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Managing Risk
in a World of

POLYCRISIS

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112979

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113306

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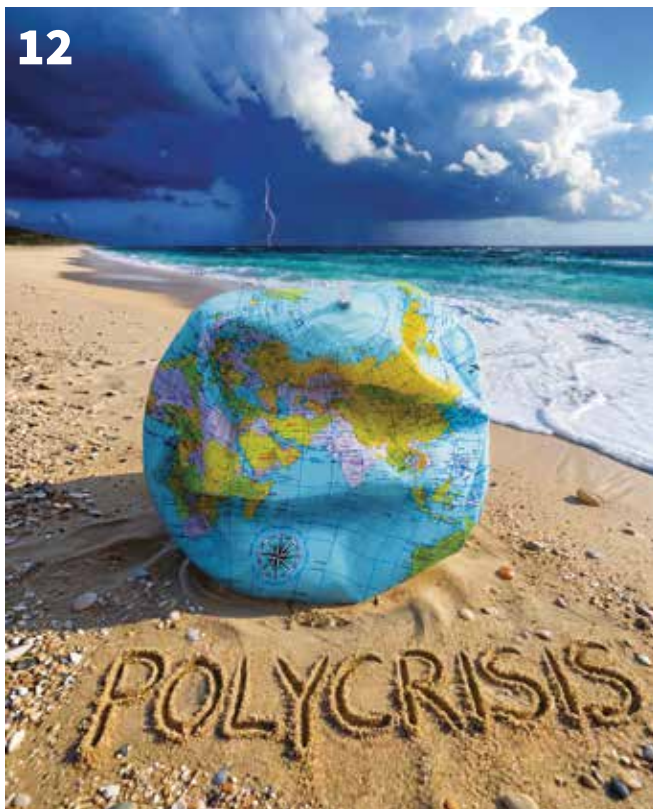
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- ♦ ASA/FSA with 7-10 years' experience in healthcare claims analytics

IN THIS ISSUE

12



12 Managing Risk in a World of Polycrisis

From extreme weather and cyberattacks to geopolitical conflict and economic volatility, multiple crises are weighing on an increasingly interconnected world. How can actuaries help insurers and policymakers prepare for these risks?

By Rade Musulin

18 How GLP-1 Drugs Are Shaping Care, Cost, and Coverage

From utilization to mortality assumptions, these medications raise new cost and risk considerations for actuaries and insurers.

By Kimberly Ferrero

26 AI and the Moral Hazard Problem in Health Insurance

Health insurance protects against financial risk, but it also shapes how care is used. Artificial intelligence points to a more targeted approach to managing incentives.

By Xinyi (Cindy) Hu

30 A Look Back: How Insurance Helped Shape America

As the United States celebrates its 250th birthday, key legal decisions, technological breakthroughs, and political battles reveal how insurance evolved alongside the nation itself.

By James Lynch

36 Global Trade and Risk Under Full Employment

How do global trade dynamics affect risk, investment, and insurance? This article uses the lens of comparative advantage and full employment to explore the economics of trade—and why it matters to actuaries.

By Carlos Fuentes

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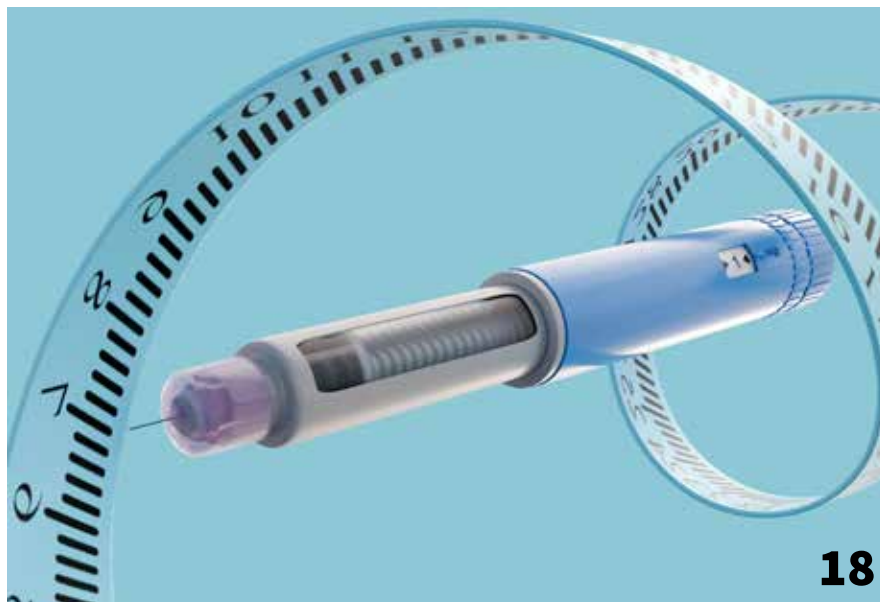
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DEPARTMENTS

- 4** **EDITOR'S NOTE**
Moon Joy
Preeti Vasishtha
- 6** **PRESIDENT'S MESSAGE**
Custodians of Financial Security
Tricia Matson
- 8** **CEO INSIGHTS**
Continuing Education as a Professional Imperative
William J. Michalisin
- 10** **UP TO CODE—THE CLASSICS**
Don't Be 'That Actuary'
John Stokesbury
- 46** **POLICY COMPASS**
International Committee Guides Academy's Global Engagement
Ted Gotsch
- 48** **MEMBER SPOTLIGHT**
Kaitlin Creighton
The Look-in-the-Mirror Test for Building Confidence
- 50** **CROSSWORD**
A—
Warren Manners
- 52** **CRYPTIC PUZZLE**
Duplicity
Tom Toce
- 54** **PUZZLES**
Pencil's Down
Josh Feldman
- 56** **LAST WORD**
We Can Do Better
Sam Gutterman

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Moon Joy

“COPY, MOON JOY,” A NASA OFFICER IN MISSION CONTROL REPLIED after Artemis II commander Reid Wiseman described the lunar surface as “absolutely unbelievable” and “incredible.” The officer captured a fleeting moment of awe, unknowingly coining a space-age catchphrase during the historic Artemis II mission in April. This was NASA’s first crewed Artemis flight, where four astronauts embarked on a 10-day lunar flyby—a major step toward returning humans to the Moon and ultimately paving the way for missions to Mars.

The mission’s riskiest part was the Orion spacecraft’s reentry into the Earth’s atmosphere at more than 30 times the speed of sound, generating temperatures exceeding 5,000 degrees Fahrenheit. After Artemis I, NASA discovered unexpected cracking and erosion in the spacecraft’s heat shield during reentry. The issue raised concerns ahead of the crewed mission. The success of Artemis II therefore depended on whether the spacecraft could withstand those extreme conditions despite the previously identified issues with the heat shield.

NASA likely went to extraordinary lengths to test and prepare for these risks. Yet no amount of preparation eliminates risk entirely. As Artemis II demonstrated, progress often requires moving forward despite uncertainty that cannot be fully removed. The challenge is not to eliminate uncertainty but to understand it, quantify it, and decide when it is acceptable to move forward. The mindset will sound familiar to actuaries.

That balance between uncertainty and progress runs throughout this issue. We examine how actuaries are engaging with risk across time and discipline—from today’s challenges in geopolitics, health care, technology, and global trade to the historical foundations that shaped the profession.

President Tricia Matson and Executive Director William Michalisin set the tone. In “Custodians of Financial Security” (page 4), Matson makes the case that actuaries remain vital problem solvers for the 21st century’s financial security challenges. Michalisin emphasizes (page 8) that as risks become more interconnected and complex, actuaries must continue investing in the knowledge, judgment, and skills needed to meet those challenges. Lifelong learning, he argues, is not simply about qualifications—it is about ensuring the profession remains relevant, trusted, and prepared for whatever comes next.

Our cover story, “Managing Risk in a World of Polycrisis” (page 12), explores how actuaries can help insurers and policymakers understand and manage the growing strain created by overlapping geopolitical, climate, and financial risks in an increasingly interconnected world. The article examines how systems thinking and scenario analysis can help actuaries identify the connections among risks that no longer occur in isolation.



Other features explore the implications of the rapid uptake of GLP-1 medications (page 18), the potential of artificial intelligence in health insurance (page 26), and the economic forces shaping global trade (page 36)—developments that promise opportunity while introducing new forms of uncertainty.

In “A Look Back: How Insurance Helped Shape America” (page 30), we step back to trace how risk and insurance have evolved alongside the United States—a fitting exploration as the nation marks its 250th anniversary. Together, these stories illustrate the expanding range of questions actuaries are being called to address in a world where risk continues to evolve.

Like Artemis II, the work of actuaries often takes place behind the scenes, long before the moment of success. It is guided by preparation, resilience, and the ability to move forward despite uncertainty. Their role is to measure uncertainty, model it, and help decision-makers understand the risks and trade-offs involved. When those efforts succeed—whether in financial security, insurance, or health care—they help create systems and solutions people can rely on. And sometimes, perhaps, even a little moon joy.



On a related note, I’m pleased to share that *Contingencies* received three 2026 Azbee Awards from the American Society of Business Publication Editors, among the most competitive honors in B2B publishing.

The magazine earned national and regional Silver Awards for Editor’s Note, and the November/December 2025 issue—commemorating the Academy’s 60th anniversary—received a regional Bronze for Cover Design.

Do you have a topic you think deserves coverage? Send us your idea at editor@actuary.org.

Our editorial focus remains the same: helping the actuarial profession bring clarity and context to complexity. ▲

PREETI VASISHTHA is editor-in-chief, *Contingencies*, and the Academy’s director of content.



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Custodians of Financial Security

ACTUARIES HAVE LONG SERVED AS STEWARDS OF FINANCIAL SECURITY—professionals who not only measure risk, but shape systems capable of withstanding it. From the earliest days of social insurance in the United States to today's evolving geopolitical landscape, actuaries have played an essential role in designing, evaluating, and safeguarding promises that Americans rely on throughout their lives. As the country faces new uncertainties, the actuarial profession's knowledge is more needed than ever.

The roots of these contributions can be traced back to the early 20th century, when the United States first began grappling with how to build national systems that could provide economic security for aging workers, unemployed families, and those struck by disability. During the development of the Social Security Act of 1935, actuarial insights were indispensable. Policymakers relied on demographic projections, mortality patterns, and economic modeling to craft a program intended to remain solvent across generations. The foundational principles of the system—risk pooling, intergenerational equity, and long-term funding discipline—reflect actuarial thinking at every level.

Over the decades, actuaries have continued to support the maintenance and evolution of America's social insurance programs. Medicare's creation in 1965 required complex assessments of health care utilization, longevity, and cost trends—challenges that have only intensified with an aging population. Today, the actuarial profession's tools and frameworks remain central to evaluating the financial condition of these programs and identifying long-term sustainability issues before they become crises.

I had the pleasure of participating in the American Academy of Actuaries' annual Hill visits this past March. It became clear to me from meetings with congressional offices that the Academy has become a critical provider of independent, nonpartisan expertise to lawmakers and regulators. In an era when public policy debates are often shaped by short-term considerations or ideological divides, the Academy's work helps ensure that decisions affecting the financial security of millions are grounded in sound analysis.

Whether testifying before Congress, publishing issue briefs, or developing practice notes, the Academy consistently emphasizes

the importance of long-term perspectives and quantitative rigor. On topics ranging from retirement income adequacy to Medicare solvency to stability of the insurance industry, the Academy's contributions help clarify the tradeoffs inherent in policy proposals and highlight unintended consequences that might otherwise go unnoticed. Perhaps most importantly, the Academy brings a shared language of risk to policymakers, enabling them to weigh uncertainty more thoughtfully.

Today's environment, however, presents another set of challenges. Geopolitical tensions are transforming global supply chains, reshaping capital markets, and introducing new forms of systemic risk. Rising cyber threats, political instability, climate-related disruptions, and shifting demographic patterns are converging in ways that create uncertainty not just for insurers and pension plans, but for governments, financial systems, and the general public.

Actuaries are uniquely equipped to help society navigate this uncertainty. Our core competencies—modeling complex systems, quantifying long-term risk, and assessing the resilience of financial structures—are directly applicable to current geopolitical risks. The profession can help organizations stress-test their assumptions, evaluate the impact of geopolitical scenarios on capital requirements, and assess the adequacy of safety net programs under alternative macroeconomic paths.

Actuaries can support policymakers by highlighting the long-term implications of geopolitical volatility for federal trust funds, private retirement systems, health care financing, and insurance markets. As governments confront the financial consequences of geopolitical shocks—from energy price spikes to migration pressures—actuarial analysis can help ensure that policy responses are both sustainable and equitable.



Ultimately, actuaries are not merely analysts—we are custodians of promises. Every pension check, every insurance benefit, and every Social Security payment reflects a commitment made today to provide security tomorrow. In times of uncertainty, the value of professionals who can evaluate the durability of those commitments becomes indispensable.

Amid a period of heightened geopolitical instability, actuaries have a unique opportunity—and responsibility—to help strengthen the financial foundations that support individuals, institutions, and society at large. By continuing to bring rigorous and fact-based analysis, long-term thinking, and a deep commitment to the public interest, actuaries can remain vital problem solvers for the financial security challenges of the 21st century. ▲

TRICIA MATSON is president of the Academy.



COMING
SOON!

Here's what we're working on:

- Convective storms as a climate risk
- Health care access gaps in rural and underserved markets
- Roth conversion decisions and retirement strategy
- Underemployment and tariffs shaping global trade

Stay tuned for in-depth insights and expert analysis on the issues shaping the actuarial profession.

Have a topic that you would like to see covered? Send your ideas to editor@actuary.org.

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Continuing Education as a Professional Imperative

AS THE ACTUARIAL PROFESSION CONTINUES TO EVOLVE, so too must the knowledge, judgment, and capabilities of those who practice within it. Today's actuaries operate in an environment shaped by rapid technological advancement, emerging risks, evolving regulatory frameworks, shifting consumer expectations, and growing demands for transparency and accountability. From artificial intelligence and predictive analytics to climate risk, retirement security, insurance access and affordability, cybersecurity, and financial resilience, the issues facing the actuarial profession are increasingly interconnected and complex.

In this environment, continuing education (CE) is not simply a professionalism requirement, it is a professional responsibility. For actuaries practicing in the U.S., continuing education represents an investment in oneself, in the organizations and stakeholders they serve, and in the long-term strength and credibility of the actuarial profession. It is how we sharpen our expertise, deepen our judgment, broaden our perspectives, and ensure we remain prepared to provide objective, trusted, and relevant actuarial insight in a changing world. As actuarial responsibilities continue to develop, ongoing learning also helps ensure actuaries remain equipped to respond to emerging challenges with rigor, relevance, and sound professional judgment.

The U.S. Qualification Standards (USQS) provide an important framework that helps guide this commitment to lifelong learning. While the continuing education requirements establish minimum expectations, they also offer something more meaningful: a reminder of the breadth and depth of knowledge necessary to responsibly practice as a qualified actuary in the United States. Equally important, the USQS reinforce the role of professional judgment. Each actuary must thoughtfully assess what education is appropriate based on their area of practice, evolving responsibilities, emerging issues, and the needs of those who rely on their expertise. Continuing education should not be viewed as a checklist exercise, but rather as a strategic and intentional investment for all practicing actuaries in maintaining competence and expanding capability over time.

In many respects, continuing education serves as a safeguard against professional stagnation, helping actuaries remain adaptable in a business and policy environment that is changing rapidly. It also plays an important role in supporting the profession's self-regulatory framework. The actuarial

profession has long benefited from a system grounded in a code of conduct, professional standards, qualification requirements, peer accountability, and a commitment to serving the public. Maintaining that framework requires ongoing investment, not only in technical knowledge, but also in professionalism, ethics, communication, and emerging competencies that strengthen the profession's ability to anticipate, adapt, and lead.

That investment matters. It matters to employers who depend on actuaries to navigate uncertainty, manage risk, and provide informed analysis in increasingly dynamic environments. It matters to policymakers, regulators, boards, and consumers who rely on actuarial work to support important financial and societal decisions. And it matters to the broader U.S. actuarial profession, whose reputation depends upon the expertise, integrity, professionalism, and accountability of its members. It also matters to the Academy, which requires all volunteers to comply with the USQS CE requirements as a means to encourage those working on the 300-plus publications and resources developed annually to stay current and professionally competent. It's also why the Academy added a voluntary CE attestation for members earlier this year, reinforcing the need and importance of investing in our continuing education.

Volunteerism as Applied Learning and Leadership Growth

One of the most meaningful ways actuaries can continue learning and growing is through volunteer engagement within the profession. Volunteer service provides opportunities to expand technical expertise and professional capabilities by working on real-world issues impacting society today. Through volunteer opportunities in public policy, professionalism, or membership, actuaries are exposed to emerging risks, evolving regulations, and complex challenges that broaden knowledge

As professionals, we should view continuing education not as an obligation, but as an opportunity. An opportunity to grow. An opportunity to remain relevant. An opportunity to lead. An opportunity to strengthen the value we bring to our employers, clients, policymakers, and the public. And an opportunity to reinforce the future strength, credibility, and impact of the U.S. actuarial profession itself.

and sharpen professional judgment. Volunteering also offers actuaries valuable exposure to cross-disciplinary collaboration and policy discussions that may extend beyond their day-to-day professional responsibilities.

Volunteering helps actuaries strengthen critical soft skills—including communication, collaboration, leadership, strategic thinking, and stakeholder engagement—that are increasingly essential in today’s business and policy environments. In many respects, volunteering serves as experiential continuing education, allowing actuaries to grow as leaders and contributors while helping advance the profession and serve the public, both of which are core to the Academy’s mission. This experience aids actuaries in deepening skills and expertise that benefit their individual performance, the public, and their employers. It also helps cultivate future leaders within the profession by providing opportunities to build consensus, navigate complex issues, and contribute to meaningful public policy discussions. This is one of the many reasons why membership and engagement with the Academy remain so important and why I encourage all members to participate in the annual Call for Volunteers, which opens in August.

Academy Resources and the Expansion of Professional Competence

As the home and voice for U.S. actuarial professionalism and public policy, the Academy is committed to supporting actuaries throughout their professional journey. The Academy’s educational resources are designed to help members remain informed, prepared, and connected to the evolving issues shaping practice and policy in the United States. They help actuaries strengthen the broader competencies increasingly necessary for professional success, including communication, leadership, strategic thinking, public policy awareness, and understanding emerging trends that may shape the future of actuarial practice.

Through Academy Learning, which is the Academy’s learning platform that offers webinars, professionalism content, practice-specific programming, and member-discounted educational opportunities, actuaries have access to a wide range of resources that support technical excellence and professional growth. Many of these programs are available exclusively to Academy members or at a member-discounted rate, reflecting the value of membership and the Academy’s commitment to investing in the continued success of the actuarial profession.

The actuarial profession has earned a high level of trust because of the expertise and professionalism its members bring to their work every day. The continuing education commitment embedded within the USQS helps sustain that trust along with the other professionalism structures, and reinforces the credibility associated with being qualified. Yet, it extends beyond qualification, helping to reinforce and encourage all actuaries to invest in themselves and their knowledge.

As professionals, we should view continuing education not as an obligation, but as an opportunity. An opportunity to grow. An opportunity to remain relevant. An opportunity to lead. An opportunity to strengthen the value we bring to our employers, clients, policymakers, and the public. And an opportunity to reinforce the future strength, credibility, and impact of the U.S. actuarial profession itself.

I encourage every actuary to thoughtfully invest in their continued development, leverage the many educational resources available through the Academy and other actuarial organizations, actively engage through volunteer opportunities, and approach lifelong learning as an essential part of professional excellence and service to the public. The strength and relevance of the actuarial profession will depend not only on what actuaries know today, but on their willingness to continue learning, adapting, contributing, and growing to meet the challenges of tomorrow. ▲

WILLIAM J. MICHALISIN is the Academy’s executive director and CEO.

Don't Be 'That Actuary'

I'VE BEEN IN THE PENSION CONSULTING FIELD for over 30 years. Most of the countless actuaries I've encountered over the years have exhibited skills and behaviors that I strive to emulate. But others have fallen short of my expectations. From time to time, I reflect on those encounters and remind myself that I don't want to be "that actuary."

One actuary—actually, more than one—failed to renew membership in one of the actuarial organizations. Maybe it was not seeing the email dues notification, or maybe it was changing jobs and not even getting the email notification, or maybe even thinking your administrative assistant was going to take care of it (OK, I admit it, that one happened to me, and I have the battle scars to prove it). So, what's the big deal? Well, Precept 12 of the Code of Professional Conduct talks about appropriate use of credentials—and if you let your membership lapse and are no longer a member of a credentialing organization, then you shouldn't be using that organization's credential. So, at the turn of each calendar year, I remind myself what a hassle it would be to update everywhere I show my credentials, and I take the necessary steps to make sure my credentials are current. I don't want to be "that actuary."



Another actuary had not completed the continuing education (CE) requirements laid out in the Qualification Standards for Actuaries Issuing Statements of Actuarial Opinion in the United States (USQS). I mean, we're all pretty smart; we aren't going to get stupid overnight. What's the harm? Well, actuaries must comply with the USQS before issuing a Statement of Actuarial Opinion (SAO); the USQS and the Code of Professional Conduct are very clear on this matter. Failure to complete the CE requirements makes you unqualified to sign SAOs—period. I've seen actuaries having to find a colleague (who did satisfy

the USQS) to co-sign—or even to redo—a valuation report. I really don't want to be "that actuary" and have to explain all of that additional effort to my client.

What if the actuary simply forgot to attest that he had satisfied the SOA's Continuing Professional Development (CPD) requirement?¹ No big deal, right?

Wrong. Even though this actuary had satisfied the USQS requirements, if the actuary appears as "noncompliant" with his or her CPD requirement in the Actuarial Directory—which would happen if he or she simply forgot to attest—another actuary may be concerned that he or she may not have satisfied the continuing education requirements of the USQS. To avoid any such appearance of noncompliance with the USQS, each February, I check that I have satisfied my USQS continuing education requirements for the year and that my listing in the Actuarial Directory is up to date—just to make sure there are no misunderstandings. I don't want to be "that actuary."

OK, these examples are really not all that controversial; we all know the right thing to do to maintain our credentials and our continuing education. It just means paying attention to details. But there are other actuaries that I recall from time to time ...

I remember one actuary with significant experience consulting in pensions. But none of this actuary's clients had ever gone through settlement accounting. How hard could that be?

Editor's Note: While this article was originally published in the September/October 2015 issue of *Contingencies*, it discusses concepts that are still relevant today. An alternative title for this article could be "Keeping Up." Many of the mistakes made by "those actuaries" are because they failed to keep current—with their dues, their continuing education (CE), or laws and regulations in their area of practice. The Code of Professional Conduct—whether directly or through the U.S. Qualification Standards and actuarial standards of practice (ASOPs)—requires all actuaries to be familiar and keep current with the knowledge needed to practice in their area, their CE, and the laws, regulations, and standards that govern their practice. Why? Because actuaries who don't keep up in all these areas may find themselves providing less-than-optimal actuarial services, thereby undermining public trust and self-regulation. Read on for some tips on how not to be "that actuary."

The actuary came up with an accounting treatment that seemed to make sense and presented it to the client. The client accepted it and prepared financials on that basis. Sounds good, right? Again, not so fast ... pension accounting has some very specific rules for how to account for settlements. And while the approach proposed might have seemed logical, it was actually not consistent with the accounting literature. Now we're talking about Precept 1 (and Annotation 1-1), providing actuarial services with skill and care.

This one actually keeps me awake some nights. How do I know what I don't know? If I do something that seems logical and makes sense to me, isn't that good enough? I wish it were. As actuaries, we often practice in areas that are regulated or where rules are provided by others for us to follow. We need to know those rules. And if we don't know the rules, or don't understand them, we need to ask someone to help us out. It might be as simple as asking the actuary in the next office, or someone you met at a conference, or even a member of the Actuarial Board for Counseling and Discipline through the Request for Guidance process. I find myself going back to source material all the time to make sure I know what the rules are—and talking with my peers if I'm not sure. It would be really embarrassing to miss a rule and have to explain that to a client. I don't want to be “that actuary.”

And then, there was an actuary—years ago, around when the RP-2000 mortality table was published. In this case, the client was reflecting the much older GA-51 mortality table in financial statements. When asked why the actuary had never updated this assumption, and with the client on the phone, the actuary replied, “Because the client never told me to.” While the assumptions

Keeping Current

While the Code of Professional Conduct has not changed since 2001, many laws, regulations, and standards have undergone multiple changes in the last 25 years. The Qualification Standards for Actuaries Issuing Statements of Actuarial Opinions in the United States (USQS) have been revised at least twice, and most ASOPs have undergone several revisions in that timeframe. Indeed, the Actuarial Standards Board (ASB) has adopted more than 20 new or revised actuarial standards of practice (ASOPs) since 2020. Laws, regulations, and technologies have also changed, in some cases significantly.

The USQS recognizes the need for actuaries to keep up with such developments, stating “Actuarial practice is grounded in the knowledge and application of actuarial science, a constantly evolving discipline. If actuaries are to provide their principals with high-quality service, it is important that they remain current on emerging advancements in actuarial practice and science that are relevant to the Actuarial Services they provide. Further, opportunities to practice are expanding beyond traditional work on pension and insurance issues to encompass the broader world of financial services. Actuaries working in emerging areas need to be familiar with relevant new techniques and concepts from other related disciplines.”

Moreover Precept 3, Annotation 3-1 specifically notes that the Actuary is responsible for keeping current regarding changes in applicable ASOPs. Actuaries who do not keep up with these changes put themselves and the profession at risk. So, please, keep up and don't be “that actuary.”

reflected in financial statements may be prescribed by the client, I'm not sure the client appreciated that the assumptions might have needed to be updated. Was there a specific Precept that addresses this? Perhaps not. And, at the time, the actuarial standards of practice did not have the expectation for actuaries to assess certain prescribed assumptions. Still, I really would want to be proactively educating my clients on changing trends (even if it is a message they may not want to hear) and not be “that actuary.”

These examples are certainly the outliers. As I stated at the outset, the vast majority of actuaries that I've met and worked with are outstanding role models. I am proud to be their peer.

But there are ... these other actuaries. And that's when I have to deal with the tough responsibilities of Precept 13. It's not easy to reach out to another actuary and discuss such matters. You are putting the actuary on the spot, and the actuary may naturally become a bit defensive. For the most part, though, the actuaries in these examples were embarrassed by the events and worked quickly to resolve the matter. At the end of the day, they actually did appreciate having the discussion with me and

assured me that they really did not want to be “that actuary” either. ▲

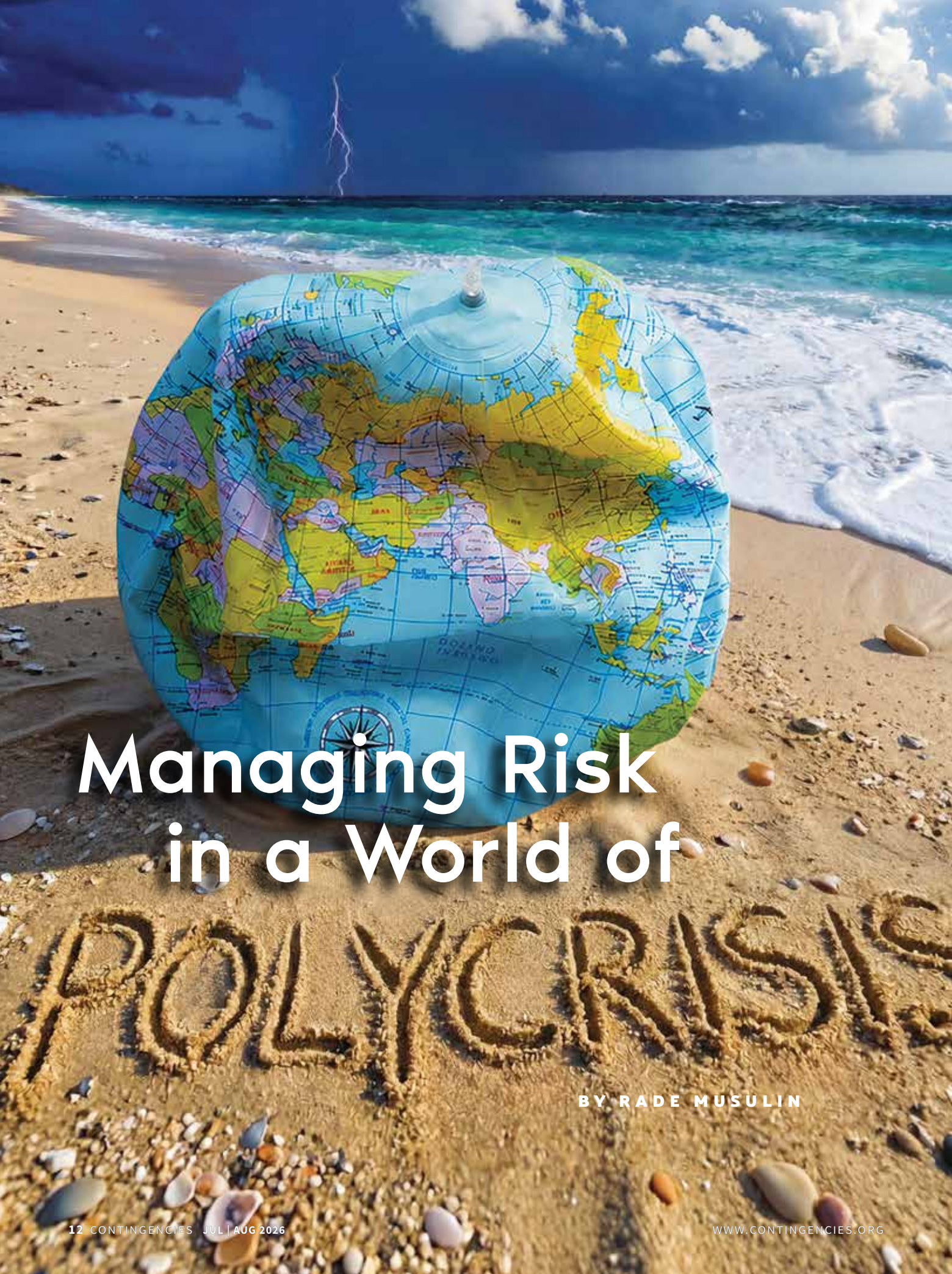
At the time of publication, **JOHN STOKESBURY** was a member of the Actuarial Board for Counseling and Discipline.

Notes

1. Although there are differences between the CAS and the SOA CPD requirements and the USQS continuing education requirements, both the CAS and the SOA accept fulfillment of the USQS requirements as fulfillment of their CPD requirements. By contrast, compliance with CPD does not necessarily indicate that you have satisfied the USQS and are therefore qualified to issue an SAO.

Voluntary Attestation

Many of the actuarial organizations ask their members to attest that they have completed the continuing education (CE) requirements each year. For example, the Academy has long required volunteers to attest that they have met the CE requirements as a condition of serving as a volunteer. This year, the Academy is offering all members the opportunity to make that attestation voluntarily. To ensure that you are shown as “in compliance” on your organization's actuarial directory, please follow your organization's instructions.



Managing Risk in a World of

POLYCRISIS

BY RADE MUSULIN



From extreme weather and cyberattacks to geopolitical conflict and economic volatility, multiple crises are weighing on an increasingly interconnected world. How can actuaries help insurers and policymakers prepare for these risks?



he decades following World War II saw the creation of strong institutions designed to support a stable, rules-based global order.

In reaction to the extreme destruction and trauma of the war years, frameworks for international relations, such as the United Nations, emerged to manage conflicts without global war, helping to create prosperity and peace. Many supranational organizations were established, including the World Health Organization, the World Trade Organization, the World Bank, and the International Court of Justice. Most of today's business leaders have grown up in this rules-based world, and business systems have been adapted to operate efficiently within it.

During this period there were occasional geopolitical crises, such as the Middle East wars and the ensuing oil embargo of the 1970s, the dissolution of the Soviet Union in the early 1990s, the 9/11 terrorist attacks, the Global Financial Crisis (GFC) in the late 2000s, and the Arab Spring in 2010-2012. All of these occurred in the context of this post-World War II order, which absorbed shocks and

appeared extremely resilient.

Recently, that rules-based order has been placed under extreme—perhaps even terminal—stress. We have seen the rise of autocracies in many countries, endured a pandemic, begun to experience severe consequences of global warming, witnessed the outbreak of wars in several regions, and are now dealing with one of the worst oil shocks in history. Recent U.S. policies have contributed to a more fragmented, multipolar world, with countries operating in competing blocs. This period has been marked by rapid and sometimes unpredictable policy actions. By contrast, earlier approaches, such as during the Iraq War, emphasized multilateral engagement and working through international institutions.

Geopolitical risk has risen dramatically, alongside risks from artificial intelligence (AI), climate change, and economic imbalances. These risks interact with a global financial system that has become extremely complex, opaque, and awash with debt accumulated during the pandemic. Systematic stress is increasing and can spread quickly.

This raises the question of whether the risk management frameworks of financial institutions—and the mindset of actuaries who help sustain them—need to evolve to meet the challenges presented by the emerging world (dis)order, and if so, how?

Growing Volatility and Rapid Change

Compared with past cycles, 2026 is marked by simultaneous disruptions across trade, technology, security, energy, and resource markets—a situation described as a “polycrisis” by the World Economic Forum. Relationships, personalities, psychology, and contagion may increasingly be overtaking rules and institutions as the framework for international relations and trade. Organizations (or institutions) across the world must now confront challenges for which there may be no reliable data or modern precedent. For example, U.S. tariff rates are now at their highest levels since the early 1940s, while fallout from the closure of the Strait of Hormuz could affect economies across the world for an extended period.

Actuaries, along with other risk management professionals, may find themselves challenged by this environment. Over recent decades, actuarial practice has become increasingly data driven. That has delivered major benefits: better segmentation, improved reserving tools, more rigorous capital modeling, and an expanding discipline of model governance. This mirrors how “big data” has transformed economics, investment strategies, supply chain management, and many other disciplines.

Unfortunately, this progress may also introduce new vulnerabilities. When organizations become highly reliant on large volumes of historical data and models built upon that data, systems can become vulnerable when conditions shift quickly, correlations change, or entirely new drivers appear.

The Need to Think in New Ways

Geopolitical risk is a clear example of this problem, as is climate risk. In both cases, the past remains informative but may no longer be sufficient to understand the future. This may mean that some older actuarial techniques familiar to practitioners trained before the “big data” era may become newly valuable. Today’s volatile world may require disciplined reasoning, explicit storyline construction, and scenario analysis designed to explore plausible futures to complement data-driven modeling.

In 2010, *New York Times* columnist David Brooks used a

Signposts

Build a small set of indicators that warn when the geopolitical regime is shifting: breadth and tempo of sanctions announcements; persistent shipping delays on key routes; sustained increases in cyber activity against critical infrastructure; commodity spikes that drive construction costs; rapid changes in alliance behavior; sustained divergence in regional inflation. Attach triggers: When two or three signposts move together, pre-authorize actions such as adjusting reinsurance structure, tightening underwriting appetite, adding pricing overlays, or increasing liquidity buffers.



phrase that captures the structural nature of the challenge: “catastrophic complexity.” When complex systems are stressed, surprises can become a structural feature, not merely a low-probability exception. That matters for financial institutions that operate within a wider political and economic system.

Geopolitical risk is not new. Insurance markets have long dealt with war risk, expropriation, terrorism, political violence, and trade disruption. What feels different today is the combination of speed, global interdependence, and weakening guardrails. The seeds are being sown for shocks to ripple through the financial system rapidly and in ways that are hard to understand using traditional methods.

From an actuarial perspective, we can say that the distribution of plausible futures has widened. Volatility is higher. Tail outcomes are more plausible. Correlations between previously separate risks may arise.

Uncertainty Has a Cost

A basic principle of economics applies in the current environment: Uncertainty carries a positive price. In finance, investors generally require higher expected returns for more volatile risks, which is why equities have historically delivered higher long-run returns than government bonds. In insurance, a stable book of motor insurance requires a smaller risk load than catastrophe reinsurance exposed to low-frequency, high-severity losses.

In a polycrisis environment, geopolitical volatility becomes a direct input to risk loads across the system. When uncertainty increases, the cost of capital tends to rise, and the capacity



available to support volatile risks tends to contract. In reinsurance, this often appears as higher attachment points, tighter terms, exclusions for emerging perils, and a greater focus on aggregation and clash risk. At the retail level, it can appear as claims inflation, coverage restrictions, and greater sensitivity to model uncertainty.

Uncertainty is not merely a forecasting problem. It is also a pricing problem. If volatility increases, someone pays, either through higher premiums, reduced coverage, or, in some cases, public intervention. In the broader economy, uncertainty can lead to higher inflation, less investment, lower productivity, and a contraction in economic activity.

How Can Geopolitical Risk Impact Insurer Finances?

Consider four broad groups of effects:

1. Claims: frequency, severity, and inflation. Traditional insured losses from political violence or terrorism are only part of the story. Claims impacts may arise from supply chain disruption, labor constraints, repair delays, and price volatility for key materials. Even when the underlying peril is not political, geopolitical shocks can increase loss severity by raising repair costs, prolonging business interruption, or limiting the availability of specialized components.

2. Assets and capital: correlated stress. Geopolitical shocks can impact interest rates, credit spreads, equity prices, and currency values. (Re)insurers may experience asset value declines even as claims rise. Correlation is the enemy of risk diversification, and geopolitical shocks can increase correlations across risks traditionally thought to be independent.

3. Operations: cyber, continuity, and infrastructure. Operational resilience is now intertwined with geopolitical competition. State-sponsored or state-tolerated cyber activity can target critical infrastructure, logistics systems, and financial institutions. According to the 2022 Microsoft Digital Defense Report, the share of nation-state cyber operations targeting critical infrastructure was reported to have doubled from 20–40% over a one-year period. Even if insured losses are limited by policy language, operational disruption can be significant. In systemic events, legal, regulatory, and reputational responses can be as consequential as the direct operational costs.

4. Legal and contractual complexity. Tariffs, export controls, stress in the judicial system, or rapid changes in regulatory standards introduce uncertainty in contract performance. Consider the rapid change in requirements for U.S. firms to provide climate risk disclosures. Such firms can face a complex environment where federal and state regulations conflict, or where global counterparties are subject to different rules and

reporting requirements. This can increase operational costs, particularly if a future U.S. administration abruptly reverses the policies of the current one.

Geopolitical risk is best understood as a set of correlated stressors that can interact. The actuarial task is to identify where those interactions could concentrate loss, weaken solvency, or destabilize operations.

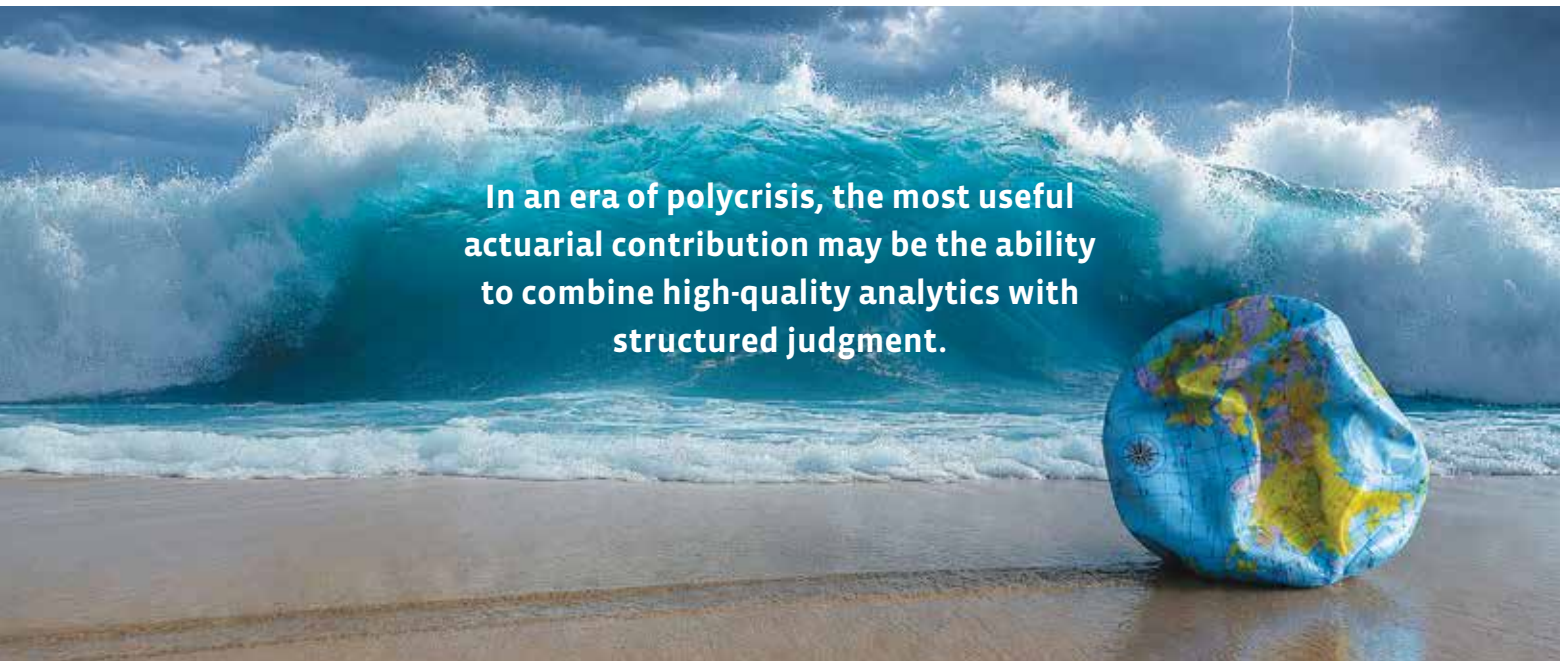
Geopolitics and Claims Inflation—An Example

During the early 2000s, reconstruction demand associated with the Iraq War was cited as one factor contributing to higher lumber prices in the United States. I recall working in Florida during the 2004 hurricane season, when four hurricanes struck and rebuilding costs rose sharply. Our models underestimated the likely magnitude of the problem, partly because they failed to consider hurricane-induced demand surge occurring in a period of supply shortages triggered by a geopolitical event.

This illustrates that extreme events do not occur in economic isolation. Loss severity is shaped by the broader economic environment: labor availability, material prices, logistics, and financing. By studying historical examples like these, we can create scenarios that supplement modeling and yield a more robust understanding of risk. The pathway from geopolitical conditions to insurance balance sheets is often indirect, involving second-order effects such as inflation, shortages, delays, and volatility.

Five Questions for the Board

1. Where are our largest dependencies by geography, supplier, and critical infrastructure?
2. Which policy contracts could be hard to fulfill if impaired by tariffs or trade restrictions (e.g., an inability to source parts for repairs)?
3. Have we tested policy language for cyber, war, and political violence in realistic scenarios?
4. What is our plan if claims inflation spikes while investment markets fall?
5. What decisions are pre-approved if the signposts dashboard deteriorates?



In an era of polycrisis, the most useful actuarial contribution may be the ability to combine high-quality analytics with structured judgment.

A Climate Analogue: Scenario Analysis and Systems Thinking

Climate risk has forced actuaries to confront the limits of using the past to predict the future. Historical loss experience remains valuable, but non-stationarity matters. The forward-looking techniques developed for climate risk have direct relevance to geopolitical risk, even though the underlying drivers differ.

For example, climate change is not a surprise. It is visible, measurable, and politically difficult. That makes it a useful analogy for geopolitics: in both cases, the most damaging outcomes often arise when known vulnerabilities interact within complex systems.

Three elements of how actuaries approach climate risk are particularly helpful.

1. Scenario analysis. Climate scenario analysis is a structured exploration of plausible pathways designed to test resilience under uncertainty. A well-designed scenario makes its assumptions explicit, identifies signposts that would increase or decrease confidence in the pathway, and quantifies impacts where possible.

For geopolitical risk, the same concepts can be applied: building plausible pathways; articulating assumptions about trade, sanctions, energy markets, cyber escalation, and institutional responses; then testing impacts on claims, assets, and operations. The value is not in trying to identify a correct scenario, but in clarifying vulnerabilities and identifying strategies that remain robust across a range of futures.

2. Systems thinking and second-order effects. One of the most important lessons from climate work is the role of feedback loops. A hazard does not only damage assets. It can disrupt supply chains, strain public budgets, shift migration patterns, and change political preferences. Geopolitical shocks can produce similar cascades: Conflict affects energy prices, energy prices drive inflation, inflation drives interest rates, interest rates affect asset values and housing affordability, affordability affects political stability, and political stability affects policy responses, which in turn influence the next iteration of risk.

3. Updating scenarios and integrating with enterprise risk management. Scenario analysis is not a one-off exercise conducted solely to inform a disclosure report. As the environment changes, scenarios should be refreshed, assumptions revisited, and findings integrated into risk appetite, reinsurance strategy, liquidity planning, and governance. For actuaries, that means connecting scenarios to solvency assessments and being transparent about limitations: what was quantified, what was not, and what factors might change the conclusions.

Building Scenarios and Using Signposts

A practical approach is to build a range of plausible scenarios, understand the interdependencies to which systems the scenarios apply, develop relevant quantitative metrics and measures, and combine this with more traditional forms of analysis. This can lead to a better understanding of the range of possible outcomes and the factors that may drive them,

including identifying signposts that can provide early warning of whether scenarios are playing out as envisioned.

Signposts refer to specific parts of scenarios that can be monitored to identify when events are diverging from the larger narrative. Signposts should link to actions: changes in reinsurance purchasing, revisions to pricing and reserving assumptions, adjustments to investment strategy, or efforts to strengthen operational resilience.

For example, if a scenario calls for 50% penetration of electric vehicles (EVs) by 2040, one might have a signpost tracking how many charging stations are constructed by 2030 or whether a tax policy is enacted by 2029 that encourages EV sales. The EV example illustrates the importance of systems thinking. Many nations are likely to double down on electrification and reducing dependence on fossil fuels following the Iran war—an outcome that might be anticipated in a scenario analysis examining how countries might react to a major oil market disruption. It also illustrates the importance of considering policy reversals by governments, as seen when the Trump administration rapidly changed the Biden-era EV policies. Elections are therefore a specific risk that should be considered when building robust scenarios.

How Actuaries Add Unique Value

Actuaries are often described as quantitative professionals, and that is true. Yet the profession's value proposition is broader. It includes disciplined reasoning under uncertainty, the ability to connect risk drivers to financial outcomes, and experience in designing systems that can survive tail events.

In an era of polycrisis, the most useful actuarial contribution may be the ability to combine high-quality analytics with structured judgment. Consider these four actions:

1. Clarify where models are reliable and where they are not. Some risks can be modeled with high confidence, some with moderate confidence, and some must be understood through scenario analysis and expert judgment. Clarity about those boundaries is itself a governance strength. It is also a safeguard against overconfidence, which is a common failure point in complex systems.

2. Translate complexity into decision-relevant measures.

Boards and policymakers do not always need larger or more complex models. Instead, they value a clear map of exposures, correlations, and vulnerabilities. Actuaries are trained to translate complex risk into decision metrics: ranges, tail outcomes, capital needs, and sensitivity to assumptions. In a world of catastrophic complexity, the ability to explain uncertainty is often as important as the capability to calculate it.

3. Make risk load explicit. When uncertainty rises, the cost of capital rises. That must be reflected in pricing, reserving margins, and capital planning. Ignoring this can create fragility.

4. Engage in public policy. When tail risks become salient, policy responses often follow. Actuaries have experience designing public-private mechanisms, explaining trade-offs, and quantifying costs and benefits. In a polycrisis environment, that skill set is likely to be in high demand, as affordability and insurability are not guaranteed. Insurance works best when risks are measurable, diversifiable, and priced with sufficient margin to support capital. When risks become too correlated, too ambiguous, or too politically constrained, insurance becomes less effective and more likely to require public mechanisms. Recognizing those boundary conditions early is preferable to discovering them during a crisis, when options are limited and political discourse is likely to be fraught.

Model Risk

Treat geopolitical scenarios as high-impact, high-uncertainty models. Document assumptions. Identify what is not captured: second-order inflation, operational disruption, legal constraints, and correlation shifts. Run sensitivities that are easy to explain: repair-cost inflation, prolonged business interruption, currency shocks, and reinsurance counterparty stress.

Back to the Future with Better Tools

The actuarial profession can integrate two strengths. The first is modern quantitative capability: data, models, and analytics that are far more powerful than those available to prior generations. The second is disciplined reasoning under uncertainty: constructing narratives, testing scenarios, and recognizing that the future can differ meaningfully from the past. In the era before big data, the second set of skills was more important. Perhaps it is time to revisit some of these qualitative skills to complement today's powerful analytics. A polycrisis environment demands both strengths: rigorous analytics where data is informative, and structured judgment where data is silent or misleading. If actuaries apply those skills to geopolitical risk, while leveraging the scenario- and systems-thinking toolkit developed for climate risk, the profession can help insurers and policymakers navigate an era of catastrophic complexity. ▲

RADE MUSULIN, MAAA, ACAS, recipient of the 2025 Jarvis Farley Service Award, is a former Academy casualty vice president, Board member, and active contributor to multiple committees and work groups. He currently serves on the Academy's International Committee and the Actuarial Standards Board's ASOP 39 Task Force.



How GLP-1 Drugs Are Shaping Care,

GLP-1 MEDICATIONS (Glucagon-like peptide-1 receptor agonists) did not begin their clinical lives as weight-loss drugs. Instead, they emerged from efforts in the early 2000s to improve treatment options for people with type 2 diabetes. Researchers focused on GLP-1, a naturally occurring hormone released in the gut after eating, because of its ability to stimulate insulin secretion in a glucose-dependent manner and suppress excess glucagon. These properties made it an attractive target for improving glycemic control while reducing the risk of hypoglycemia.

The first GLP-1 receptor agonist, exenatide (Byetta), received U.S. Food and Drug Administration approval in 2005, marking a novel approach to diabetes management. Over time, newer agents improved both convenience and effectiveness. Liraglutide (Victoza) followed in 2010 with once-daily dosing, while

semaglutide (Ozempic), approved in 2017, introduced once-weekly administration. More recently, tirzepatide (Mounjaro), approved in 2022, expanded the therapeutic concept further by combining GLP-1 activity with glucose-dependent insulinotropic polypeptide (GIP) receptor agonism.



Cost, and Coverage

From utilization to mortality assumptions, these medications raise new cost and risk considerations for actuaries and insurers.

By Kimberly Ferrero

As these drugs entered wider clinical use, it became clear that their impact extended well beyond blood sugar control—raising early questions for actuaries about how the therapies might affect long-term health risk and insurance costs. Weight loss, initially viewed as a secondary benefit, proved to be a substantial and consistent effect of GLP-1 usage across multiple clinical trials. This observation ultimately led to the approval of higher-dose formulations of liraglutide (Saxenda) and semaglutide (Wegovy) specifically for sustained weight management, formally repositioning GLP-1 medications as obesity treatments rather than solely diabetes medications.

For actuaries, that shift matters more because obesity is a major driver of long-term health costs and mortality risk across insured populations. As these medications move from diabetes care into large-scale weight

management, actuaries and insurers are beginning to evaluate how their expanded use can influence health care utilization, insurance pricing, and long-term population health outcomes.

How GLP-1 Medications Contribute to Weight Loss

GLP-1 medications work by amplifying the effects of the body's own GLP-1 hormone, which plays a central role in regulating appetite, digestion, and glucose metabolism. After we eat, GLP-1 (made in our intestines) helps signal fullness, slows the rate at which food leaves the stomach, and coordinates insulin and glucagon release to keep blood sugar levels in check. Pharmacologic GLP-1 receptor agonists are designed to mimic these effects of the body's own GLP-1 but remain active in the body far longer than the naturally occurring hormone. Recent

analysis by the American Academy of Actuaries suggested that the high cost of these medications, combined with the need for long-term use, could place upward pressure on 2025 health insurance premiums, particularly as more patients met clinical criteria for covered diagnoses.

Several mechanisms appear to work together to produce clinically significant and sustained weight loss. First, GLP-1 medications act on the appetite-regulating centers in the brain, reducing hunger and increasing feelings of satiety. Patients often report eating less, not because of conscious restraint, but because they feel full sooner and for longer periods. Second, by slowing gastric emptying, these medications prolong post-meal fullness and dampen spikes in blood glucose. Third, they enhance insulin secretion and suppress glucagon release in a glucose-dependent way, improving metabolic efficiency without substantially increasing hypoglycemia risk.

Taken together, these effects help explain why GLP-1 drugs have produced more durable weight loss than many earlier pharmacologic approaches, which often relied on stimulant-based appetite suppression or had limited tolerability. What remains most novel about GLP-1 medications is that they target underlying biological drivers of energy intake and metabolic regulation—factors closely tied to chronic disease risk—rather than simply promoting short-term weight reduction, and may, in the long run, contribute to lower health insurance costs by treating related comorbidities, even as they may impact patient longevity and, thus, how life insurance treats these drugs.

Entrance onto the Insurance Landscape

Interest in GLP-1 medications has grown rapidly, not only because of how the drugs work, but also because of the scale of the problem they target.

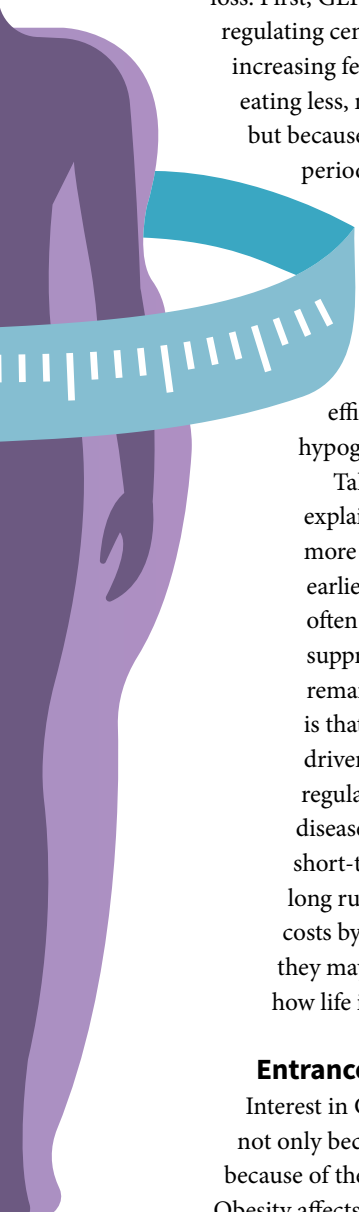
Obesity affects an estimated 42% of U.S. adults, based on nationally representative data from 2017–2020, and is associated with approximately \$173 billion in annual medical costs, driven largely by increased rates of cardiovascular disease, diabetes, and related chronic conditions. Against that backdrop, the magnitude of weight

loss observed in GLP-1 clinical trials stands out as historically atypical for pharmacologic obesity treatments.

In randomized controlled trials, semaglutide has produced average weight loss of approximately 15% of baseline body weight, while tirzepatide has delivered reductions exceeding 20% in some study populations. A meaningful share of participants achieved weight-loss levels previously associated primarily with bariatric surgery. Beyond weight reduction alone, these trials have also shown improvements across a range of cardiometabolic markers, including blood pressure, lipid profiles, glycemic control, and inflammatory measures. More recent outcomes data suggests potential reductions in major adverse cardiovascular events among high-risk populations, further broadening interest in the downstream health implications of sustained GLP-1 drug use.

For actuaries, these findings raise a critical question: whether clinical benefits will translate into durable improvements in population health and, ultimately, measurable changes in health care utilization and mortality. That question becomes more complex once clinical trial results give way to real-world prescribing patterns, heterogeneous adherence, and uneven insurance coverage. Preliminary real-world data from Milliman suggests that while increased GLP-1 adherence may lower the medical cost of care for certain chronic conditions, these offsets do not yet fully recover the high cost of the medications themselves. As GLP-1 drug use expands beyond controlled trial settings and into employer-sponsored plans, Medicaid programs, and state-regulated markets, attention increasingly shifts from efficacy to access—how many patients receive these therapies, under what conditions, and at what cost? This challenge is further compounded by the shifting landscape of pharmacy spending; in early 2025, a small group of GLP-1 medications accounted for approximately 21% of total prescription costs for large pharmacy coalitions, a massive jump from just 1% in 2020.

To better understand how the emerging evidence is shaping actuarial thinking, we interviewed a panel of health and life actuaries about prescribing trends, coverage



decisions, and signals they are watching across markets. Their perspectives illustrate how GLP-1 medications are raising new questions about cost, utilization, and long-term risk for insurers and policymakers.

The Rapid Expansion of GLP-1 Prescribing

GLP-1 prescribing has expanded rapidly, reflecting its expansion from a niche diabetes therapy to a widely utilized metabolic treatment. Recent survey data suggest that between 6 and 12% of U.S. adults are currently using a GLP-1 agonist, while roughly 1 in 8 reports having used one at some point. Claims-based estimates also indicate that prescription prevalence increased sharply from less than 1% of adults in 2019 to about 4 percent by 2024, representing several-fold growth in just five years. Among adults diagnosed with type 2 diabetes, historically the primary prescribing indication, GLP-1 medication use reached 26.5% in 2024. This is equivalent to nearly 7 million people, underscoring how quickly the GLP-1 agonist drug class has become integrated into standard metabolic care.

Demographic patterns suggest that providers—both medical and insurance—must balance clinical needs and access considerations. Utilization tends to be highest among adults aged 50–64 and among individuals with obesity or cardiometabolic conditions, consistent with risk profiles targeted in clinical guidelines. Gender differences have emerged as well, with women reporting higher usage rates than men, particularly when weight management is the primary indication. Socioeconomic disparities are also emerging in the early data, although insurance coverage and affordability remain key determinants of access.

At the same time, real-world persistence remains a significant actuarial unknown.

Claims analyses consistently show substantial discontinuation rates, with approximately 36 to over 50% of patients discontinuing therapy within 12 months, with higher rates among individuals using GLP-1 medications primarily for obesity rather than diabetes. Some estimates suggest discontinuation may reach 50 to 75% within the first year, depending on patient

population and cost-sharing exposure. Integrated claims research by Prime Therapeutics found that while one-year persistence for weight-loss-indicated GLP-1s improved to roughly 63% by 2024—likely due to resolving drug shortages—long-term persistence remains a hurdle, with only about 1 in 12 patients remaining on therapy at the three-year mark. These persistence patterns reflect a combination of factors, including side effects, cost barriers, and the chronic nature of obesity treatment, and have important implications for projecting long-term cost offsets and population health outcomes.

For actuaries, these early utilization and discontinuation trends highlight both the scale of the GLP-1 medication adoption and the uncertainty surrounding its long-term financial and health impact. While adoption rates continue to rise rapidly, sustained treatment—and the degree to which it translates into measurable reductions in downstream medical costs—remains a critical area for ongoing study in both the health and life arenas.

Early Signals and Limits in Health Actuaries' Data

GLP-1 medications pose a familiar yet unusually complex challenge for health actuaries: a high-cost innovation with promising long-term clinical benefits, but limited actuarial credibility in the near term. Unlike traditional medical trend drivers, such as hospital price increases or incremental pharmaceutical innovations, GLP-1 agonists combine rapid uptake, significant per-patient costs, and uncertain long-term offsets. Actuaries are closely monitoring early claims data knowing that it only offers a partial picture of eventual impact.

Ben Rayburn, a senior principal actuary at Mercer and chairperson of the Academy's Health Practice Council's Active Benefits Committee, works extensively with employer-sponsored health plans and explained that the employer perspective is largely shaped by time horizon. "In the health space, every year is a new decision," he said. While GLP-1 therapies may reduce long-term risks of cardiovascular disease, diabetes complications, and disability, those benefits often accrue over



decades—well beyond the timeframe relevant to most employer plan sponsors.

Mick Diede, chairperson of the Academy's Health Practice Council's Health Care Delivery Committee, added that most health coverage decisions operate on a 12-month cycle. Even if actuaries model longer-term outcomes, annual premiums, contracts, and regulatory requirements often dictate how coverage is evaluated. As a result, GLP-1 medications are currently seen primarily as a cost increase rather than a cost offset in employer-sponsored plans. "To the employer, it's paternal to give that benefit," Rayburn said, noting that competitive benchmarking often outweighs actuarially demonstrated return on investment. High employee turnover further limits visibility into long-term effects. "People turn over every five to 10 years," Rayburn said. "That's another reason they're not going to see the long-term effects."

Diede agreed that, at current prices, the economics are difficult to justify purely on cost savings. "At current U.S. prices, use of GLP-1s for treatment of overweight or obese patients absent other conditions is almost certainly a net cost driver," he said. "In the short term there is no doubt that this is a cost increase."

The immediate "cost tsunami" associated with widespread uptake currently dwarfs measurable savings, even if clinical benefits may eventually emerge.

From a claims trend perspective, the impact of GLP-1 adoption is already noticeable. Prescription drug trend rates are diverging significantly between plans that cover GLP-1 therapies and those that do not. "Actuaries have two different trends," Rayburn explained. "One if your prescription drug includes GLP-1 coverage and one if it doesn't. The difference can be very meaningful—several percentage points higher for the Rx trend." In some cases, overall prescription drug trend may jump by as much as 15% when GLP-1 medications are included, making them a dominant contributor to pharmacy cost growth.

At the same time, actuaries face considerable uncertainty in projecting future costs, due in part to evolving utilization patterns and the complex dynamics of pharmaceutical pricing. Pharmacy benefit managers (PBMs) and manufacturers negotiate rebates that depend heavily on formulary positioning and utilization controls. "Manufacturers will give different rebates for different levels of controls," Rayburn said. Plans that impose stricter eligibility requirements, such as higher

body mass index (BMI) thresholds or more restrictive prior authorization, may limit utilization but receive less generous rebates, increasing the net cost per prescription. Conversely, broader access may increase total utilization while lowering net cost per unit. This creates a delicate balance among access, affordability, and overall spending.

Beyond pricing and utilization, Diede highlighted a broader set of uncertainties that actuaries must incorporate into long-term projections. These include potential future price changes, innovations that could improve long-term adherence, and the possibility that scientific understanding of treatment duration may evolve. "There are still open questions about whether these drugs truly need to be taken for life," he said.

Additional uncertainty comes from the possibility of new therapies or weight-management innovations entering the market, as well as the potential for longer-term side effects that have not yet emerged in real-world populations. Direct-to-consumer availability and alternative access pathways add further complexity. Patients who do not qualify under plan criteria, or whose plans exclude GLP-1 coverage entirely, may obtain medications outside traditional insurance channels, sometimes using manufacturer coupons or compounded formulations. These pathways may reduce insurer spending in the short term while increasing overall population utilization, making actuarial forecasts of future demand more complicated.

Despite the rapid adoption and growing claims experience, actuaries remain cautious about drawing conclusions from early data. "We don't see any medical savings yet because of the short-time horizon," Rayburn said. This reflects both the relatively recent introduction of GLP-1 medications for obesity treatment and the time required



Tracking Costs and Coverage

GLP-1 medications are already influencing health plan spending and coverage decisions.

- **Near-term cost driver:** Prescription drug trend can rise several percentage points for plans that cover GLP-1s.
- **Coverage varies:** Access differs by federal, state, and employer plan; inequities may emerge.
- **Utilization controls matter:** Step therapy, prior authorization, and BMI thresholds affect total spend.
- **Persistence is key:** Roughly 36%–50% of patients discontinue within 12 months, affecting long-term cost projections.

for weight loss to translate into reduced incidence of chronic disease complications.

Diede echoed this view. “No,” he said when asked whether meaningful cost offsets are visible yet. “The short-term cost tsunami easily dwarfs any savings,” adding that attributing improvements to a specific therapy is inherently difficult outside controlled clinical trials. Consulting actuaries in particular must balance long-term uncertainty with immediate forecasting needs.

Rayburn described a planning process that relies heavily on ongoing dialogue with PBMs and carriers. “We inquire the heck out of things,” he said, referring to efforts to understand drivers of utilization, pricing changes, and projected trend. This collaboration helps reduce the risk of unexpected cost increases and allows actuaries to incorporate emerging experience into short-term projections.

Coverage decisions themselves also reflect a complex set of institutional dynamics. Diede said public discussions sometimes overplay the role of insurers in determining access to GLP-1 medications. In reality, he explained, coverage policies are often shaped by other stakeholders. “Coverage decisions are largely driven by the federal government for Medicare, state governments for Medicaid, and the ACA individual market, and plan sponsors for self-funded commercial groups,” he said. Health insurers therefore have relatively limited discretion in many segments of the market.

Where plans can exercise influence—particularly in commercial coverage—they often focus on how GLP-1 medications fit within a broader set of weight-management interventions, including lifestyle counseling, dietary programs, and bariatric surgery. These decisions frequently manifest through step therapy requirements or prior authorization policies, which can become points of friction between patients, physicians, and insurers.

New formulations and pipeline developments may further influence utilization patterns. Oral GLP-1 therapies, for example, lower the barrier to initiation for some patients and may expand the eligible population. At the same time, competition among manufacturers and the eventual introduction of new drug classes, including combination and multi-agonist therapies, may affect both pricing and clinical outcomes. These developments introduce additional uncertainty into actuarial projections, underscoring the importance of continuous monitoring.

Equity and access considerations also remain central. Coverage varies widely across commercial plans, Medicaid programs, and other payers, creating disparities in access. “Equity is probably going to become more of a challenge,” Rayburn observed, noting that coverage decisions differ across states and employer plans. Individuals without insurance coverage may still obtain GLP-1 medications through direct-purchase channels, but cost remains a barrier for many.

Ultimately, health actuaries are navigating a transitional landscape in which utilization is expanding rapidly, costs are rising, and long-term benefits remain largely unobserved in real-world data. While clinical evidence suggests substantial potential for improving population health, actuarial modeling must contend with limited historical experience, evolving prescribing patterns, and complex behavioral and economic factors.

For now, GLP-1 medications represent a clear near-term cost driver for health plans, accompanied by the possibility—but not yet the actuarial certainty—of long-term cost savings. As Rayburn summarized, coverage decisions today are driven less by demonstrated financial return than by strategic considerations and competitive positioning. “GLP-1s are very benefit-oriented—people want them, and competitors are offering them—but we don’t yet have enough data to substantiate long-term savings.”

Understanding Uncertainty

Even with strong clinical results, real-world outcomes remain uncertain.

- **Limited historical data:** Short-term claims experience may not reflect long-term savings.
- **Behavior affects outcomes:** Adherence, discontinuation, and lifestyle changes shape eventual impact.
- **Strategic pressures:** Coverage decisions often reflect competitiveness and employee demand rather than immediate ROI.
- **Ongoing monitoring:** Track utilization, rebates, and formulary adjustments to refine assumptions over time.

Life Insurance and Mortality Implications

While health actuaries are grappling with the immediate cost implications of GLP-1 medications, life actuaries are focused on a different question: whether the drugs will ultimately translate into measurable improvements in mortality. From a life insurance standpoint, the key issue is whether weight loss and metabolic improvements translate into sustained reductions in long-term mortality risk.

Kimberly Pouloupoulos, head of Mortality Innovation & Transformation and senior vice president at Swiss Re, noted that GLP-1 drugs are unlikely to immediately change actuarial assumptions. “Pricing and reserving assumptions are set holistically,” she said. “GLP-1 drugs are one factor among many, not a standalone driver.” Mortality projections already incorporate general improvement trends reflecting ongoing medical, technological, and societal advances.

Richard Bellomo, actuarial risk manager at Lincoln Financial, described a similar framework for evaluating emerging medical innovations. “As an actuarial risk manager, I look at potential medical advancements such as GLP-1 drugs through a three-question lens,” he said. “Are they clinically effective? Can adoption reach a critical mass? And if those conditions are met, can they move the needle on something actuarially relevant?” While uncertainties remain, Bellomo said the emerging evidence increasingly points toward affirmative answers.

For GLP-1 therapies to materially affect mortality assumptions, both actuaries emphasize that insurers will need clear, long-term evidence that improvements in metabolic health translate into durable reductions in mortality across populations. “Robust evidence of that kind will take years to emerge and confirm,” Pouloupoulos said, meaning any adjustments to mortality assumptions would likely occur

Mortality Implications

Life actuaries are focused on whether GLP-1 drugs will measurably affect long-term mortality.

- **Long-term evidence needed:** Durable reductions in mortality will take years to confirm.
- **Gradual assumption changes:** Adjust mortality assumptions slowly as real-world outcomes emerge.
- **Primary impact through cardiometabolic improvements:** Most mortality benefit is expected from reductions in cardiovascular disease.
- **Portfolio implications:** Better health could reduce life insurance claims but increase demand for annuity products.

Underwriting and Selection Risks

GLP-1 therapies introduce new considerations for underwriting and selection risk.

- **Beyond BMI:** Consider metabolic health, historical weight, and GLP-1 usage rather than just current BMI.
- **Behavioral dynamics:** Discontinuation, adherence, and policy lapse patterns influence long-term mortality outcomes.
- **Hidden selection risk:** Uneven access and persistence may create unexpected portfolio effects.
- **Considerations:** Update disclosure questions and underwriting practices to better capture policyholder health trajectories.

gradually rather than abruptly. Bellomo likewise noted that long-term real-world outcomes—including adherence, discontinuation rates, and sustained lifestyle changes—will ultimately determine whether the drugs produce meaningful improvements in population-level mortality.

The clinical potential is significant. GLP-1 drugs have demonstrated benefits across a range of obesity-related conditions, including improved glycemic control, cardiovascular outcomes, liver disease, and obstructive sleep apnea. Emerging clinical evidence, including cardiovascular outcome studies such as the SELECT trial, suggests the therapies may reduce major cardiac events. If those benefits prove durable, Bellomo noted that mortality improvements would likely arise primarily through reductions in cardiovascular disease, with smaller contributions from other obesity-related conditions.

For life insurers, the drugs also introduce new underwriting questions. Rapid weight changes associated with starting or stopping GLP-1 treatment challenge traditional risk metrics such as body mass index. “This reinforces the importance of looking beyond a single point-in-time measure,” Pouloupoulos said, noting that underwriters increasingly consider broader indicators of metabolic health and weight history rather than current BMI alone.

Bellomo emphasized the importance of capturing both medication use and behavioral commitment to long-term health improvements. “Underwriting practices can evolve to ensure risks remain accurately priced,” he said, adding that assessing historical weight patterns and drug use—along with well-designed disclosure questions—can provide a clearer picture of policyholder health trajectories.

Disclosure and behavioral dynamics may further complicate underwriting. Many insurance applications rely on general medication questions that may not reliably

capture GLP-1 use, potentially affecting risk assessment. Meanwhile, treatment persistence and weight regain following discontinuation remain important uncertainties. As Pouloupoulos observed, “Behavior, not just biology, will determine long-term mortality outcomes.”

Even if GLP-1 therapies ultimately improve population health, their impact on insured portfolios may be more modest than headline projections suggest. Insured populations typically have lower obesity prevalence than the general public, limiting the scale of potential mortality improvement. Differences in access, treatment persistence, and policyholder behavior, including lapse and re-entry patterns, could also introduce new forms of selection risk. Bellomo noted that these dynamics may affect insurers in multiple ways: Improved health could reduce life insurance claims, while longer lifespans may increase demand for retirement income products such as annuities.

For now, life actuaries are monitoring the emerging evidence closely. As Bellomo put it, “The evidence is approaching the threshold where practical planning should begin in earnest, even as we await data on sustained real-world outcomes.” GLP-1 medications may ultimately become an important driver of cardiometabolic health improvement, but translating clinical promise into measurable mortality experience will take years of real-world data.

What Actuaries Should Watch

If nothing else, the rise of GLP1 medications has made one thing clear: These drugs are neither a panacea nor a passing trend. They represent a lasting shift in cardiometabolic care, with actuarial implications that will unfold over years. They’re also reshaping conversations across health and life insurance, even as many of the long-term answers remain just out of reach. In the near term, they are a clear cost driver; over the long term, their value depends on persistence, clinical durability, and whether real-world outcomes mirror trial results.

Medicare coverage debates will be pivotal. If obesity indications receive broader federal coverage, expect step-changes in utilization, rebate dynamics, and formulary strategy across markets tied to Medicare benchmarks. Conversely, continued limits will sustain uneven access and redirect demand through commercial plans, direct-purchase channels, and compounded alternatives—each with distinct trend implications.

The reframing of obesity as a chronic disease—rather than a lifestyle condition—continues to shape coverage policy, underwriting, and benefit design. This shift supports integration with lifestyle and behavioral interventions, tiered eligibility, and

outcomes-based approaches, while putting pressure on legacy policies built solely around BMI. Equity and access remain central. Variation by payer, state, and employer plan design, combined with high discontinuation rates, risks widening health gaps. Actuaries should monitor differential uptake, adherence, and downstream outcomes across demographic and clinical segments to avoid hidden selection effects.

Finally, the long-term public health implications on cardiovascular events, diabetes complications, disability, and mortality are all promising but not yet actuarially credible. Expect gradual, evidence-driven adjustments rather than abrupt assumption changes. Across sectors, actuaries share a common to-do list: track persistence and discontinuation patterns, watch for credible cost offsets, and gauge potential mortality impacts as evidence matures. Progress will require crosssector dialogue among actuaries, clinicians, PBMs, manufacturers, and policymakers to align coverage, clinical practice, and evidence generation—turning therapeutic promise into measurable, equitable value. ▲▲

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Health insurance rests on a simple, humane promise: When you get sick, your financial life shouldn't collapse before your body does. But the very system designed to protect people brings its own tension. Pooling resources to spread individual risk means balancing access with cost, making sure that everyone gets the care they need while avoiding waste, inefficiency, or misuse. Economists have a term for this: moral hazard.

Moral hazard in health insurance refers to the tendency for individuals to consume more medical care—or to take fewer preventive steps—because insurance shields them from the full cost. The phenomenon typically arises from psychology: When someone else is footing the bill, it's easier to say yes to tests, treatments, consultations, or ER visits that feel reassuring even if they're not strictly necessary. Similarly, when out-of-pocket costs are low, it's tempting to delay preventive care. The ripple effects of these choices impact health care systems daily.

Economists distinguish between two primary forms. “Ex-ante” moral hazard emerges before illness: People engage less diligently in health maintenance, knowing that insurance will cushion the consequences. This form is subtle—few individuals consciously think, “I’ll skip my blood pressure meds; insurance will fix me later.” Instead, insurance reduces the sense of urgency, lowering the perceived personal cost of neglect.¹ “Ex-post” moral hazard occurs after illness has developed, when insurance lowers the out-of-pocket price of care and thereby influences utilization decisions. Once sick, insured individuals may be more likely to use additional or higher-intensity medical services—such as diagnostic imaging, emergency care, or specialist visits—because insurance shields them from the full financial cost.² Providers can play a role, too, by ordering extra tests or procedures out of caution, habit, reimbursement structures, or fear of litigation.

Structural Inefficiencies

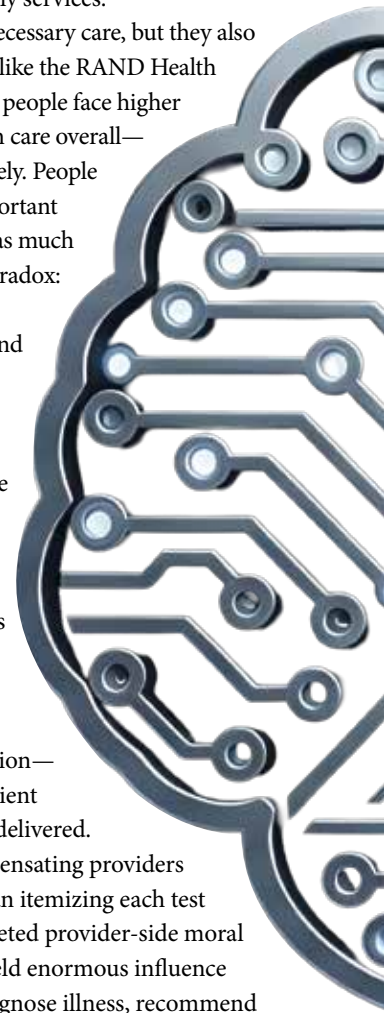
Long before artificial intelligence (AI) entered health care, insurers were already grappling with these inherent inefficiencies. Their early solutions focused on making patients share some of the cost. Deductibles, copayments, and coinsurance are classic examples. By requiring patients to pay the first portion of health care expenses themselves, deductibles discourage unnecessary early-year spending. Copays add friction to each

visit or prescription, reminding patients that resources are finite. Coinsurance—covering a percentage of medical costs—keeps patients mindful of price, even for costly services.

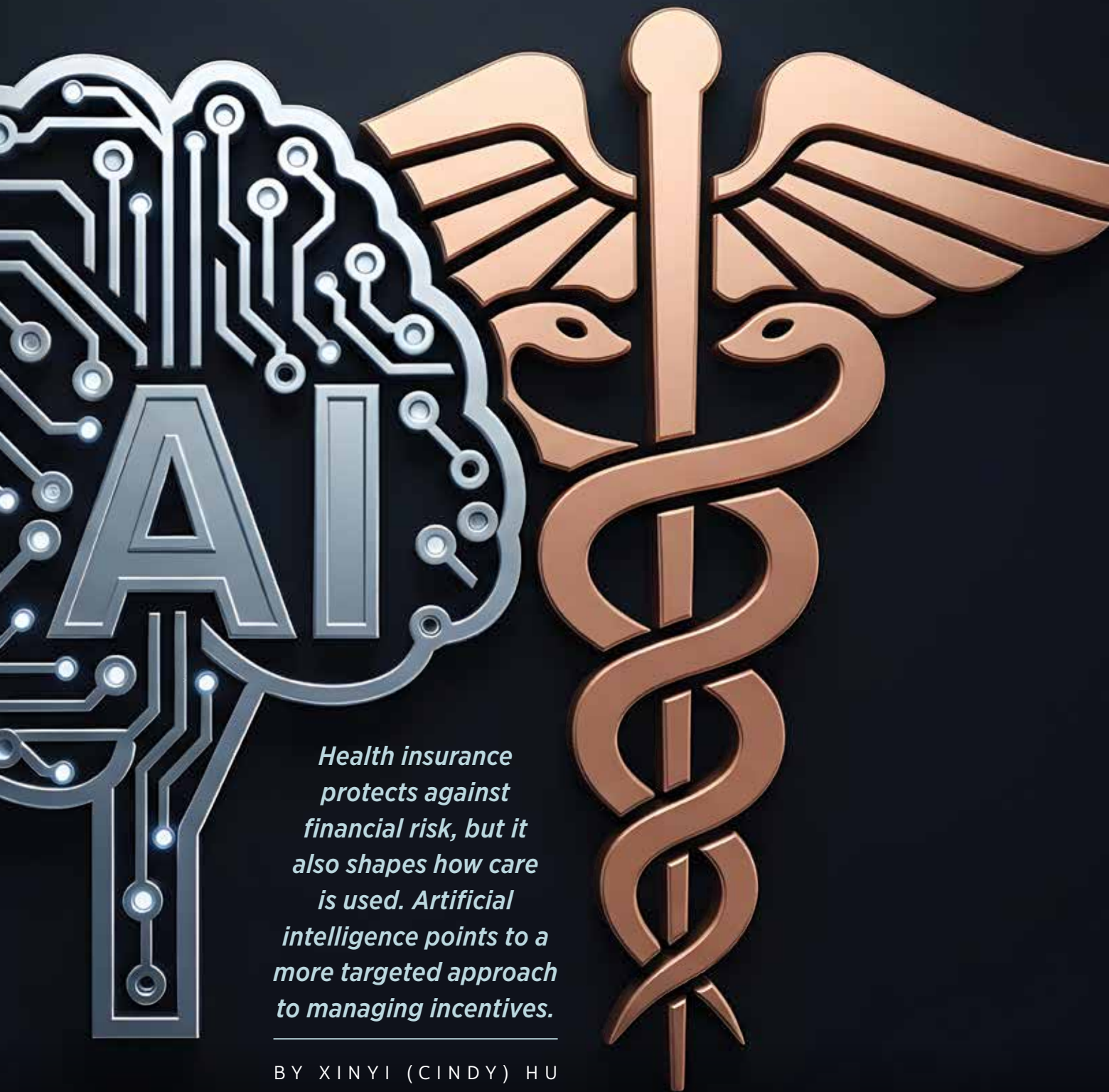
These methods reduce not just unnecessary care, but they also discourage necessary care, too. Studies like the RAND Health Insurance Experiment show that when people face higher out-of-pocket costs, they use less health care overall—but the reduction occurs indiscriminately. People skip unnecessary doctor visits and important ones alike. Preventive services fall just as much as redundant services. This creates a paradox: Moral hazard goes down, but so does health, especially among low-income and chronically ill individuals.

Realizing that cost-sharing alone could not solve the system's deeper structural inefficiencies, insurers in the 1980s and 1990s began to experiment with managed care. They created narrower networks, established primary care physicians as gatekeepers to specialists, and tested new payment models aimed at curbing overuse. Instead of paying providers for every service, some insurers adopted capitation—paying doctors a fixed amount per patient regardless of how many services they delivered. Others used bundled payments, compensating providers for an entire episode of care rather than itemizing each test and procedure. These approaches targeted provider-side moral hazard, recognizing that clinicians wield enormous influence over health spending because they diagnose illness, recommend treatments, and determine which services patients ultimately receive—or forgo.³

Yet, for many people, managed care became synonymous with restriction.⁴ Utilization reviews and prior authorization processes, meant to prevent unnecessary spending, often delayed critical treatments and buried physicians in administrative tasks.⁵ Patients felt uncertain about whether care would be approved, and physicians felt that insurers were second-guessing their clinical judgment.⁶ While these mechanisms did reduce some waste, they also created friction that left patients, providers, and insurers frustrated.



AI and the Moral Hazard



Health insurance protects against financial risk, but it also shapes how care is used. Artificial intelligence points to a more targeted approach to managing incentives.

BY XINYI (CINDY) HU

Problem in Health Insurance

AI's Potential to Shape Health Care Use

AI now offers the potential to transform how insurers approach this longstanding dilemma. Instead of restricting or imposing financial burdens on patients, AI can reshape the system through precision, prediction, personalization, and prevention,⁷ impacting nearly every aspect of health care utilization.

One of AI's most accessible and immediate contributions lies in triage.⁸ Many unnecessary health care encounters stem from uncertainty: People aren't always sure whether their symptoms are serious, whether they need a doctor, or whether a late-night ER visit is warranted. AI-powered symptom checkers and triage tools are beginning to fill this gap, offering real-time guidance that directs individuals to the appropriate level of care. These tools can recognize patterns across millions of examples, providing a level of statistical sophistication that no human nurse hotline could match.⁹ AI can reduce the ex-post moral hazard by directing people away from high-cost settings when unnecessary—and toward appropriate care when needed.

Predictive analytics takes this even further.¹⁰ AI can analyze vast datasets to identify individuals likely to overuse certain services or underuse others. For example, it might detect patterns suggesting someone is prone to unnecessary ER visits or at risk of missing essential preventive screenings. Insurers can use these insights to intervene early, offering personalized reminders, targeted benefits, or care management support. AI can help insurers to anticipate poor choices and gently guide patients toward better decisions.

AI's Potential to Reduce Waste

Fraud, waste, and abuse have long challenged health care systems.¹¹ Traditional rule-based detection systems tend to catch only the most obvious

AI can analyze vast datasets to identify individuals likely to overuse certain services or underuse others. Insurers can use these insights to intervene early, offering personalized reminders, targeted benefits, or care management support. AI can help insurers to anticipate poor choices and gently guide patients toward better decisions.

abuses—patterns defined in advance by analysts and compliance teams—while missing more subtle or evolving schemes.¹² AI, however, is exceptionally good at identifying anomalies in large datasets. It can detect unusual billing patterns, phantom claims, suspicious prescriptions, and clusters of behavior indicative of coordinated exploitation. By targeting the financial incentives that enable abusive patterns, AI indirectly reduces a significant portion of systemic moral hazard.

On the clinical front, AI-powered decision support systems help clinicians avoid unnecessary care by providing evidence-based guidance at the point of service.¹³ These tools, embedded within electronic health records, can flag duplicative imaging orders, highlight more cost-effective medication options, or identify deviations from clinical guidelines. Unlike traditional prior authorization systems—which often require lengthy paperwork and insurer approval—AI decision support for clinicians is immediate, integrated, and advisory.

Personalization, Prevention, and the Future of Incentives

Perhaps AI's most transformative promise is its ability to personalize

incentives. Traditional cost-sharing structures assume that all patients respond similarly to financial incentives, but real-world behavior is far more complex. AI can analyze individual health behaviors, risk profiles, and usage patterns to design cost-sharing frameworks tailored to each patient. For example, a patient with a chronic condition might receive lower cost-sharing for preventive visits, medication refills, or monitoring devices that reduce the likelihood of complications. Meanwhile, another individual who tends to overuse low-value services might see more targeted cost-sharing for those services, rather than uniformly higher out-of-pocket fees. This degree of personalization shifts incentives from punitive to supportive and rational.

Wearables and remote monitoring technologies, combined with AI, introduce an entirely new approach to address ex-ante moral hazard.¹⁴ Devices that track heart rate, sleep patterns, blood pressure, glucose, and physical activity generate continuous streams of data. AI can interpret these trends, detect early warnings, and trigger interventions before costly complications arise. Insurers can encourage participation

through incentives, rewards, or reduced premiums. Patients gain greater self-awareness, and insurers benefit from reduced long-term costs.

AI can also bring greater transparency to health care. In a system where costs are opaque and quality can be hard to assess,¹⁵ AI-driven tools can help patients understand the financial implications of their choices. Algorithms can compare hospitals or clinics based on cost and outcomes, predict out-of-pocket expenses in real time, and suggest alternatives when a chosen treatment is clinically equivalent to a cheaper option. With clearer information, patients make more cost-conscious decisions—not because they are forced to, but because they finally understand how.

Care coordination represents a persistent challenge in health care delivery—one that aligns closely with AI's strengths.¹⁶ Fragmented records, disconnected providers, and redundant testing often result not from intentional overuse but from poor communication across the system. AI can bridge these gaps by integrating data across providers, flagging inconsistencies, and ensuring clinicians share accurate, up-to-date information. This reduces waste at a structural level—without the friction that traditional utilization controls introduce.

Ethical Dilemmas

Yet the rise of AI also introduces ethical complexities. Privacy concerns are key when intimate health data is analyzed continuously. Algorithmic bias could reinforce or worsen inequities if left unchecked.¹⁷ Some worry that AI “nudges” might become paternalistic or manipulative, raising questions of patient autonomy.¹⁸ Clinicians, already managing digital overload, may view AI tools as yet another layer of intrusion unless they are thoughtfully designed.¹⁹

Despite these challenges, AI has a potential to improve how we manage moral hazard. Instead of asking patients to pay more, it helps them understand better. Instead of questioning doctors after the fact, it can support them in the moment. Instead of treating everyone the same, it adapts to individual needs.

And perhaps the most fitting anecdote comes from a veteran actuary who once quipped, “Trying to manage moral hazard without good data is like trying to find your glasses without your glasses.” AI, in many ways, is that missing pair—a way to finally see clearly the patterns, behaviors, and opportunities that have long shaped the uneasy dance among risk, responsibility, and care. ▲

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How Insurance Helped Shape America

BY JAMES LYNCH



Editor's Note: This article is the first in a two-part series marking America's 250th anniversary. It explores the key legal, technological, and political turning points that shaped the early development of the American insurance system. Part II will examine how modern innovations transformed the profession and the management of risk.

As the United States celebrates its 250th birthday, key legal decisions, technological breakthroughs, and political battles reveal how insurance evolved alongside the nation itself.

The United States is celebrating its 250th birthday this July, and insurance has shaped—and been shaped by—the nation's economic, political, and technological evolution.

In this two-part series, we highlight some turning points in the history of insurance in the United States. It's not meant to be a comprehensive history; we're highlighting moments that, as an underwriter might say, serve as proximate cause—the “but for” moments that triggered a chain of events leading to some aspect of modern insurance.

We talk about the lawsuit that codified state regulation; the moment the United States almost plunged into universal health insurance; the legislation signed by former President Theodore Roosevelt that made some sort of pension implicit in the social contract; and the technological and product innovations that turned actuarial science from mathematical arcana into an operational necessity for insurers.

We've also tried to cover the practice areas that are the focus of the American Academy of Actuaries: health, life, casualty, retirement, and risk management.

You might notice that most of the events discussed here occur after about 1900. That's not because insurance didn't exist before that. You can find risk management concepts going back to the Code of Hammurabi of nearly four millennia ago (which describes marine loans that were canceled if the ship sank) and the Old Testament (Joseph's grain-storage strategy would sound very much like modern risk management).

Insurance companies were a critical part of the War for Independence. Historian Hannah Farber argues that revolutionary-era marine insurers were essential to building the early nation.¹ Good marine underwriters had to understand the political risks in the ports where their insureds docked, and they shared this information with the Founding Fathers. They helped negotiate foreign loans and sell state debt, and they invested capital in federal debt and American businesses.

Farber's book focuses on America's first 50 years, but insurers never stopped doing much of what she described: protecting first financial assets like ships and buildings, later lives and longevity, and investing in the promise of a growing republic.

We don't focus much on those early moments. For the first 125 years of the Republic, insurance and risk management were establishing themselves through a series of firsts—the first fire insurer, the first actuary, the first state insurance department, and more. We've listed those in a separate timeline (see "Firsts in the Actuarial World" below).

Instead, we zoom in on pivotal moments that helped make insurance and risk management into the critical industries they are today.

Part I looks at several foundational developments that shaped modern insurance practice. In Part II, in the next issue of *Contingencies*, we will explore later turning points that transformed the profession in the late 20th century and beyond.

Insurance Is "Not Commerce" (1869)

The Constitution gives Congress the power "to regulate Commerce with foreign Nations, and among the several States...."

What that meant when the Constitution was written—specifically the word *commerce*—has given American insurance its unique regulatory structure.

The Oxford English Dictionary will tell you that the "-merc-" in the word *commerce* refers to merchandise—which would make the Commerce Clause of the U.S. Constitution apply only

to the physical exchange of goods: "Here's some money; where is my stuff?"

Courts slowly embraced the idea that commerce could involve services, too. For example, the Supreme Court ruled in 1824 (*Gibbons v. Ogden*) that commerce included steamboat travel across state lines: ² "Here's some money; take me to New Jersey."

But what about a person in one state buying fire insurance from a company in another state? "Here's a little bit of money; give me a lot of money if my building burns." Is that commerce? No goods change hands, and no explicit service is performed.

States were the first insurance regulators, and they often treated in-state companies better than out-of-state and international insurers.³ Virginia, for example, passed a law in 1866 requiring non-Virginia insurers to deposit a bond with the state Treasurer—between \$30,000 and \$50,000.

New York insurers believed this was unconstitutional. First, it seemed to violate the Privileges and Immunities Clause, which prevents one state from discriminating against the residents of another state. Second, it seemed to regulate interstate commerce, which was Congress' job.

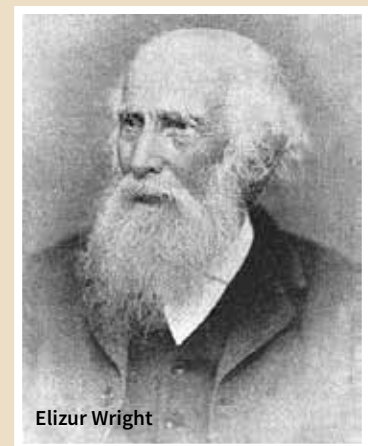
They created a test case. Virginian Samuel Paul applied to be an agent but didn't post the required bond. The state denied his application; he sold a policy anyway. He was fined \$50.

Firsts in the Actuarial World

Key milestones and trailblazers that marked some of the firsts in American actuarial history:

- **1735:** In South Carolina, The Friendly Society becomes the first insurer established in the American colonies. It goes out of business by 1740.
- **1752:** The Philadelphia Contributionship for the Insurance of Houses from Loss by Fire, the oldest carrier continuously operating in the United States, is established.
- **1759:** The Presbyterian Ministers' Fund, the first life insurer in the American colonies, is founded.
- **1804:** Nathaniel Bowditch becomes the first person in the United States to hold the title of actuary.

- **1809:** Jacob Shoemaker becomes the first practicing company actuary.
- **1858:** Actuary Elizur Wright of Massachusetts becomes the first state insurance commissioner.



- **1871:** The National Association of Insurance Commissioners (NAIC) is founded.



- **1889:** The Actuarial Society of America is founded.

His appeal reached the Supreme Court.

- **Ruling 1:** The insurers were corporations, and corporations were not people. A state could discriminate against out-of-state corporations.⁴
- **Ruling 2:** “Issuing a policy of insurance is not a transaction of commerce.” The buyer isn’t getting merchandise or a steamboat trip. They are entering into a contract that is absent goods or services. Insurance policies, the court said, “are like other personal contracts between parties which are completed by their signature and the transfer of consideration.”⁵

Conclusion: Insurance was not commerce, and therefore not subject to federal regulation.

From this ruling, insurance’s unique, complex regulatory environment grew. States regulate insurance, and the National Association of Insurance Commissioners coordinates those efforts. The federal government plays a minimal role.

The system might seem cumbersome, but it eventually became revered. When the Supreme Court partially reversed *Paul* in 1944 and thrust the regulatory structure into peril, Congress acted quickly. In just two months, as the final battles of World War II raged, the McCarran-Ferguson Act was passed “to preserve to the states the power to regulate but to compel them to regulate more adequately.”⁶

President Franklin D. Roosevelt signed the bill on March 9, 1945. He died five weeks later.

The decision in *Paul v. Virginia* cemented a regulatory structure that still defines the American insurance industry today. But regulation alone did not determine the future of insurance. Equally important were innovations that transformed how risk itself could be measured and analyzed.

One of the most consequential of those innovations emerged from an unlikely place: the U.S. Census.

Punch Cards and the Rise of Insurance Data (1889)

The mathematical theory of life insurance was worked out well before data collection was good enough to make life tables reliable.

There were tables going back to Roman times (Ulpian’s table from the third century C.E.), and in 1693 Edmond Halley—the comet guy—published a mortality table based on records from Breslau, Silesia (now Wroclaw, Poland).

There were early American attempts. The Wigglesworth table, published in 1789, drew on records from 10 towns in New Hampshire and Massachusetts. In 1814, the Pennsylvania Company for Insurances on Lives and Granting Annuities—the first U.S. company organized solely to issue life insurance policies and annuities—published a mortality table based on

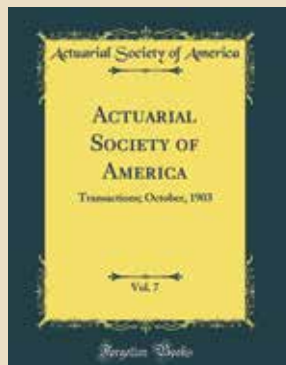


A diploma issued by the American Institute of Actuaries

- **1895:** Emma Warren Cushman becomes the first woman member of the Actuarial Society of America.
- **1905:** New York’s Armstrong investigation reveals sordid and corrupt insurance practices, leading to collective rate-setting and greater protections for life insurance policyholders.
- **1909:** The American Institute of Actuaries is founded.
- **1911:** 146 people, mostly young women, die in NYC’s Triangle Shirtwaist Factory fire,

which becomes the catalyst for establishment of workers’ compensation across the United States.

- **1914:** The Casualty Actuarial Society is founded.
- **1914:** In *German Alliance Insurance Company v. Lewis*, the Supreme Court rules that states may regulate insurance rates.



Actuarial Society of America, Vol. 7: Transactions; October, 1903 (Classic Reprint)

- **1930:** Esther Tibbs becomes the first Black actuary.
- **1949:** The Actuarial Society of America and the American Institute of Actuaries combine to form the Society of Actuaries.
- **1965:** The American Academy of Actuaries is founded.
- **1968:** The NAIC requires that life company annual statements be signed by a qualified actuary.
- **1971:** The *Borel v. Fibreboard* decision triggers tens of billions of dollars of asbestos losses.
- **1975:** Life actuaries signing annual statements are required to render an opinion.
- **2017:** Principles-based reserving standards are implemented.



SOURCES: AMERICAN ACADEMY OF ACTUARIES; CASUALTY ACTUARIAL SOCIETY; INSURANCE INFORMATION INSTITUTE; TEXAS STATE HISTORICAL ASSOCIATION; NATIONAL ASSOCIATION OF INSURANCE COMMISSIONERS; SOCIETY OF ACTUARIES; AND “TRIANGLE: THE FIRE THAT CHANGED AMERICA,” BY DAVID VON DREHLE.

records from the Episcopal Church and the local Board of Health. The company built on earlier American insurance traditions, including the Presbyterian Ministers' Fund, founded in 1759 as the first life insurer in the colonies.⁷

Before 1850, though, American insurers mainly relied on an 1816 table taken from records in the British town of Carlisle.⁸ They would tweak these based on local data, but more often rates were adjusted for competitive reasons.⁹

Data collection was laborious and inconsistent through most of the 19th century. In 1880, for example, U.S. Census workers traveled across the country on horseback to collect information that took 7½ years to publish.

Census worker Herman Hollerith witnessed that inefficiency firsthand. A decade later, the Census used his new system—a machine reading punch cards—to cut processing time by two-thirds. The government saved \$5 million.¹⁰

Hollerith didn't invent the punch card: The Jacquard loom used punch cards to weave complicated images into cloth. Hollerith, inspired by a train conductor punching tickets, made the punch card the backbone of data collection.

In 1890, census data was punched onto 60 million cards, one per person. They were fed manually into Hollerith's tabulation machines, which were adorned with rows of clock-face dials that registered how many times a particular hole was punched. The process was "at least ten times faster than manual methods."¹¹

The system had a side benefit, crucial to insurers: It was now easy to calculate cross-tabulations. A separate sorting machine recorded how many times certain hole combinations appeared. So the Census told you not only how many people lived in the United States, but also how many were, say, married farmers over 40 years old.

Actuaries immediately saw the value. In 1890, 25 members of the Actuarial Society of America saw a demonstration—the beginning of what business historian JoAnne Yates called "a decades-long interaction between the punched-card tabulating industry and the life insurance industry."¹²

In 1910, the Actuarial Society of America and the Association of Life Insurance Medical Directors used Hollerith's technology to create life tables. It wasn't the first multi-company study, but because Hollerith's system was near ubiquitous by then, it was easy to submit data.

It was also easy to verify accuracy. Companies submitted two sets of cards, and data checkers would hold a card from each set up to the light and look for holes.

The market for punch-card systems grew. Competitors emerged, primarily J. Royden Peirce and James Powers. All sought to gain prominence with insurers, which of course were enormous organizations with enormous data needs.



A woman operates a Hollerith pantograph punch, using its keyboard to create population cards for the 1940 U.S. Census.

The Powers Accounting Machine Company eventually became a division of data-processing giant Remington Rand Inc. Hollerith hired Peirce, and his company became the core of IBM.

The technology made large-scale statistical analysis practical for insurers. For the first time, massive datasets could be processed systematically, allowing actuaries to refine mortality tables and improve pricing accuracy.

Yet while technology was making insurance more scientific, political forces were simultaneously reshaping debates about who should bear risk in society.

The Push for Universal Health Insurance (1916)

Caught up in the tidal wave of Progressive-era social insurance movements, the American Medical Association (AMA) may have brought the nation as close as it ever would come to government-sponsored universal health insurance.

As the world industrialized in the late 1800s, millions left farms to join the mechanized work force. Labor saving devices made them more productive—but at a horrid cost, with thousands maimed and killed.

In response, Germany in the 1880s created an umbrella of protections, including health insurance and workers compensation. Other nations followed.

In the United States, some workers had for decades gotten health insurance through their trade union, if they belonged to one. The tradition dates back to at least 1796, with the founding of the Mutual Assistant (sic) Society of Hair Dressers, Surgeon Barbers, Etc. (Healthy barbers would take on for free the work of sick brethren.)¹³

These evolved into a network of voluntary funds. They petered out by the 1950s, but in the early 1910s they remained viable.

The fervor behind the new social insurances was considerable. In 1912, former President Theodore Roosevelt ran on a universal health plan under the Bull Moose ticket.¹⁴

That same year, the American Association for Labor Legislation created a multiyear strategy to adopt universal health care state by state. Several states were immediately interested. New York's bill, introduced in 1916, drew the most attention.

It didn't pass, but something seemed likely to pass soon. The AMA worked with Progressives to tailor the bill's 1917 version.

One reason: money. Many doctors struggled financially, physicians in particular. Wealthier patients often used specialists, and physicians saw a large number of charity cases. An AMA council reported that barely 10% of physicians in 1913 "are able to earn a comfortable income." In a universal plan, the state would guarantee a steady income.

At the end of the year, the AMA's Social Insurance Committee endorsed compulsory, state-run insurance.

But the AMA was out of touch with its membership. Less than a year later, boards in several New York counties, including New York (Manhattan), Livingston, Monroe, and Erie, all formally objected.

Many doctors were convinced—with little evidence—the state-run insurer would cap their income at \$2,000. (Average annual income then was about \$1,200.) And by 1917, the United States was at war with Germany. All German things were, well, *verboten*, including universal health insurance.

Even as the AMA backed away—its formal vote occurred in 1920—support for the idea was collapsing.

Labor leader Samuel Gompers, for one, preferred having unions negotiate health benefits. California held a referendum in 1918. More than 70% voted against. In 1919, a survey of 13,000 factory workers in Utica, New York, found that only 1% favored the New York plan.

The New York Senate did pass a universal health insurance law that year. It was doomed. The leader of the state's other legislating house, the State Assembly, made sure it never came up for a vote.¹⁵

New York provided the movement its only (partial) victory. Writes historian John E. Murray: "Why a movement that was so successful in workmen's [sic] compensation and industrial safety failed so consistently with health insurance has puzzled observers ever since."

Turning Points

The moments described here represent a turning point in how the United States approached risk. The *Paul v. Virginia* decision defined who would regulate insurance. Hollerith's punch-card machines helped make actuarial science practical at scale. And the Progressive-era health insurance movement revealed how deeply insurance policy is intertwined with broader social debates.

In Part II, we move forward in time to explore how late-20th century innovations—from spreadsheets to retirement savings plans to enterprise risk management—transformed the actuarial profession and expanded its role in the modern economy. ▲

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2. "Meaning of Commerce | Constitution Annotated | Congress.Gov | Library of Congress," accessed March 25, 2026.
3. This acted as a barrier to entry and helps explain why European companies focused on reinsuring U.S. business until well into the 20th century.
4. After Paul broke the law (1866), but before the Supreme Court decision (1869), the 14th Amendment was adopted. It guaranteed that enslaved persons were citizens, and corporate lawyers quickly argued it also meant that corporations were people, too. The Supreme Court adopted that position in 1886 with *Santa Clara County vs. Southern Pacific Railroad Company* [118 U.S. 394].
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Global Trade

A large container ship is shown from a high-angle, top-down perspective, sailing across a dark blue ocean. The ship's deck is densely packed with colorful shipping containers in shades of red, orange, green, and blue. The ship's wake is visible as a white, frothy trail behind it. The background of the entire image is a collage of US dollar bills, including the faces of George Washington and Benjamin Franklin, floating as if on the water's surface.

How do global trade dynamics affect risk, investment, and insurance? This article uses the lens of comparative advantage and full employment to explore the economics of trade—and why it matters to actuaries.

By Carlos Fuentes

and Risk Under Full Employment

Editor's Note: This is the first in a two-part series exploring how global trade dynamics influence risk, investment, and insurance. A follow-up article will focus on trade under conditions of unemployment and tariffs, examining the resulting implications for risk and policy.



At least half of the popular fallacies about economics come from assuming that economic activity is a zero-sum game, in which what is gained by someone is lost by someone else. But transactions would not continue unless both sides gained, whether in international trade, employment, or renting an apartment.

—Thomas Sowell

International trade is best understood as the movement of goods, services, and capital across borders—a process that binds economies together and deepens global interdependence. At its foundation lies the principle of comparative advantage: Nations specialize in what they can produce most efficiently, exchanging those outputs for goods and services that would be costly or impractical to generate domestically. This specialization is not merely a technical arrangement; it is one of the engines of globalization, driving productivity gains, innovation, and the diffusion of prosperity.

The efficiency gains from trade are evident in the way countries align production with their strengths. Tropical economies channel resources into crops such as coffee or fruit, while technologically advanced nations export machinery and electronics. These exchanges create reciprocal benefits, broadening consumer choice and lowering costs, while raising living standards through access to a wider array of competitively priced goods. Trade also intensifies competition, compelling firms to innovate, improve quality, and expand into new markets. For developing economies, integration

Key Points

- Comparative advantage shapes specialization and mutual gains, even when absolute efficiencies differ.
- Production possibility curves highlight scarcity, opportunity cost, and resource trade-offs.
- Full employment maximizes output, but tight labor markets can drive scarcity, inflation, and productivity risks that affect actuarial assumptions.
- Terms of trade—set by global supply, demand, and efficiency—impact pricing, returns, and risk exposure.
- Actuaries can use these insights to model claims volatility, quantify macroeconomic risk, and stress-test portfolios.

into global commerce can serve as a pathway to industrialization, foreign investment, and long-term growth.

Yet the benefits of trade are tempered by its vulnerabilities. Disparities in economic power can foster exploitation or asymmetrical agreements. Tariffs, quotas, and other barriers disrupt flows of goods and services, often escalating into geopolitical friction. Heavy reliance on global supply chains exposes economies to shocks—whether natural disasters, pandemics, or political conflict—that reverberate far beyond national borders.

Underlying these dynamics are financial theories that explain how capital flows, exchange rates, and trade balances interact with risk management. For financial professionals, fluency in these concepts is essential. Actuaries, in particular, have a role to play in quantifying and mitigating the risks that arise from tariff-driven volatility. Such volatility can elevate claims costs, compress investment returns, and constrain diversification, with direct consequences for insurers and public finances. Inflation and unemployment—sometimes the byproducts of protectionist measures—further complicate actuarial assumptions, influencing discount rates, benefit indexing, and stress-testing frameworks.

This article draws on established economic theory, which explores international trade in two parts. First, it frames trade in the context of the production possibility curve, which provides the conceptual tool for later arguments. Second, it examines trade under conditions of full employment, drawing on the theory of comparative advantage. A subsequent article will broaden the discussion to encompass trade in the presence of unemployment and the strategic deployment of tariffs, highlighting how deviations from idealized assumptions shape trade policies.

Considerations on Unemployment Measuring Unemployment

Unemployment is quantified through large-scale surveys conducted by national statistical agencies such as the U.S. Bureau of Labor Statistics (BLS). The most familiar indicator—the unemployment

Unemployment is rarely considered desirable except by those who have not experienced it.

—John Kenneth Galbraith



rate—measures the share of the labor force that is actively seeking work but remains without employment. Formally, it is expressed as:

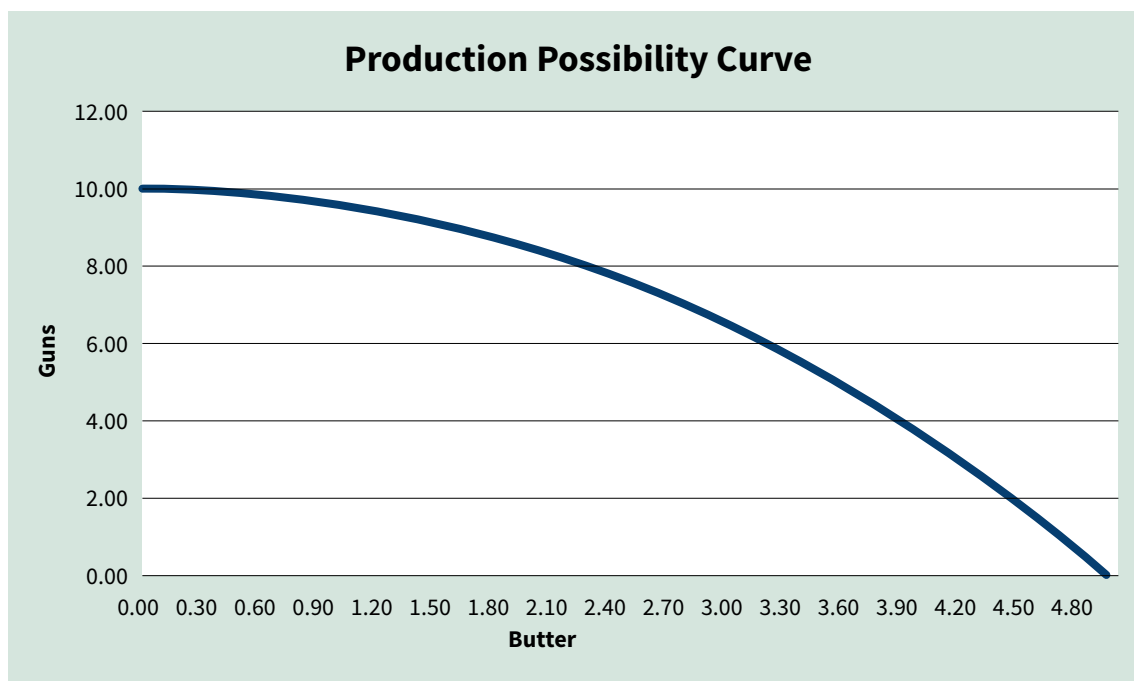
$$\text{Unemployment Rate} = \frac{\text{Number of Unemployed People}}{\text{Labor Force}}$$

The definition of the labor force is deliberately narrow. It includes individuals aged 16 and older who are either employed or actively searching for work, while excluding retirees, students outside the labor market, and those unwilling or unable to participate. Informal employment, though often precarious and outside the reach of taxation or social protection, is nonetheless counted.¹ To qualify as unemployed, individuals must demonstrate active job search efforts within the preceding four weeks. In practice, governments rely on instruments such as the Current Population Survey to generate these estimates.

Yet these statistics are imperfect. They fail to capture underemployment—workers employed part-time involuntarily or in roles that underutilize their skills—and they omit discouraged workers who have abandoned the search for jobs altogether. As a result, unemployment figures often understate the extent of labor market slack.

Defining Low Unemployment

The notion of “low” unemployment is context-dependent, shaped by historical benchmarks and the structure of individual economies. In advanced industrial nations, rates below 4% are generally interpreted as signs of a strong labor



market, approximating what economists call “full employment.” This concept allows for frictional unemployment—the natural churn of workers moving between jobs—but implies that the economy is operating near capacity.

Still, very low unemployment is not an unqualified good. When labor markets tighten excessively, several distortions emerge:

- **Labor scarcity.** Employers struggle to fill vacancies as the pool of available workers shrinks.
- **Inflationary pressures.** Competition for scarce talent drives wages upward; higher labor costs are often passed on to consumers, fueling inflation,
- **Productivity concerns.** Firms may be forced to hire workers whose skills do not align with job requirements, reducing efficiency.
- **Economic inefficiencies.** Overextended resources and mismatched labor allocation hinder optimal production.

Thus, while low unemployment is celebrated as a marker of economic strength, its interpretation requires nuance. It must be assessed against broader macroeconomic conditions, cyclical dynamics, and historical experience. A rate that signals prosperity in one context may, in another, foreshadow inflationary strain or structural imbalance.

Production Possibility Curves Conceptualizing Production Possibility Frontiers

The production possibility curve (PPC) or production possibility frontier (PPF) offers a structured way to think about the limits of an economy’s productive capacity. The curve maps out the maximum attainable combinations of goods that can be produced within a given period assuming:

1. **Fixed resources.** The total quantity and quality of available resources, such as labor, capital, natural resources, and entrepreneurial talent, are constant over the period of analysis.
2. **Fixed technology.** The state of technological knowledge and production techniques remain unchanged.
3. **Full employment.** All available resources are fully and efficiently employed in the production process. Under conditions of full employment, the economy operates on the PPC.

To make the analysis tractable, economists often reduce the complexity of production choices to a two-good model. The familiar “guns and butter”² example illustrates the tension between civilian and military production and goes along the following lines: Suppose that five units of butter³



Never confuse activity with productivity.

—Rick Warren

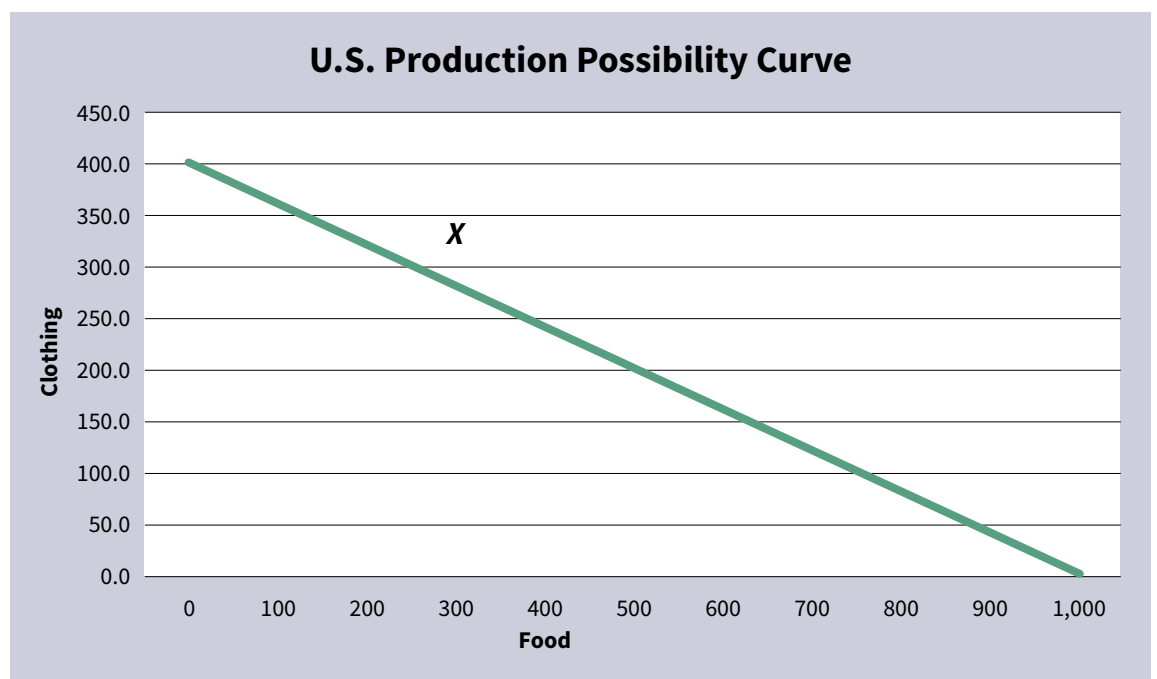
The deeper insight of the PPC lies in its portrayal of scarcity, efficiency, and the trade-offs economies must take. In a fully employed economy, producing more of one good necessarily requires producing less of another. This inverse relationship embodies the principle of opportunity cost—the value of the next-best alternative that must be forgone. The slope

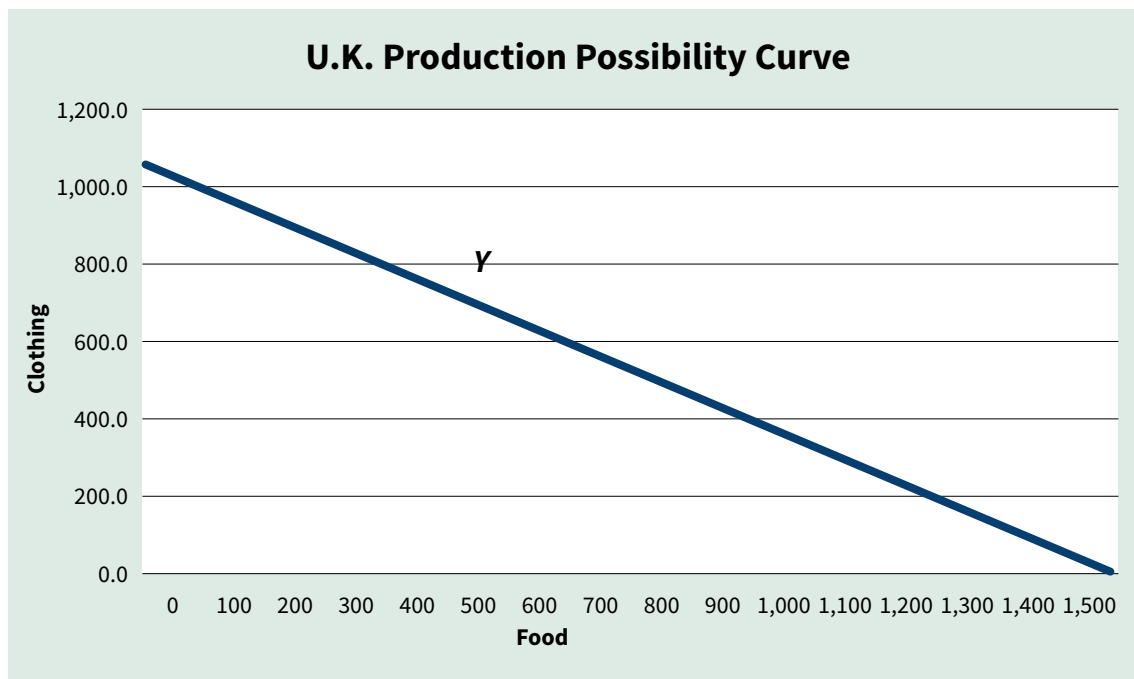
is the maximum amount that can be produced with existing technology. At the other extreme, imagine that if all of society's resources were devoted to the production of guns, 10 units would be manufactured. Points between these extremes represent alternative allocations where resources are shifted between the two goods. At one extreme, dedicating all resources to butter yields a maximum of five units, while at the other, full commitment to guns produces 10 units.

of the curve at any point captures this cost, expressing how much of one good must be sacrificed to gain an additional unit of the other.

Understanding how the PPC responds when its underlying assumptions are relaxed is essential for interpreting real-world economic dynamics. The curve is not static; it expands, contracts, or becomes more complex depending on changes in resources, technology, employment, and the scope of goods considered.

1. **Resource endowments.** The PPC reflects the productive capacity of an economy, so changes in resource availability directly alter its position. An expansion of resources—through population growth, capital accumulation, or the discovery of new natural inputs—pushes the curve outward, signaling greater potential output. Conversely, resource depletion, war, or natural disasters contract the frontier inward, reducing the economy's ability to produce across all goods.
2. **Technological change.** Technology determines how efficiently resources are transformed into output. Advances in knowledge or production methods shift the PPC outward, enabling more goods to be produced with the same inputs. On the other hand, a regression in technology or





restrictions on its use can move the curve inward, reflecting diminished efficiency.

3. **Employment of resources.** The assumption of full employment places the economy on the frontier itself. When resources are underutilized—due to unemployment or inefficiency—the economy operates inside the PPC rather than on it. The curve remains unchanged, but actual production falls short of potential.
4. **Expanding beyond two goods.** The two-good framework is a simplification for analytical clarity. Relaxing this assumption does not shift the curve but complicates its representation. With multiple goods, the PPC becomes a higher-dimensional surface, capturing the trade-offs among many possible combinations rather than just two.

Rising Costs and Resource Allocation

The outward curvature of the PPC reflects the fact that resources are rarely equally adaptable across all forms of production. As an economy pushes further into the output of one good, it must increasingly draw on inputs that are less well-suited to that activity. The result is a growing sacrifice in the production of alternative goods. In practical

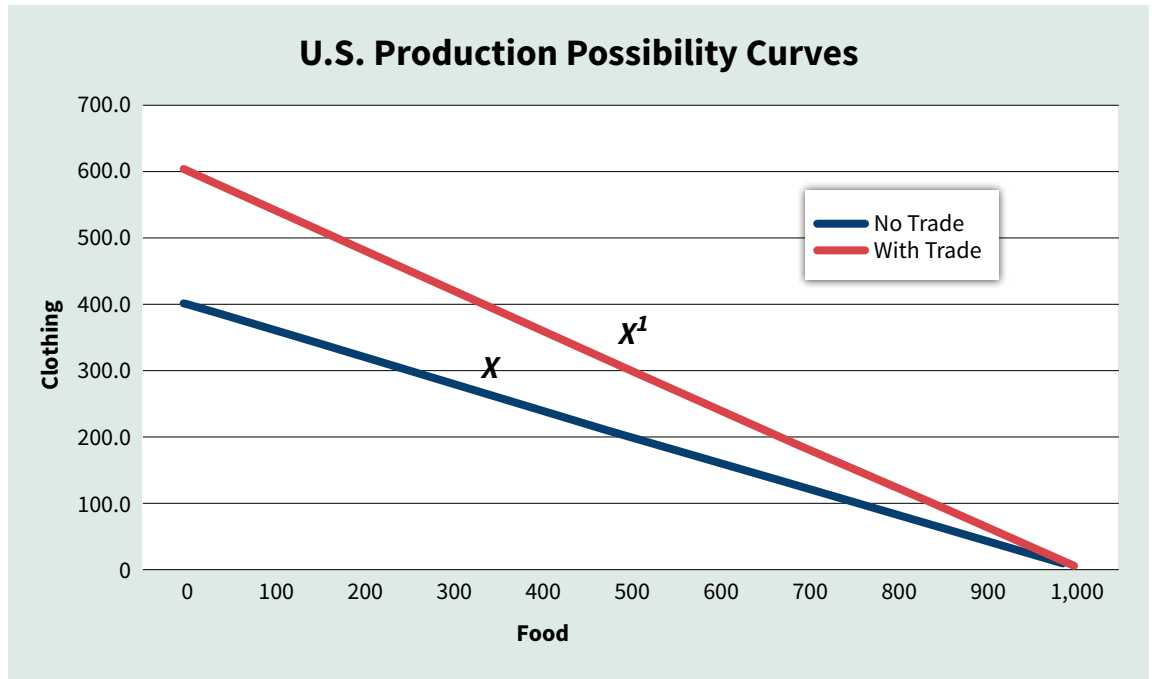
terms, the first units of military equipment might be produced using resources that contribute little to civilian consumption, yet as production expands, resources that are highly effective in producing butter must be redirected toward guns, amplifying the trade-off.

Efficiency Gains and Economies of Scale

Before rising costs dominate, production often benefits from efficiencies associated with scale. Larger operations, standardized processes, and specialized labor can reduce average costs, a phenomenon captured by the concept of economies of scale. These gains, however, are limited. Once the most efficient facilities are in place and no further scale advantages can be realized, the economy confronts the familiar law of increasing costs. In the guns-and-butter example, early expansion of gun production may exploit scale efficiencies, but beyond a certain threshold, the trade-offs reassert themselves.

Diminishing Returns and Marginal Productivity

A related dynamic is the law of diminishing returns. When one input is expanded while others remain



fixed, the additional output generated by each new unit of input eventually declines. For instance, adding more labor without expanding land or capital will yield progressively smaller increases in production. This principle reinforces the rising costs observed along the PPC, as reallocating resources across sectors rarely produces proportional gains.

International Trade Under Full Employment

The intellectual foundations of comparative advantage were laid most prominently by David Ricardo⁴ and later refined by John Stuart Mill,⁵ among others, as part of a broader effort to explain the logic of international exchange. Their work established comparative advantage as a principle with enduring relevance to policy debates. When articulated in its rigorous form, the argument is unassailable under the assumption of full employment, and it continues to carry considerable weight even in economies where unemployment persists at modest levels. The durability of the theory lies in its ability to demonstrate that relative efficiency, rather than absolute productivity, is the decisive factor in shaping mutually beneficial trade.



Logic: The art of thinking and reasoning in strict accordance with the limitations and incapacities of the human misunderstanding.

—Ambrose Bierce

When comparing the productive capacities of nations, it becomes clear that differences in resource endowments—land, capital, labor, and technical expertise—shape the range of goods each country can feasibly produce. Although it is theoretically possible for every nation to attempt the production of all commodities, the reality is that such efforts often prove inefficient or prohibitively costly. Economic logic therefore favors specialization: Countries concentrate on the goods they can produce most efficiently and rely on trade to obtain the rest.

The counterintuitive insight of comparative advantage is that trade can generate mutual gains even when one country is more efficient across the board. A nation with absolute advantage in every sector does not eliminate the possibility of beneficial exchange. What matters is relative efficiency. Even the less efficient country will find areas where its disadvantage is least severe, and in those sectors it holds a comparative advantage. Conversely, the more efficient country maximizes its gains by focusing on industries where its superiority is greatest, while importing goods that its partner can produce with relatively lower inefficiency.

A historical illustration can be drawn from the 19th-century economic relationship between the United States and the United Kingdom. The U.S., endowed with abundant land and natural resources, faced relative scarcity of labor and capital. Britain, by contrast, possessed a surplus of labor and capital but limited land.⁶ These asymmetries shaped production choices: food production was relatively cheaper in the U.S., while clothing production was relatively cheaper in the U.K. The policy debate in the U.S. over protective tariffs thus hinged on whether restricting imports would improve welfare or whether specialization and trade would yield greater efficiency.

To formalize the example, assume that in the U.S. the opportunity cost of producing clothing is four units for every 10 units of food forgone. If all resources (factors of production⁷) were devoted to food, the economy could produce 1,000 units. In a self-sufficient equilibrium, represented by point X, the U.S. produces and consumes 300 units of food and 280 units of clothing. This allocation reflects the workings of the price mechanism, where supply and demand determine the mix of goods.

In the U.K., the trade-off differs: Diverting 10 units of food allows the production of seven units of clothing. At equilibrium point Y, the U.K. produces 700 units of clothing and 500 units of food. The critical distinction lies in the opportunity-cost ratios—10:4⁸ in the U.S. versus 10:7 in the U.K.—which reveal the basis for comparative advantage. The U.S. is relatively more efficient in food production, while the U.K. is relatively more efficient in clothing. Trade between them, therefore, allows both to consume beyond the limits of their domestic production frontiers.

Free Trade and Terms of Exchange

When nations move from self-sufficiency to international exchange, the terms of trade are set not arbitrarily but through the interplay of global supply and demand.⁹ For trade to be mutually beneficial, these ratios must fall between the opportunity costs faced by each country in autarky.¹⁰ In the U.S., the domestic trade-off is 10 units of food for four units of clothing, while in the U.K. it is 10 units of food for seven units of clothing. If the global price ratio were less favorable than these domestic benchmarks—say 10:1 for the U.S. or 10:9 for the U.K.—neither country would have an incentive to participate since they could achieve better terms internally.

Now consider a world-market equilibrium at 10:5. This ratio lies between the autarkic costs of both nations, creating scope for gains from trade. The U.K., with its relative efficiency in clothing, specializes in textile production and exports five units in exchange for 10 units of food. This outcome improves upon its domestic conversion rate of 7:10. Conversely, the U.S. specializes in food, trading 10 units for five units of clothing—a more favorable exchange than the four units attainable under self-sufficiency. Both countries thus expand consumption possibilities beyond their domestic production frontiers.

Another counter-intuitive consequence of trade based on comparative advantages is that the economic benefits are not determined by wage levels;¹¹ rather, in the absence of distorting factors such as price controls, wages adjust upward toward productivity in export sectors, not downward toward import-competing industries.¹²

Efficiency and Technological Progress

Trade gains are not static; they evolve with changes in productivity. Suppose a technological advance in the U.S. raises food output, improving its opportunity-cost ratio from 10:4 to 10:6. The production-possibility frontier shifts outward, allowing simultaneous increases in food and clothing. This innovation also alters the international terms of trade. If the U.S. can now offer 10:6 while the U.K. remains at 10:7, the equilibrium ratio may settle at 10:6. Under these conditions, the U.S. secures more clothing per unit of food exported, while the U.K. sacrifices fewer textiles to import food. Should both nations experience productivity gains, the benefits compound, reinforcing the dynamic link between technological progress and expanded trade possibilities.

Terms of Trade and Reciprocal Demand

John Stuart Mill advanced the classical theory of trade by introducing the principle of reciprocal demand, which explains how exchange ratios between nations are determined. Mill's insight was that comparative costs alone do not dictate the terms of trade; rather, the equilibrium ratio emerges from the interaction between those cost boundaries and the relative intensity of each country's demand for the other's goods. In this framework, three elements shape the outcome.

First, comparative cost ratios establish the outer limits of possible exchange following Ricardo's logic that nations specialize in the goods they can produce at the lowest opportunity cost. Within those limits, the balance of reciprocal demand determines where the actual terms of trade settle. A country with stronger demand for its partner's exports will, *ceteris paribus*, concede more of its own goods, shifting the exchange rate in favor of the other. Finally, elasticity of demand¹³ plays a decisive role: nations with inelastic demand for imports are forced to accept less favorable terms, while those with highly elastic demand can negotiate closer to their own advantage. Mill's contribution was to integrate supply-side constraints with demand-side responsiveness, producing a more dynamic account of how trade ratios are set in practice.

Extension to Multiple Goods and Countries

The logic extends naturally beyond the two-good, two-country model. When nations produce a range of commodities, these can be ordered by relative advantage. For example, if the United States holds its strongest comparative edge in Commodity 1 and the United Kingdom in Commodity n , liberalized trade will push each toward specialization at opposite ends of the spectrum. The intermediate goods fall along a continuum, with the dividing line determined not by cost ratios alone but by the global demand schedule for each product. Aggregate supply and demand across world markets jointly establish the threshold at which production shifts from one country to another.

Adding more countries does not alter the underlying mechanism.¹⁴ From the perspective of any single nation, the rest of the world can be treated as a composite trading partner, and the same principles of cost boundaries, reciprocal demand, and elasticity apply. Within larger trading blocs, subregions interact according to the same logic, reinforcing Mill's point that international trade is governed by both productive efficiency and the structure of global demand.

Final Remarks

At its foundation, international trade rests on the recognition that exchange across borders generates mutual gains rather than constituting a zero-sum contest.¹⁵ Whether economies operate under full employment or face pockets of under-utilized labor, prevailing theory consistently emphasizes the efficiency of free trade. The principle of comparative advantage anchors this logic: nations specialize in sectors where their relative efficiency is greatest, thereby unlocking productivity gains, fostering innovation, and widening the scope of consumption possibilities. In this way, trade functions as a catalyst for globalization and a mechanism for raising living standards.

To formalize the limits of production, economists employ the PPC. This framework traces the maximum feasible combinations of goods under the assumption of full employment, embedding the concepts of scarcity and opportunity cost. The slope of the curve captures the trade-off between goods, while its outward concavity reflects rising



**I am so clever that sometimes I
don't understand a single word
of what I am saying.**

—Oscar Wilde

costs—resources are rarely perfectly transferable across different forms of production.

For trade to deliver net benefits, the terms of exchange must fall between the domestic opportunity costs of the participating nations. The precise equilibrium ratio is not dictated by costs alone but emerges from reciprocal demand: the interplay between comparative cost structures and the relative intensity and elasticity of each country's appetite for the other's exports. In this synthesis of supply and demand, the profitability of trade is determined, and the benefits of comparative advantage are realized in practice.

The analysis of trade under unemployment and the strategic use of tariffs are the subject of a subsequent article. ▲

Disclaimer: This article is based on established economic theory. The discussion is interpretive and does not purport to advance new theoretical contributions.

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Endnotes

1. Interpreting data can be tricky. Consider the following unemployment rates: Mexico 2.7%, U.S. 4.1%, Germany 6.3%, Israel 2.7%, Japan 2.5%. Yet, the informal employment rates are 54.8% in Mexico, 17.7% in the U.S., 14.5% in Germany, 25.4% in Israel, 10.3% in Japan).
2. The metaphor is simple, memorable, and frequently utilized to describe the PPF. It is also useful in many contexts such as in discussions of geopolitical tensions, economic policies, global challenges, and public debates.
3. Units of butter can be one pound, one thousand pounds, one million pounds or any amount that is suitable for the example at hand. The fact that there are many variations of butter is ignored. Similar considerations apply to units of guns.
4. David Ricardo (1772-1823) was a British political economist and politician. He is known for his theories on comparative advantage, economic rent, and the labor theory of value. His work laid the foundation for classical economics.
5. John Stuart Mill (1806-1873) was an English philosopher, political economist, and civil servant. He was a proponent of utilitarianism and contributed to social theory, political theory, and political economy.
6. The metaphor of food and clothing is simple and memorable. It is often used to illustrate fundamental concepts such as comparative advantage, opportunity cost, and the benefits of international trade.
7. Factors of production are essential inputs used in the production of goods and services. They are typically classified into four categories: (1) land: natural resources, such as water, minerals, forests, and agricultural land; (2) labor: human effort, skills, and time contributed to the production process; (3) capital: manufactured tools, machinery, buildings, and equipment used to produce goods; (4) entrepreneurship: the initiative, innovation, and risk-taking of individuals who organize the other factors to create and run businesses.
8. A constant ratio implies that the production possibility curve is a straight line. This assumption simplifies the analysis but does not affect the validity of the argument because costs still increase as production expands.
9. See "The Dynamics of Market Forces-Setting the Stage" in the May-June 2025 issue of *Contingencies*, and "The Dynamics of Market Forces-Squaring the Circle" in the July-August 2025 issue.
10. Economic independence or self-sufficiency.
11. Assumptions about wage levels or wage relativities are not required in this analysis.
12. To give an example: manufacturing wages in Mexico tend to be higher for employees working in American companies vis-a-vis Mexican companies.
13. Elasticity of demand measures how the quantity demanded of a good changes in response to a change in its price. If demand changes significantly with a small price change, demand is elastic; if demand changes little with a price change, demand is inelastic.
14. Consider the inefficiencies that would result if each state (in the U.S.) were to apply tariffs to other states. Conversely, consider the economic benefits that free trade between states generates.
15. In game theory and economics, a zero-sum game describes a strictly competitive interaction. If one side wins, the other side loses by the same amount, leaving no possibility of mutual gain.

International Committee Guides Academy's Global Engagement

WHILE THE ACADEMY remains the U.S.-focused public policy and professionalism membership association for actuaries, we don't exist in a vacuum. Remaining aware of the issues and conversations that take place on the international stage has been a priority throughout our history.

In the past year, the Board established a new International Committee—which works in conjunction with the Prudential Regulation Committee—to ensure that we appropriately monitor and engage with our international partners. This November, the Academy will take center stage with several presentations at the International Congress of Actuaries (ICA) in Tokyo.

if it's a professionalism issue, something isn't done internationally that has an unintended consequence either on our work in other countries or in the U.S."

Additionally, there are issues that transcend borders and are of interest to the Academy. Topics such as artificial intelligence (AI), the impact of climate events, and the governance of financial systems are among the "mega-issues"

information and best practices. The International Committee is composed of experienced Academy volunteers and members, representing each practice area and focused on both professionalism and public policy matters.

Academy volunteers and invited speakers will present at the upcoming ICA on several topics, including professionalism and its relationship to self-regulation in the U.S.; AI from a professionalism, climate, and regulation perspective; and research related to capital standards. In the lead-up to the ICA, the International Committee will host webinars in which members will highlight these topics and discuss opportunities for increasing engagement.

Slotznick said these ICA presentations are part of a concerted effort by the Academy to increase its involvement at the event. "This is a new thing for us to formally do as part of the Academy," she said. "We are very excited that a good number of our sessions got selected."

Specifics about the Academy's presentations are detailed in the abstracts submitted to the ICA. The three AI-themed sessions, while separate, will be held consecutively. Individually, each session delivers insights into the implications of AI for actuarial practice and the ongoing evolution of risks related to the rapid adoption and use of technology. Together, the presentations create a cohesive program that allows participants to assess global methods, evaluate challenges, and consider future directions in AI regulation.



The committee, chaired by former Academy President Lisa Slotznick, recognizes the importance of engaging on key industry topics beyond the nation's borders. While the Academy is focused on serving its U.S. membership, it also recognizes that many members are employed by insurers or consulting firms with a global presence, and that their work intersects with international issues.

"There could be trends outside the U.S. that come to the U.S. that we want to be aware of," Slotznick said. "We want to influence those trends so that,

prioritized by the Academy that are global in nature, regardless of nation or language.

The International Committee is responsible for ensuring that the Academy's focus on global issues is well coordinated and is strategically directed. Previously, Academy volunteers in key committees monitored relevant issues, while Academy leadership maintained relationships with other associations such as the North American Actuarial Council and the Actuarial Association of Europe, holding bilateral meetings with various actuarial groups and sharing

- **Generative AI and Professionalism** will encourage actuaries to consider the Academy's 2024 *Actuarial Professionalism Considerations for Generative AI* paper as an approach to professionalism considerations when evaluating the use of generative AI in assignments. The session is led by Kathy Wong, who served on the Academy's Artificial Intelligence Task Force that helped draft the paper.
- **The U.S. Regulatory Environment for AI** will examine National Association of Insurance Commissioners' (NAIC) initiatives and state-specific regulatory actions aimed at ensuring companies implement AI systems responsibly, maintain effective governance frameworks to monitor their performance, and protect consumers from undue harm. The session is being presented by Roberto Perez Santiago, an Academy member and a NAIC P&C rate modeling actuary.
- **Generative AI and Climate**, led by Joint Climate Change Committee member Dorothy Andrews, will explore the consequences of data centers on climate, actuarial pricing assumptions, environmental resources, and host communities, while also asking the question, "Is this just a background issue or does it have direct implications for the actuary beyond the pricing of the property and liability coverages for utilities?"

Meanwhile, three connected professionalism presentations offered by Academy President Tricia Matson, Academy President-Elect Frank Todisco, and International Committee member Tom Terry will enable participants to compare global professionalism approaches; understand how U.S. actuarial

While the Academy is focused on serving its U.S. membership, it also recognizes that many members are employed by insurers or consulting firms with a global presence, and that their work intersects with international issues.

standards of practice, counseling, and disciplinary processes were developed; and consider the implications of self-regulation in a world that frequently looks to government licensure to ensure professional standards.

- **Self-regulation of the U.S. Actuarial Profession** will explore how the U.S. actuarial profession has responded to the challenge of self-regulation, while also describing Academy-led efforts to offer objective contributions to public policy development and provide balanced analysis and actuarial perspective to American policymakers.
- **Accountability in the U.S. Actuarial Profession** will describe the ways in which the U.S. actuarial profession's disciplinary infrastructure contributes to actuaries' accountability in the United States. It will detail the U.S. disciplinary process, highlighting what has worked to unite the actuarial profession and maintain its standing as a self-regulated profession.
- **Practice Standards: Evolution in the U.S.** will compare global professionalism approaches; explain how U.S. actuarial standards of practice, counseling, and disciplinary processes were developed; and examine the implications of self-regulation in a world that frequently looks to government licensure to ensure professional standards.

Finally, Academy Research Director Steve Jackson will present an Academy research paper addressing scalars in the International Association of Insurance Supervisors aggregation method. Scalars are amounts by which solvency calculations of U.S.-owned entities operating internationally are multiplied to make them comparable to the calculations of U.S.-based entities before they are combined. The paper will assess the AM and the Group Capital Calculation, as implemented by the NAIC in the United States, and will examine existing scalars in light of empirically derived scalars, finding a use for a data-driven approach to scalars beyond their use for regulatory purposes.

Beyond the ICA, the International Committee will continue to focus on identifying opportunities to engage and share the Academy's expertise with the global community, while highlighting our leadership within the profession to ensure that our members and all U.S.-practicing actuaries remain aware of the global policy and professionalism issues that influence our work. While we remain fully focused on the U.S.—ensuring that the actuarial voice is a strong and consistent presence within our borders—the Academy will continue to be a voice and resource for those beyond them. ▲

TED GOTSCH is policy content and publications manager at the Academy.

The Look-in-the-Mirror Test for Building Confidence

FOR LIFE ACTUARY KAITLIN CREIGHTON, MAAA, FSA, CERA, the appeal of the profession began with a childhood fascination with numbers and puzzles. Today, that curiosity drives her thoughtful approach to professional judgment—the “look-in-the-mirror test.” Creighton, who is a 2025 Rising Actuary Award recipient, also values the guidance, standards, and community offered by the Academy, which she credits with helping her grow as a professional while ensuring that the work of actuaries continues to earn public trust.

What led you to become an actuary, and what attracted you to the profession?

When I was a little kid, I always thought I wanted to be an accountant when I grew up. I have many accountants in my family, and I loved the idea of using math within a business application and solving puzzles all day. However, I wanted the math to be more challenging than what you use as an accountant.

During my freshman year of high school, our personal finance teacher required us to research a career that used finance, so I picked actuary from the list of options. I found myself on websites like BeAnActuary.org, doing practice problems, and having so much fun, and I was instantly hooked. I interviewed an actuary as part of that project, and after talking to her, I knew this was the perfect career for me. The rest is history.

Describe a time when your professionalism training helped you in your career.

Whenever I am starting a new project or endeavor, I always think about the “look-in-the-mirror test” to determine if I am



qualified to be completing the work or not. It helps me stop and take inventory of all of my qualifications and experiences that have led me to taking on the work.

This serves two purposes. First, it helps me with imposter syndrome. By taking an analytical approach to assessing my qualifications, it helps remind me that I have actually achieved quite a lot in my career so far, and I am often more qualified than I initially feel that I am.

Second, it helps me identify the gaps in my knowledge or experience so I can be sure I am thinking about resources or people I will need to help me complete whatever project I am embarking on.

Tell us about a time where your actuarial expertise influenced an important decision in your workplace.

Many of my most rewarding projects have involved streamlining processes. This was usually done either by finding better data sources or by automating processes. Using an actuarial approach has always been very important. First, you have to make sure you properly understand the problem at hand and the questions the process is trying to answer. Once you understand the purpose, then you can better define the process. Next is making sure you understand the data—where it comes from, its accuracy, and what controls are there to make sure it ties out, etc. Then you have to make sure there are checks and controls in place to reduce errors. The process needs to be transparent enough that people can understand what is going on and can easily detect when something has gone wrong.

Finally, the most rewarding part is getting to help someone take a task that once took them hours or days and turn it into something that can be accomplished in a fraction of the time.

Help Us Highlight Exceptional Members

Do you know a talented Academy member we should profile? We're looking for members who are making an impact in their practice areas, contributing to the profession, or inspiring others through their work or volunteer activities. Tell us about them at editor@actuary.org.

What's one of the biggest lessons you've learned in your career?

Never be afraid to share your ideas. Early on in my career, I would fall victim to assuming that people more experienced than me must be doing things a certain way because they knew better than me. However, once I gained the confidence to start questioning everything and challenging things, I realized that often we all fall into the habit of keeping the status quo. This could apply to how analyses are done, or how departments are structured.

There's always the potential for better ideas, and almost always, people are eager to hear new ideas, even when the ideas may not actually pan out.

You will learn more from talking to experienced actuaries and working alongside them than you could ever learn on your own. This is why networking, attending conferences, and volunteering with the Academy are so important.

What advice do you wish you were given at the beginning of your career?

Be curious! So much of an actuary's job is solving puzzles and trying to answer the question "why?" The more curious you are early in your career, the more it will serve you later when your role shifts from completing processes to answering stakeholders' questions. It is so important to not just understand how your spreadsheet works or how to complete a journal entry, but also to know how the spreadsheet will be used downstream or where in the annual statement that journal entry will appear.

Understanding how your work product will be used and being curious about the downstream impact of your work will help you design a better process

and work product. It is also prudent to know that your work is being used for its intended purpose.

What do you value most about your Academy membership or volunteer work?

One of the things that really drew me to the actuarial profession is that it is self-governing. Having professional standards that we hold each other to and that offer guidance is paramount to ensuring that the public has trust in what we do. I believe these standards are what set actuaries apart from the growing industries of data science and artificial intelligence.

I believe one of the most valuable things the Academy does is to provide

those professional standards and guidance to its members. I think the ABCD [Actuarial Board for Counseling and Discipline] is such a unique and valuable resource, and I also get a lot of value from the work papers and practice notes the Academy provides. Volunteering with the Academy has given me a behind-the-curtain look at how some of these are developed, and I am always in awe of the great depth of expertise and knowledge that exists among the members.

What is the value of your MAAA?

Having the MAAA credential brings a level of prestige and trustworthiness to one's work. The Academy has high standards for its members, and being

able to identify those who are held to those standards and who meet them is important in the industry.

Would you like to share anything else with aspiring or new actuaries, or those interested in volunteering for the Academy?

The greatest wealth of knowledge does not lie in the various white papers or textbooks available to you; rather, it lies in the people within this great profession. You will learn more from talking to experienced actuaries and working alongside them than you could ever learn on your own. This is why networking, attending conferences, and volunteering with the Academy are so important.

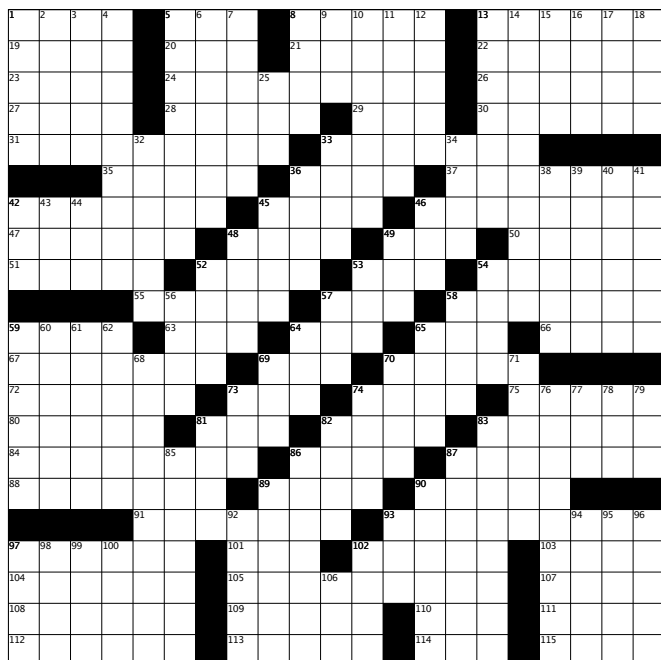
When you are working within your role, you will only ever see the type of work, products, or challenges that your specific company has. When you talk to other actuaries, you will gain a much broader perspective on how you can approach different problems or challenges facing the industry on a larger scale.

Beyond work—what are your hobbies or personal interests?

In my downtime, I enjoy reading, doing jigsaw puzzles, and dancing. I belong to several book clubs and like to read a variety of genres. I feel like each book can bring a new idea or perspective. I also love doing jigsaw puzzles that doubles as art. I have many finished puzzles that I've glued and framed and now have hanging in my house.

Dancing has also been such a great community, especially as an adult. There is such joy in sharing choreography and expression with a group. I've also had the privilege of serving as treasurer on the board of a small, nonprofit dance studio in Bloomington, Illinois. I am always so inspired by the women I serve with, and I have learned many leadership skills from them. ▲

A-



Across

- 1 Scratch
5 British pols
8 Noted Franciscan philosopher
13 Taxing times
19 Gardener's purchase
20 Period
21 Astringents
22 Coal tar product
23 Code word?
24 Authenticated in Aughton
26 Drool over, perhaps
27 Pinochle action
28 Middle Eastern nabobs
29 Prof. baseball league of South Korea
30 Steaming
31 Common Junior ye_r test
33 Well-known four
35 Hot
36 Back in the day
37 Like many precision parts
42 Cataclysmic
45 Snow
46 Merge and mingle
47 Forces
48 Solicitude
49 Inconvenient, maybe
50 1935 Triple Crown winner
51 Like about 15% of New Zealanders
52 Calliope or Clio
53 The ___ of Madelon Claudet
54 Genus of fish known for their compressed, deep bodies
55 Bring to the screen, perhaps
57 Back stroke?
58 Sugar or honey, e.g.
59 It's all downhill from here
63 ___ de veau (sweetbread)
64 Rotary disk
65 Driving need
66 Former Winter Palace resident
67 Music characterized by harmonics
69 Nate Ruess band
70 Main protagonist in Vanity Fair
72 Ship with a single mast
73 Wobegone
74 Stevie Wonder album "Talking ___"
75 Interpellated
80 Shiver-inducing
81 Diamond datum
82 2 Pac's "___ Mama"
83 Sci-fi oddity
84 More penurious
86 Cloakroom item
87 Elides
88 A traditional Zulu healer
89 Mediterranean seaport
90 Kitchen gadget
91 Holstein, e.g.
93 Fin_nci_l_M_them_tics, for ex_mple
97 Actuarial subset
102 Stimulate
103 Northern California Indian
104 Nation north of Lake Victoria
105 Danseuse
107 Egyptian sun god
108 Lingerie fabric

- 109 Be of service
110 False friend
111 Insurance concern
112 Arcadian
113 Viscus
114 Some Mercedes-Benz models
115 Forensic concerns

Down

- 1 Get a grip
2 Drying rack
3 Nose job
4 Elton John or Taylor Swift, e.g.
5 Helen of Troy's husband
6 Does an offstage job
7 Mad magazine material
8 Gear for a trireme
9 Year in the reign of Pius I
10 Bottom dwelling marine fish
11 Protozoan-like
12 IBM feature from 1981
13 Result of hyperventilation
14 Milton t_le
15 Units of concern to nuclear scientists
16 Sis of Osiris
17 Old wives' tale
18 Racing vehicle
25 Animal house?
32 Genus of sandpipers
33 Type of tree
34 Polecat's defense
36 Wasted no time
38 Make firm
39 Mat positions
40 Diagrammatic model
41 Film promo
42 BlackBerry maker
43 Mrs. Ethan Hawke
44 Facebook's was in May '12
45 Spartacus author Howard
46 Preserve, perhaps
48 Stanley and Ryder
49 Burst of anger
52 Galahad garb
53 1917 director Mendes
54 Ibsen character

- 56 Mae West play, with "The"
57 Go for the gold
58 Kitt ___ National Observatory
59 Hacking goal
60 Bristles found on arthropods
61 We feel your pain sloganeer
62 Human activity, reportedly
64 Gnu chew
65 B.C. character
68 Subordin_te only to Messi
69 Waist material
70 Daily drama
71 Pope of 1963-78
73 Private address
74 Noodle or noggin
76 Pittsburgh work area
77 Actress Dennings of "The 40-Year-Old Virgin"
78 Suffix in chemistry
79 Rehab problem, for short
81 Make whole
82 Inducement
83 Mongoose cousins
85 Lack originality
86 Polish city on the Oder
87 Active from dawn to dusk
89 Publishing size
90 Link between stories
92 Mideast dish
93 YMCA class
94 Dinette descriptor
95 Nelson Mandela's first language
96 Weasel cousins
97 Salon services
98 D&D character
99 Drain bane
100 Whilom
102 Hard or soft item
106 Remain unused

A Note to Puzzle Solvers

Several readers rightly pointed out an error in the May/June puzzle, and I apologize for the mistake. To help prevent similar errors in the future, we have implemented a formal peer-review process to catch them before publication.

Thank you for your vigilance and continued support. Good luck with this issue's puzzle!

—Warren Manners

Previous Puzzle: N'homme de Plume



Solvers: Steve Alchuld, Dean Apps, Alan Clark, Todd Dashoff, Jared Dashoff, Ken Kudrak, George Levine, Tim Luker, Jim Muza, Ray Niswander, Madhumathi Windon, and Wendy Windsor.

Solutions may be emailed to puzzles@actuary.org. In order to make the solver list, your solutions must be received by Aug. 1, 2026.



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AMERICAN ACADEMY
of ACTUARIES

Duplicity

THE THEME CLUES ALL HAVE SOMETHING IN COMMON. These duplicitous clues are presented in a random order. They are not cryptic clues.

There are 13 proper nouns among the regular entries. Everything else is playable in Scrabble, except the two-word entry. And, to quote Stephen Sondheim, who brought cryptic puzzles to the U.S. in the 1960s, "Ignore punctuation, which is designed to confuse."

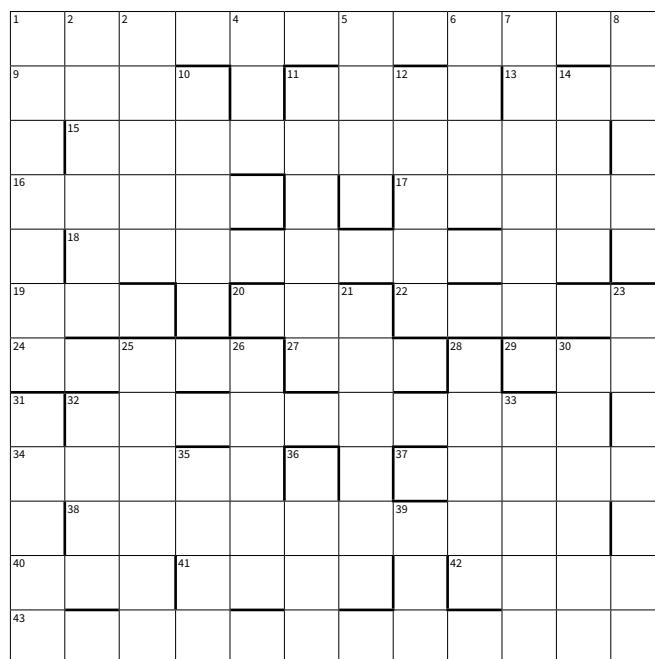
Thanks to Jerry Miccolis for test-solving and editorial suggestions.

Across

1. *See instructions*
9. Mixologist cut off the Dread Pirate Roberts
11. Biblical king in the audience for comic Mort
13. Making a pitch to do lawn care for well-known tavern owner
15. *See instructions*
16. Broadcast remained boring
17. Froot Loops, not so oddly, contain candy
18. *See instructions*
19. Part-time plant worker
20. Send weapons but harm no humans at first
22. Flock of birds finally get interested
24. Grub served in spectacular variety
27. Native American tribe proposes to bring litigation
29. Al, I met a famous boxer
32. *See instructions*
34. Bringing back AJ as Jake's third wheel, man
37. People speaking with airs
38. *See instructions*
40. Tuna caught right in the middle of Bahia
41. Gaelic poem that needs no introduction
42. Stone and iron, for example, experience shortages in the Far East
43. *See instructions*

Down

1. Baby's male features not much to write home about
2. Weaving material from Democrat tantrums
3. Rated not so good for remaining rubber
4. Family member in crisis after missing a few beats
5. Too much ratatatat at a plantation Sherman is said to have destroyed
6. Fundamental solutions provided as well
7. Mailed slips to Ferdinand's wife
8. Notice we're talking pennies
10. Riots controlled by the police and Charlie's Angels



11. Disassociates from nonsense verses
12. Rosemary and Mary Jane encounter that woman's drivel
14. Let's consider the odds on those people from the Midwest
21. Clearly is mold, but ephemeral at first (*two words*)
23. Misestimated as characters keep reemerging from the Persian Gulf
25. Sign up again in reply
26. One who questions certain elements of Maradona's kerfuffle
28. Aural loops getting wilder
30. Contract for practice in elocution
31. Doctor mails in submission, literally
32. L.A.'s hot wind
33. Lord, Ellie gets unwound
35. Help with one risky thing
36. "Rear end" is coarse; company may bugger off
39. A little late for lox and eggs

Theme clues

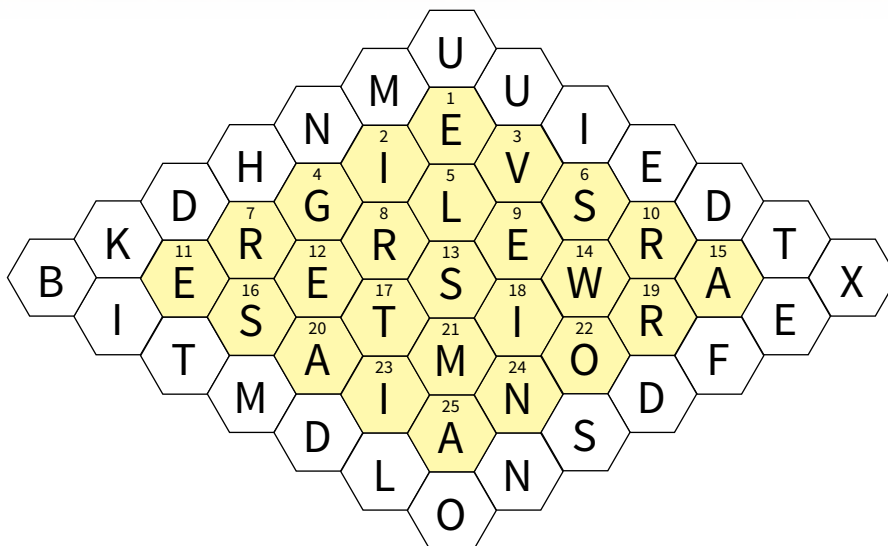
- a. Again
- b. Condition of the piece of day-old bread I'm going for
- c. Home of the Pueblos
- d. "If I knew I was going to live this long, I would have taken better care of myself"
- e. They may be on the wagon, but do they have to go on and on about it?
- f. For Dali, flamboyant clothing and a long-waxed mustache

Solution to Previous Issue's Puzzle—Honeycombs

Apologies to Corinne and David Promislow for omitting them from the list of solvers last time.

Apologies to everyone for an imperfect clue below, #1. The logic of the wordplay implies that the word “mule” will carry some letters from “Peruvians,” namely UVI, and then the whole thing will be turned around to yield ELUVIUM. The problem is that UVI appears in that order, not reversed. The logic should really tell the mule to turn around and then carry some Peruvians to mineral deposits. Which is funnier anyway!

1. ELUVIUM—“Mule” reversed over UVI (“some Peruvians”)
2. GREMLIN—Anagram of “Mingler”
3. ELUSIVE—Anagram of “EU evils”
4. HERRING—Pun on HER RING (“That lady’s band”)
5. SERVILE—An even worse pun on SIR VILE (“Despicable one knighted”)
6. REVIEWS—Homophone of REVUES (“plotless musicals”)
7. HEDGERS—Scramble “greed” and insert into HS (“high school”)
8. GRISTLE—GR (“Greece”) + IS + last letters in “nonbelligerent until peacetime”
9. SWIVELS—SW (“two directions”) and scramble “lives”
10. REWARDS—Anagram of “drawers”
11. SKIRTED—Outside of “Skip’s heavyhearted”
12. GARTERS—Anagram of “garrets”
13. MILTERS—MILERS (“Some middle distance runners”) around T (“turkey at first”)



14. WORRIES—Outside of “work-song series”
15. DRAFTER—DR (“Doctor”) + AFTER
16. STEAMER—Inside “Paste ‘America’”
17. SMARTIE—Anagram of “imarets”
18. WINSOME—One half of “win some, lose some” (“a philosophical statement of acceptance”)
19. FORWARD—Double definition
20. MISDATE—Punny double definition
21. ANAMIST—Anagram of “Tim, Ian’s”
22. WINDSOR—Punny double definition (i.e. neckties and “Windsor and Wally’s affair,” as Stephen Sondheim put it in his song “I’m Still Here”)
23. MATILDA—ADAM over LIT (“excited”) reversed
24. MANSION—Anagram of “Onanism”
25. NOMINAL—Anagram of “name only” without the Y (“Yen does not exist”)

- Center row: BEESWAX
- Rows 4 and 10: HIVE MIND
- Four-letter word from unchecked cells in groups 11 and 15: KITE

Solvers: Steve Alpert, Dean Apps, Lois Cappellano, Laura Cremerius, Jared Dashoff, Todd Dashoff, Christopher Dickens, Mick Diede, Deb Edwards, David Handelman, Jason Helbraun, Pete Hepokoski, Catharine Hornby, Max Jackson, Ruth Johnson, Paul Kolell, Mike Kosciuk, Ken Kudrak, George Levine, Tim Luker, Ben Lynch, Michael Manos (and Eric and Lillie), Mathew Marchione and Marika Brown, Dave McGarry, Jim Muza, David and Corinne Promislow, Ram Raman, Zig Swistunowicz, Tim Tebbe, and T. O. C. E. (Josh DenHartog and Sean Donohoe).

TOM TOCE is an FCAS and a seasonal director at KPMG. He is a member of the Jeopardy Hall of Fame. Solutions may be emailed to ttoce@nyc.rr.com. In order to make the solver list, you should send him your solutions by Aug.1, 2026.

Pencil's Down

ONE WOULD LOGICALLY THINK THAT THE HOLE-IN-ONE CHALLENGE would have, for once and for all, ended the epic rivalry between Doc and Hoss, but over the past few weeks both rivals continued to challenge themselves in the most interesting of ways. The hatred between the two became not only a local story, but thanks to a couple of viral TikTok videos, a national (if not an international) one.

First, both Hoss and Doc attempted to complete the Oreo Power Hour. Both failed spectacularly. Then came the epic hopscotch competition; judges deemed the results too close to call. And, of course, our two heroes fought over who could amass the most money in Scritchy Scratchy, as both players scratched an insane number of lottery tickets. And who could forget that rock-paper-scissors duel? Hoss allegedly reread the rock-paper-scissors strategy guide four times to prepare. Alas, not even that produced a clear winner. The one-upmanship seemed to never end!

Finally, my friend Chef realized this needed to end, as there is more to puzzle writing than the adventures of Hoss and Doc. Chef proposed a summit at Dada Doner, known to be the best restaurant in town, where Hoss and Doc could for once and for all air out their grievances and get on with their lives. It seemed like a good idea, as who could get upset while eating Turkish street food? Everyone felt optimistic that a peaceful resolution was close at hand. Alas, not even the shawarma could calm things down. Tempers boiled. To prove their superiority, Doc and Hoss started listing what they viewed as their greatest accomplishments. Hoss completing a sub-six-minute beer mile. Doc claiming he understood *Finnegans Wake*. Hoss mining the Klopman Diamond. Doc performing a triple-Lindsey. Hoss claiming to know where Vermeer's *The Concert* is located. And then suddenly, it all stopped. Doc made such an outlandish claim that even Hoss was taken aback. The entire restaurant—no, the entire city—hushed at even the thought of the claim.

Doc claimed he could score an 800 on the SAT math section without a calculator.

After sitting in stunned silence for what felt like minutes, Hoss finally said, "There is no way you can do that." Hoss then told Doc, "You can even have that actuary puzzle writer as a tutor. If you can get a perfect SAT math score, you win."

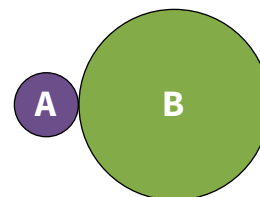
I had no idea how I got roped into all of this, but Doc quickly agreed. In two weeks, Doc would take the SAT, and whether or not he got every question correct would, for once and for all, end all of this madness.

As we walked out of the eatery, Doc said that as his tutor I had one job and one job only: Find the three toughest SAT



math questions known. If Doc could solve those, he could solve anything. I told Doc I could find him some problems, but I might not be able to solve them. "Don't worry about it," Doc said. "Your puzzle solving friends can help you there." Solve each of these three problems without the use of a calculator:

1. If $3x + 4y = 5$, what is $27^x \times 81^y$?
2. In the picture below, the radius of Circle A is 1 and the radius of Circle B is 3. Circle A rolls around circle B, so that it rolls exactly one time around Circle B, back to its starting point. How many times will Circle A revolve in total?



3. If shoppers enter a store at an average rate of r shoppers per minute and each stays in the store for an average time of T minutes, the average number of shoppers in the store, N , at any one time is given by the formula $N = rT$. The owner of Ernie's Elbow-Grease Emporium estimates that every hour 168 shoppers wait in line to make a purchase, and that each shopper spends an average of five minutes in line. On average, how many shoppers are waiting in line to make a purchase?

Solutions to Last Issue's Puzzles—Jigsaw-Puzzle Puzzles STEPHEN MESKIN

In puzzles 1 and 2, we assume ordinary rectangular jigsaw puzzles, with rows and columns running cleanly from one edge to the opposite edge.

■ **Puzzle 1:** A jigsaw-puzzle manufacturer wants to make puzzles with at least 1,000 pieces. Among those puzzles she wants the total number of pieces to be as small as possible. She also wants the ratio of the number of columns to the number of rows to be as close as possible to the Golden Ratio. She agrees that minimizing the sum of the percentage deviations from her two targets would be appropriate. Select the number of rows and columns she should have in her puzzles.

- **Answer:** 40 columns and 25 rows.
- **Solution:** The hardest part of this puzzle is proving that the answer is the correct one among the million discrete possibilities. The goal is to minimize

$$T(c, r) = |(c/r)/((1 + \sqrt{5})/2) - 1| + |(c \times \frac{r}{1,000}) - 1|,$$

where $c = \text{\#columns} \geq r = \text{\#rows}$ and $c \times r \geq 1,000$.

We calculate that $T(40, 25) = 1.11\%$; we want to show that this is the minimum.

- **Lemma:** If $T(C, R)$ is the minimum then $C \approx 1.618R$ and (allowing for a 2% margin) $1,000 \leq 1.02 \times 1.618R^2$ implying:

$$25 \leq R \leq 32 \text{ and } 40 \leq C.$$
- **Lemma:** If $c > 40$ and $r \geq 25$ then $T(c, r) > T(40, 25)$.
- **Lemma:** If $c = 40$ and $r > 25$ then $T(c, r) > T(40, 25)$ by calculation.
- **Corollary:** $T(40, 25) = 1.11\%$ is the minimum.

“The most common layout for a thousand-piece puzzle is 38 pieces by 27 pieces ...”—Wikipedia

■ **Puzzle 2:** A jigsaw puzzle has n edge pieces where n is an even integer. How many pieces can the puzzle have altogether? For example, if $n = 14$, then the puzzle could have 14, 18 or 20 pieces. Your answers should be in terms of n .)

- **Answer:** $n, 3(\frac{n}{2}-1), 4(\frac{n}{2}-2), \dots, R(\frac{n}{2}+2-R)$ where $R = \text{floor}((n/4) + 1)$
- **Solution:** Assume a landscape format thus $c = \text{\#columns} \geq r = \text{\#rows}$ (as in Puzzle 1).
 - **Case 1:** $r = 1$, then number of pieces $= c \times r = c \times 1 = n$.
 - **Case 2:** $r > 1$, so $n = 2r + 2c - 4$ (subtract 4 otherwise corners are double counted).

Thus $2 \leq r \leq c = n/2 + 2 - r$. For each r from 2 to $\max r = R$, the number of pieces, P , is $P = r \times (n/2 + 2 - r)$.

For $r = 2$, $P = n$ (again) and for $r = R$, $R \leq n/2 + 2 - R$ so $R \leq n/4 + 1$ and R is an integer so $R = \text{floor}((n/4) + 1)$

And P can take $R - 1$ values for each n .

■ **Puzzle 3:** In the original column, I wrote “jigsaw” followed by “puzzle” six times. Half the time I used a hyphen and half the time I didn’t. Provide the reasons for hyphen use and non-use.

- **Answer:** The hyphen was used when “jigsaw-puzzle” was used as an adjective to describe a type of puzzle or manufacturer. “Jigsaw puzzle” was used when “puzzle” was the noun described by the single word “jigsaw.”

Solvers: Bob Conger, Deb Edwards, Cindy Hu, Clive Keatinge, Scott Parker, David Promislow, Anthony Salis, Jason Shaw, John Vrysen, and Daniel Wade.



AD INDEX

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We Can Do Better

THE COST OF HEALTH CARE IN THE UNITED STATES IS NEARING 20% OF GROSS DOMESTIC PRODUCT; at the same time, our life expectancy is lagging. We can do better!



The scope of public health efforts is broad. These efforts include rules for preparing foods, pharmaceutical regulation, air and water pollution control, workplace safety, smoking restrictions, and science-based vaccination policies. Further, social determinants of public health—poverty, education, and access—are essential for improving healthy life expectancy, which prevention-first strategies can enhance.

Comprehensive public health systems promote health education, monitor outbreaks, set safety standards, and organize emergency responses. The World Health Organization estimates that 60% of premature deaths from non-communicable diseases are preventable through public health interventions and reduced risk factors. More, not less, health-related research is needed.

Public health measures are not one-time interventions; they require continuing effort and continuous improvement, which in turn require societal and individual buy-in.

Although its roots in combating infectious diseases go back centuries, public health has often been considered a third-world problem. That is, until COVID-19. It reminded us that public health systems attempt to address inequities, because no matter who people are or where they live, some face worse health conditions and outcomes than others. We must improve access to care, nutrition, housing, and education.

We need accurate public health information; not the widespread circulation of misinformation and flawed health care guidance available online, sometimes generated by artificial intelligence or an unreliable source. Once deeply rooted in

social networks, misinformation is difficult to overcome. Trusted information should be based on evidence from leading health organizations or from high-quality, independently reviewed research.

The medical self-help movement has democratized both access to and the creation of health knowledge. However, in some cases, it has also led to questionable practices that don't help users.

Public health involves building and sustaining health care infrastructure. Resources such as doctors, nurses, and research findings must be accessible, which is challenging in our fragmented American health care system.

Behavior counts. Diet matters. Smoking can be deadly. Exercise and sleep are beneficial. Access to health care depends on provider incentives, locations, healthy food availability, and whether preventive services reach those in need. Investing in housing, healthy food access and assistance, and mental health care is also crucial.

A health care system that manages chronic illnesses and focuses on prevention, not just acute episodes, is inherently complex. As health actuaries know, the system must be based on four core considerations: access, choice, cost, and quality.

Acting for the common good, personal health is optimized through both personal responsibility and social guidance. When an individual's actions can adversely affect others' health, it is sensible for society to take action, for instance, in the case of infectious diseases, pollution, and misinformation, each of which can spread and harm others.

Globally, according to the International Labour Organization, unsafe work environments cause nearly

three million deaths and 395 million injuries annually, with long working hours being a leading risk factor, followed by respiratory hazards. Workers' compensation, Occupational Safety and Health Administration standards, and regulation of toxic substances, including asbestos, lead, vinyl chloride, and benzene, can improve health outcomes.

A healthy population is a public good that benefits society. It reflects a country's strength and vitality. Prevention—through healthier environments, behaviors, and treatments—lowers health care costs, reduces workplace absenteeism, and minimizes economic disruptions.

When public health works well, we hardly notice it—but when it fails, the effects are swift and widespread. Since U.S. life expectancy and health care costs continue to lag behind other high-income countries, we must expand our efforts to enhance effective and safe public health measures, including those directed at establishing sustainable health care infrastructure, preventive care, and accessible, evidence-based health information.

From disease outbreaks to natural disasters, public health systems are responsible for preparedness and quick and effective response. They can be taken for granted, their value questioned when outcomes are not evident.

Recently, public health has become a political battleground. Disagreements are, of course, reasonable—but this public good should be cherished and enhanced, not politicized. Such altruistic efforts should not be turned into a political issue.

We are all affected. ▲

SAM GUTTERMAN is chairperson of the Social Security Committee and member of the Retirement Practice Council.

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