service professionals and is frequently used by many of them in their daily work, as reflected in the frequency of use, the breadth of projects, and the percentage of tasks for which they use GenAI. The evidence indicated that almost 100% of financial service respondents have adopted it and use it regularly, with more than 80% reporting using it at least 5 times in the prior 30 days. This is valuable because widespread usage of GenAI by financial service professionals enables them to increase productivity, improve decision-making, and focus on the more key aspects of their jobs.

A second contribution of the findings is that there is meaningful variation within financial services by employment level. Although adoption is near 100% for the two groups, senior-level respondents reported heavier use frequency than mid-level respondents, as 96% of senior managers reported using GenAI at least 5-6 times over the past 30 days, which is 23% more than mid-level managers where 73% reported using GenAI at least 5 times over the past 30 days. This can indicate that senior-level managers are using GenAI for both strategic and task-related capabilities, such as analyzing large-scale industry trends and exploring new markets.

The industry comparisons indicate that financial services professionals are among the more intensive users of GenAI, combining wide project-level adoption with comparatively high task-level integration, suggesting that GenAI has become a routine part of work for a considerable percent of these managers.

In the governance findings, financial services respondents had the highest rate of formal GenAI policy adoption in the sample at 80%, with government, manufacturing, and technology showing roughly similar levels. This is not surprising, as there are many government regulations and

sensitive data in the financial services sector. The survey also showed that this industry exhibits a combination of high reported policy coverage and high usage rates.

Findings on agentic AI adoption indicate that all industries in the study exhibit a high non-adoption rate of agentic AI for work-related tasks. Agentic AI is an emerging field in artificial intelligence that has recently attracted considerable interest due to its ability to transform industries by producing autonomous AI agents that can analyze data, set goals, and take actions with little human supervision. As a note, about 10% of the survey respondents were not certain whether they had used it, underscoring that it is still in its nascent stages.

LIMITATIONS

This research used a descriptive, cross-sectional survey design. Data were collected via convenience sampling using an online survey distributed to the authors' professional networks. This recruitment approach may limit generalizability. Respondents connected to the lead researcher may be more digitally savvy than the general population, possibly inflating adoption and usage rates. Participation was voluntary, and responses were anonymous. All data are self-reported, which may introduce response bias. Only two survey questions covered agentic AI, limiting the analysis for that technology. These limitations reflect the study's exploratory nature.

FUTURE RESEARCH

Based on the findings from this research, there are a few opportunities for future research. These include researching other organizational factors that help to better understand why financial services is leading with the adoption and usage of GenAI and why the higher usage in GenAI has not translated to higher rates of agentic AI when compared to other industries. In addition, a longitudinal study that looks at these variables over a longer period of time would also be useful.

Similar to other research, professionals in the financial services industry were among the leading industry adopters and users of GenAI. However, more than half of AI projects fail due to things such as technical issues and limited workflows. Existing studies only partially explain why these projects fall short. The data also revealed that financial services tended to have senior-level employees with higher usage than middle-level employees. A study investigating what is driving this dynamic would be quite useful. This study also did not capture much data from entry level people, which could be valuable as they tend to have higher exposure to routine tasks and granular level work.

In addition, there should be more research that extends the comparisons among different sectors in the financial services industry. Looking at sectors such as banking, insurance, and fintech could help to provide greater insight into adoption and usage in this industry. These organizations operate under different regulations and capital constraints that impact adoption and usage rates.

Given the rapid change and dynamic environment of AI, a longitudinal study would provide valuable insight into how AI adoption evolves over time in the financial services industry. A study of this nature could help to distinguish between temporary differences among industries and more stable adoption patterns.

Finally, financial services professionals, as well as other industries, reported a relatively low agentic AI usage rate. Agentic AI has the potential to directly decrease organizational costs and increase efficiency, and organizations are rapidly piloting agents, but only a minority are effectively scaling them across processes and departments. Future research that investigates this recent phenom can add value.

CONCLUSION

The research is significant for several reasons, including contributing to the discourse and body of knowledge on GenAI adoption and use, and helping provide insight into differences across industries. The rapid expansion of AI technologies presents major opportunities for businesses, as the adoption and usage rates are inconsistent due to differing perceptions, a lack of training, and organizational barriers. This research will help to provide a better understanding of the current adoption and usage rates in business.

First, given the rapid advancements of AI technologies, it is important to conduct research to better understand the impact that these tools are making on organizations. These tools have the potential to significantly change the dynamics of how organizations conduct business. The study provides evidence that GenAI has been widely adopted by financial service professionals and is used frequently by many of them in their daily work, as reflected in the frequency of use, the breadth of projects, and the percentage of tasks for which they use GenAI. This is valuable because widespread usage of GenAI by financial service professionals enables them to increase productivity, improve decision-making, and focus on the more key aspects of their jobs.

Second, the data revealed that within financial services, senior-level managers had higher adoption and usage than middle-level managers. This could be because senior managers use it for strategy and decision support, while middle managers may deal with more compliance and accountable risk information, making them less likely to use it as often.

Third, this research is significant because it can help provide insights into how GenAI is impacting industries. This includes comparing adoption and usage rates across different industries to help understand the variation among industries. Similar to other research, professionals in the financial services industry were among the leading industry adopters and users of GenAI.

Finally, the data showed that non-adoption of agentic AI is widespread across all industries as organizations are at the beginning of the agentic AI adoption curve. This provides financial service organizations with an opportunity to do such things as autonomously process loan approvals and automate compliance and legal documents. This is a relatively untapped space for research, with much of it still being exploratory.

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LEAST MEDIAN SQUARES AS THE OPTIMUM REGRESSION ALGORITHM TO ESTIMATE EQUITY BETA

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ABSTRACT

The subject of this paper is equity beta and the regression algorithms used to compute it. This subject is significant because different regression algorithms yield different estimates of the population beta, with some more accurate than others. Therefore, we must find the best regression algorithm for estimating equity beta. To do this, we used statistical software to obtain the most accurate estimate of beta from residual plots and the median values of alpha and beta for each regression algorithm. We determined that Least Median Squares (LMS) provides the most accurate estimate of equity beta, which should be useful to portfolio managers, investment bankers, and academics, among others.

Keywords: Least Median Square (LMS), Robust Method of Moments, Least Trimmed Squares, Least Absolute Deviation, Scatter Plot, Timeline Plot, Regression Algorithm

INTRODUCTION

Beta, in portfolio management, is the slope of the regression line, β_i, which is an estimate of βi, modeling the sensitivity of a company's equity rate of return, i.e., rr_i, to the market rate of return, i.e., rr_{mkt}, as depicted in the following model.

$rr_i = f(rr_{mkt})$	Functional specification	(1)
$rr_i = \alpha + \beta_i * rr_{mkt}$	Population Regression line	(2)
$rr_i = \alpha + \beta_i * rr_{mkt}$	Sample regression line	(3)

In finance and portfolio management, equity beta is the regression coefficient relating a security's return to the market return. Estimates of beta are, however, difficult to obtain due to skewed or

outlying underlying data. The solution is to use one of several robust regression methods. Each robust method, however, has its own nuances, and hence each provides different estimates for the population beta. Using monthly data taken from FactSet, five regression algorithms, OLS, and four Robust Regression Methods, are used to estimate regression equations for each of the SP500 constituents. Alphas, betas, and goodness-of-fit metrics are logged for each constituent and each regression algorithm. Least Median Squares Robust Regression is the superior algorithm for estimating equity beta. This conclusion should be of great interest to portfolio managers, investment bankers, and academics, among others.

Institutional portfolios consist of 70 to 100 names, and portfolio management contracts usually specify target weighted-average portfolio betas with a specified tracking error. Actual, i.e., ex-post, portfolio performance depends on accurate ex-ante b_i estimates. Hence, portfolio managers require accurate estimates of beta for portfolio construction.

Financial rate-of-return data can be highly skewed or contain outliers, which can significantly influence the calculated beta. The problem becomes more severe as the data frequency increases. For example, monthly data is more susceptible to outliers and skewness than yearly data, and daily data is even more so than monthly data. Using OLS with skewed or outlying data can yield highly inaccurate betas and lead to poor ex-post portfolio performance.

Several robust regression algorithms are available to estimate regression parameters in the presence of skewed or outlying data. Among these are:

a. Robust Method of Moments
b. Robust Least Trimmed Squares
c. Robust Least Median Squares
d. Robust Least Absolute Deviation

This research estimates and compares equity betas for each SP1500 constituent using five regression algorithms, i.e., OLS and the four Robust algorithms identified above. This research aims to identify the optimal regression algorithm to compute equity beta.

People interested in this research should include portfolio managers, investment bankers, and academics, among others.

BACKGROUND

The sample regression line to estimate beta is given in Eqn. 4:

$$rr_i = \alpha + \beta_i * rr_{mkt} \quad (4)$$

The α's and β's can be estimated using any of five regression algorithms. Each algorithm accommodates skewness and outliers differently, as follows:

1. OLS - Ordinary Least Squares
   Minimize Sum of Squared Deviations from Predicted Values
   $\alpha, \beta = f$ (Min (S (X-Predicted Value)^2)

2. MM - Robust Method of Moments
   Models the tail regions of the distribution.

3. LTS - Least Trimmed Squares
   It optimally eliminates outliers or influential observations.

4. LMS - Least Median Squares
   $\alpha, \beta = f$ (Minimize (S (X-Median) ^{2})

5. LAD - Least Absolute Deviation
   Minimize the Sum of Squared Deviations from Predicted Values.
   $\alpha, \beta = f$ (Min (S (abs (X-predicted Value)))

One can reasonably expect that the average population beta should be 1.0 and the average population alpha should be 0.

LITERATURE REVIEW

Estimating the beta coefficient has been the focus of many studies. Lately, many studies have demonstrated that robust regression methods offer significant advantages over Ordinary Least Squares (OLS) Estimation, especially when real-world datasets are affected by outliers, skewness, and kurtosis. In this section, we discussed relevant studies on the use of a robust estimator when the dataset does not strictly follow a normal distribution. Martin and Simin (2003) determined that the outliers can bias OLS beta estimates. Then, they introduce a new beta estimator that is resistant to outliers. They compare their suggested robust method to the traditional OLS of beta using U.S. stock return data.

Winker et al. (2011) considered using the least median of squares estimators as one possible alternative to ordinary least squares. Since the objective function for the least median of squares estimator is rather complex, they ended up using heuristic optimization methods. Later, McDonald et al. (2009) found that when stock return data are skewed, using a robust regression can yield biased intercepts (alpha) if the error is assumed to be symmetric. In their simulations and empirical tests, M-estimators (estimators that are resistant to outliers) could provide more efficient beta estimates than OLS, as long as the underlying distribution is fat-tailed.

Yuan and Lee (2015) used various methods to predict beta, based on the financial statements of 88 Taiwan corporations from 2001 to 2010. Their study results indicate that the most accurate forecasts are produced by the least squares regression algorithm optimized with a genetic algorithm, a computational search technique for finding approximate solutions to optimization and search problems.

Bian et al. (2013) developed a Modified Maximum Likelihood (MML) robust estimator for linear regression, for a "Student t" error distribution. This estimator is more efficient than ordinary least squares when the underlying distribution is heavy-tailed. They proved that the MML estimator is more appropriate for estimating Capital Asset Price Model (CAPM) parameters than OLS when returns have fat-tailed distributions.

Theodossiou and Theodossiou (2014), using U.S. pharmaceutical stocks, examined the impact of outliers on beta coefficient estimation. In their study of pharma stocks, the OLS method, which assumes normally distributed residuals, was vulnerable to large outliers, leading to distorted beta estimates. On the contrary, the robust M-estimator (which down-weights outliers rather than excluding them entirely) yielded more stable beta estimates that were not significantly affected by the extreme return.

Maravina and Martin (2022) used a statistical Hausman-type test to compare the OLS method with robust beta estimation formally. They derived the asymptotic distribution of the difference between the OLS estimate of beta and a robust MM-estimator (an iterative regression method that is more resistant to extreme values than OLS). Based on their empirical results, the test identified cases in which robust beta estimates would be more reliable. Overall, these studies support the notion that robust regression methods offer significant advantages over OLS for estimating beta coefficients when working with real-world data sets that are laden with outliers, skewness, and kurtosis.

METHODOLOGY

Monthly SP1500 equity price data for the period 1999.01 - 2024.02 were obtained from FactSet. The data include 291 observations of companies in the SP1500 across all months—fewer observations for those companies newer to the index. In addition to graphical methods (e.g., histograms, time-series plots, and scatterplots) and analytical methods (e.g., descriptive statistics and correlation), the analysis will make significant use of OLS and robust regression.

Five regression models, one OLS and four robust regression models, will be estimated for each constituent. Alphas, betas, and median absolute residuals will be logged for each constituent across the five algorithms.

The superior regression algorithm will be selected based on the minimum median absolute residual. The statistical program used was S-Plus. S-Plus is a variant of R.

RESULTS

Table 1 displays a sample of the downloaded FactSet data.

TABLE 1. SAMPLE PRICE DATA FOR 8 COMPANIES

obs	Date	sp500	AAPL	DIS	FDX	IBM	MRK	UNP	XOM	WMT
1	1999.12	1469.25	0.92	29.25	40.94	107.88	67.19	10.92	40.28	23.04
2	2000.01	1394.46	0.93	36.31	39.56	112.25	78.81	10.06	41.72	18.25
3	2000.02	1366.42	1.02	33.50	34.94	102.75	61.56	9.50	37.66	16.29
4	2000.03	1498.58	1.21	41.25	38.81	118.00	62.12	9.78	38.97	18.83
5	2000.04	1452.43	1.11	43.31	37.69	111.50	69.50	10.53	38.84	18.46
6	2000.05	1420.60	0.75	41.94	35.50	107.38	74.62	10.62	41.66	19.33
:	:	:	:	:	:	:	:	:	:	:
286	2023.09	4288.05	171.21	81.05	264.92	140.30	102.95	203.63	117.58	53.31
287	2023.10	4193.80	170.77	81.59	240.10	144.64	102.70	207.61	105.85	54.47
288	2023.11	4567.80	189.95	92.69	258.83	158.56	102.48	225.27	102.74	51.90
289	2023.12	4769.83	192.53	90.29	252.97	163.55	109.02	245.62	99.98	52.55
290	2024.01	4905.65	184.40	96.05	241.29	183.66	120.78	243.93	102.81	55.08
291	2024.02	5096.27	180.75	111.58	248.97	185.03	127.15	253.69	104.52	58.61

Figs. 1 - 4 display histograms and time series plots of both SP1500 and Exxon Mobil monthly returns. Both histograms are symmetric, but the Exxon Mobil returns histogram is slightly leptokurtic.

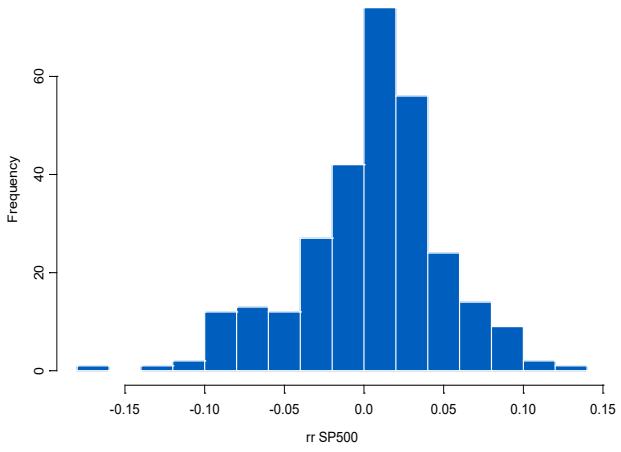

FIGURE 1. HISTOGRAM OF S&P 500 RATE OF RETURN

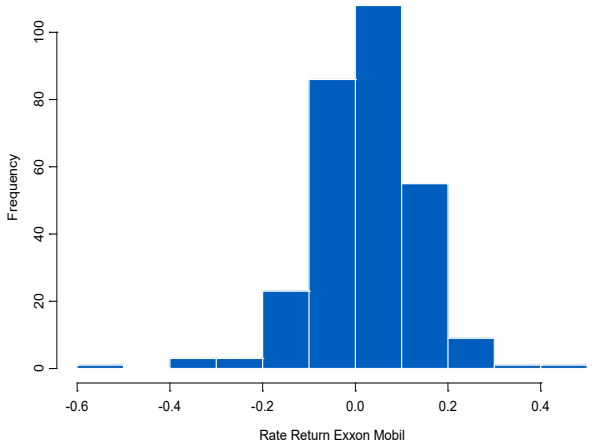

FIGURE 2. HISTOGRAM OF EXXON MOBIL RATE OF RETURN

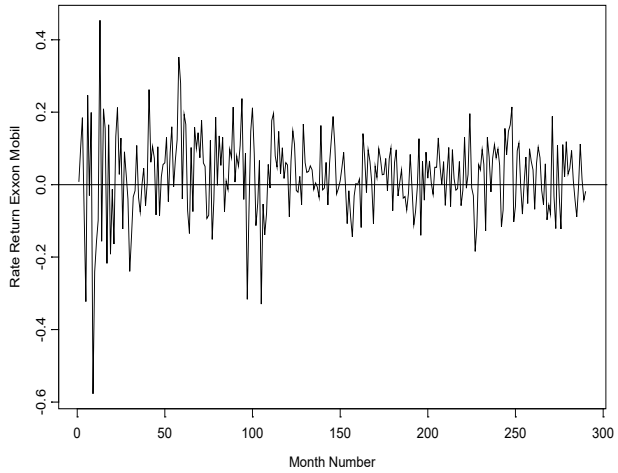

FIGURE 3. TIME-LINE PLOT EXXON MOBIL RATE OF RETURN

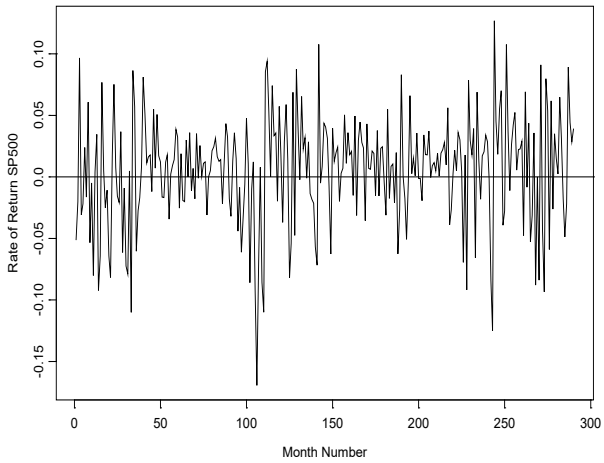

FIGURE 4. TIME-LINE PLOT OF S&P 500 RATE OF RETURN

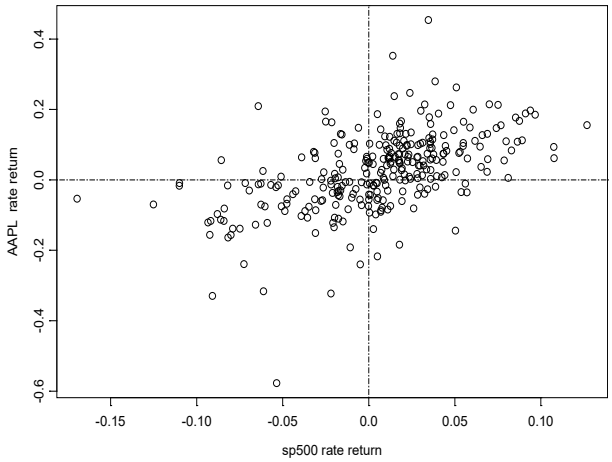

FIGURE 5. SCATTERPLOT: EXXON MOBIL RETURN VS. S&P 500 RETURN

Figure 5 displays a scatterplot of ExxonMobil's rate of return vs. the S&P 500's rate of return. The plot is generally positive with moderate to strong correlation. No outliers are present.

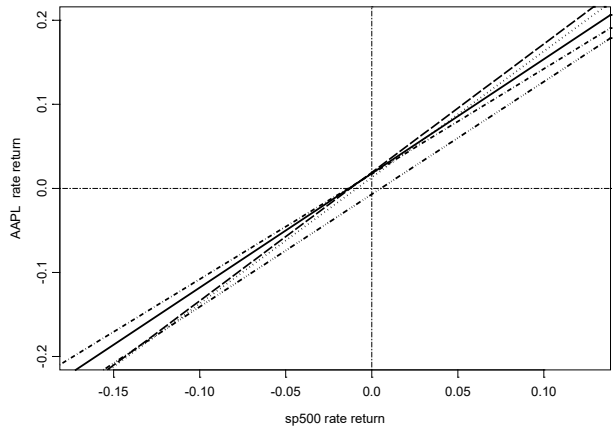

FIGURE 6. EXXON MOBIL V S&P 500 ROBUST BETAS

Figure 6 displays the same scatterplot with regression overlays for each regression algorithm.

Notice the large Exxon Mobil beta (i.e., slope) differentials. The Exxon Mobil alphas differ only slightly. This research aims to determine which algorithm is superior in general.

The above analysis is for Exxon Mobil. Alpha, beta, and median absolute residuals are now computed and logged for all SP1500 constituents for each of 5 regression algorithms. The regression results for the sample of 8 companies are displayed in Table 2, below. Notice that for any ticker, the betas are similar across regression algorithms. Predictably, OLS estimates are most dissimilar, owing to extreme observations (i.e., outliers) that pull the beta coefficient toward the outlier.

OLS β=.69 mar=.31
MM β =.59 mar=.30
LTS β =.56 mar=.29
LMS β =.39 mar=.27
LAD β =.65 mar=.30

TABLE 2. REGRESSION RESULTS FOR 8 COMPANIES

		OLS			RobMM			LTS			MLS			LAD		
tkr	n	alpha	beta	medRes	alpha	beta	medRes	alpha	beta	medRes	alpha	beta	medRes	alpha	beta	medRes
FDX	290	0.004	1.088	0.039	0.002	1.021	0.040	0.002	0.909	0.040	0.005	1.264	0.037	0.003	1.043	0.039
IBM	290	(0.001)	0.978	0.028	(0.003)	0.925	0.028	(0.002)	0.880	0.028	(0.015)	1.091	0.026	(0.002)	0.952	0.028
XOM	290	0.002	0.690	0.031	(0.001)	0.590	0.030	0.001	0.564	0.030	0.001	0.392	0.027	0.000	0.653	0.030
AAPL	290	0.018	1.359	0.049	0.013	1.501	0.048	0.017	1.252	0.050	0.019	1.529	0.046	0.017	1.443	0.049
DIS	290	0.001	1.189	0.030	(0.005)	1.186	0.033	(0.006)	1.157	0.032	0.006	1.040	0.028	(0.002)	1.181	0.032
WMT	290	0.002	0.442	0.030	0.001	0.531	0.030	0.001	0.562	0.030	(0.011)	0.858	0.028	0.002	0.488	0.030
UNP	290	0.008	0.927	0.033	0.002	1.138	0.032	0.002	0.930	0.033	0.002	1.065	0.031	0.006	0.984	0.033
MRK	290	0.002	0.509	0.036	0.004	0.477	0.035	0.004	0.479	0.035	0.004	0.379	0.034	0.002	0.508	0.036
med	290.00	0.002	0.953	**0.032**	0.002	0.973	**0.033**	0.002	0.895	**0.033**	0.003	1.053	**0.030**	0.002	0.968	**0.033**

Importantly, note that MLS and LAD tie for the lowest median residual at .030.
Table 3 displays descriptive statistics for the results of all 1500 constituents, as in Table 2, but in table format.

TABLE 3. SUMMARY REGRESSION RESULTS FOR SP1500 COMPANIES

	OLS	MM	LTS	LMS	LAD
Median Absolute Residual (n=1500)	0.049	0.048	0.048	0.044	0.048
Median Alpha (n=1500)	0.005	0.001	0.001	0.000	0.002
Median Beta (n=1500)	1.110	1.1038	1.049	0.997	1.052

Notice the following important results from Table 3:

1. LMS delivers the lowest Median of the Median Absolute Residuals at .044.
2. The median Alpha is 0, and
3. The median Beta is .997, only marginally different from 1.0.

TABLE 4. CORRELATION MATRIX OF BETA COEFFICIENTS

	Beta - OLS	Beta - MM	Beta - LTS	beta - MLS	Beta - LAD
beta - OLS	1.000	0.067	0.050	0.052	0.071
beta - MM	0.067	1.000	0.926	0.758	0.919
beta - LTS	0.050	0.926	1.000	0.735	0.937
beta - MLS	0.052	0.758	0.735	1.000	0.768
beta - LAD	0.071	0.919	0.937	0.768	1.000

Table 4 displays the correlation coefficients of the betas for each algorithm.

As expected, the median OLS beta coefficients are least correlated with the robust betas. The robust betas are most correlated.

Figure 7 displays a scatterplot of LMS alphas and betas for SP1500. Figure 7 shows an apparent negative relationship between equity alpha and equity beta. An explanation for this phenomenon should be the subject of further research.

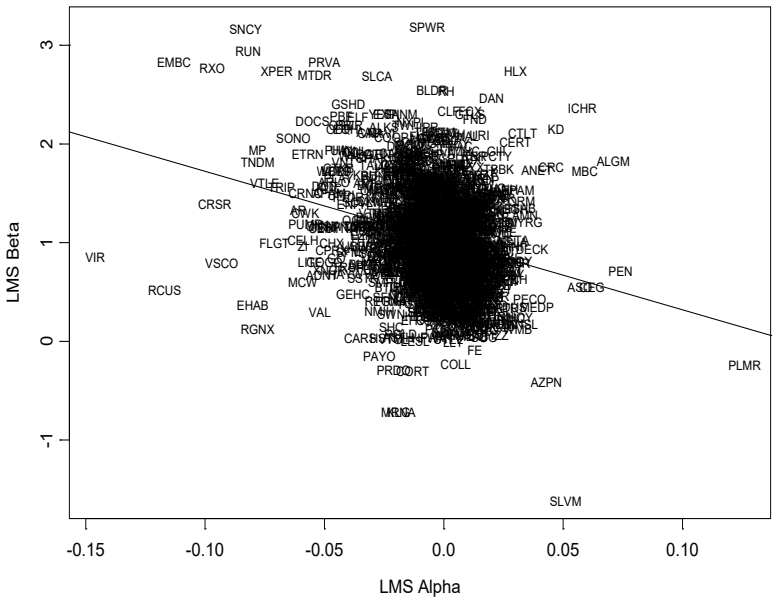

FIGURE 7. LEAST MEDIAN SQUARE BETA VS. LEAST MEDIAN SQUARE ALPHA

SUMMARY AND CONCLUSIONS.

This research identified Least Median Squares (LMS), a robust regression algorithm, as the best method for measuring equity beta, compared with OLS, MM, LTS, and LAD.

Using the Least Median Squares algorithm yields better estimates of alpha and beta, improved ex-ante portfolio construction, and better ex-post portfolio results. Further research should address and resolve the apparent negative relationship between equity beta and alpha. The results of this research should be of great value to portfolio managers, investment bankers, and other participants in the financial world.

Further research should investigate the generalizability of LMS as a superior algorithm for other modeling exercises compared with the other methodologies investigated here.

Notes:

1. Factset. Factset Systems, Inc., Greenwich, CT

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