Global Regulatory Framework

Policy Design as an Optimisation Problem

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Abstract

This White Paper explores the advantages of implementing an algorithmically supported Global Regulatory Framework (GRF) for companies operating in at least three differently regulated jurisdictions. It outlines the necessary framework conditions, procedures, and potential benefits to help globally active firms navigate increasingly competitive and dynamic environments. These dynamics are currently shaped by geopolitical tensions among major powers including the USA, EU, China, Russia, and India, where regulation has emerged as a strategic tool to influence market conditions for domestic and international players. For multinational enterprises, this regulatory complexity presents both opportunities and significant cost-intensive risks that directly affect profit margins.

Given that regulation is a mandatory element of any regulated business model, mathematical principles of complexity management can be leveraged to reduce both regulatory risk and compliance cost. To this end, companies should adopt a GRF tailored to one of three governance-driven implementation scenarios: a maximum approach applying a unified global policy, a minimum approach with jurisdiction-specific guidelines, or a „set-cover" approach where a core framework defines common standards while local deviations are handled through supplementary rules within a standardized system. The latter, informed by the computational set-cover problem, allows for algorithmically optimized management of regulatory complexity.

By deploying such a model, companies can achieve cost reductions of over 30% while simultaneously minimizing legal and operational risks in a structured and sustainable manner.

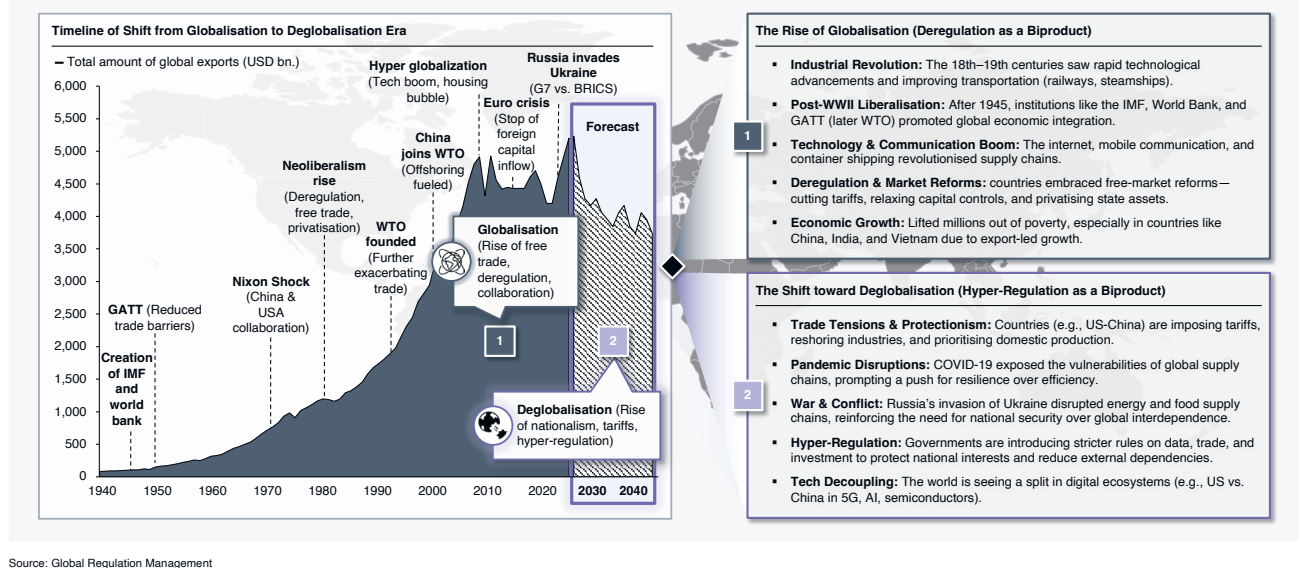# 1   Transnational Regulation Amid Shifting Global Conditions

The momentum of industrial and political change is gaining momentum internationally. Disruptive changes in global business are already being felt in the areas of geopolitical distribution struggles, technology development and regulation, and not just since the start of the second Trump administration at the beginning of 2025.[1]

The dynamics between states and multinational enterprises (MNEs), i.e. organisations that produce or control goods or services outside their home country, have continued to accelerate. This will inevitably have a massive impact on the strategies and operational capabilities of multinational institutions.[2]

Essentially, the main players have remained the same and can still be divided into Western and (South-)Eastern groups. However, this classic dichotomy is increasingly being broken down by the expansion of the BRICS group vis-à-vis the G7.[3]

The driving forces behind the underlying efforts to achieve efficiency and market advantages are well known and can be explained by two established concepts: **Kondratiev waves** and **Moore's Law**, named after a Soviet economist and an American tech entrepreneur.

We are shifting from an era of globalisation—marked by open trade, deregulation, and international cooperation—to one of deglobalisation, driven by trade barriers, tighter regulation, and rising nationalism

Timeline of Shift from Globalisation to Deglobalisation Era

The Rise of Globalisation (Deregulation as a Biproduct)

- **Industrial Revolution:** The 18th–19th centuries saw rapid technological advancements and improving transportation (railways, steamships).
- **Post-WWII Liberalisation:** After 1945, institutions like the IMF, World Bank, and GATT (later WTO) promoted global economic integration.
- **Technology & Communication Boom:** The internet, mobile communication, and container shipping revolutionised supply chains.
- **Deregulation & Market Reforms:** countries embraced free-market reforms—cutting tariffs, relaxing capital controls, and privatising state assets.
- **Economic Growth:** Lifted millions out of poverty, especially in countries like China, India, and Vietnam due to export-led growth.

The Shift toward Deglobalisation (Hyper-Regulation as a Biproduct)

- **Trade Tensions & Protectionism:** Countries (e.g., US-China) are imposing tariffs, reshoring industries, and prioritising domestic production.
- **Pandemic Disruptions:** COVID-19 exposed the vulnerabilities of global supply chains, prompting a push for resilience over efficiency.
- **War & Conflict:** Russia's invasion of Ukraine disrupted energy and food supply chains, reinforcing the need for national security over global interdependence.
- **Hyper-Regulation:** Governments are introducing stricter rules on data, trade, and investment to protect national interests and reduce external dependencies.
- **Tech Decoupling:** The world is seeing a split in digital ecosystems (e.g., US vs. China in 5G, AI, semiconductors).
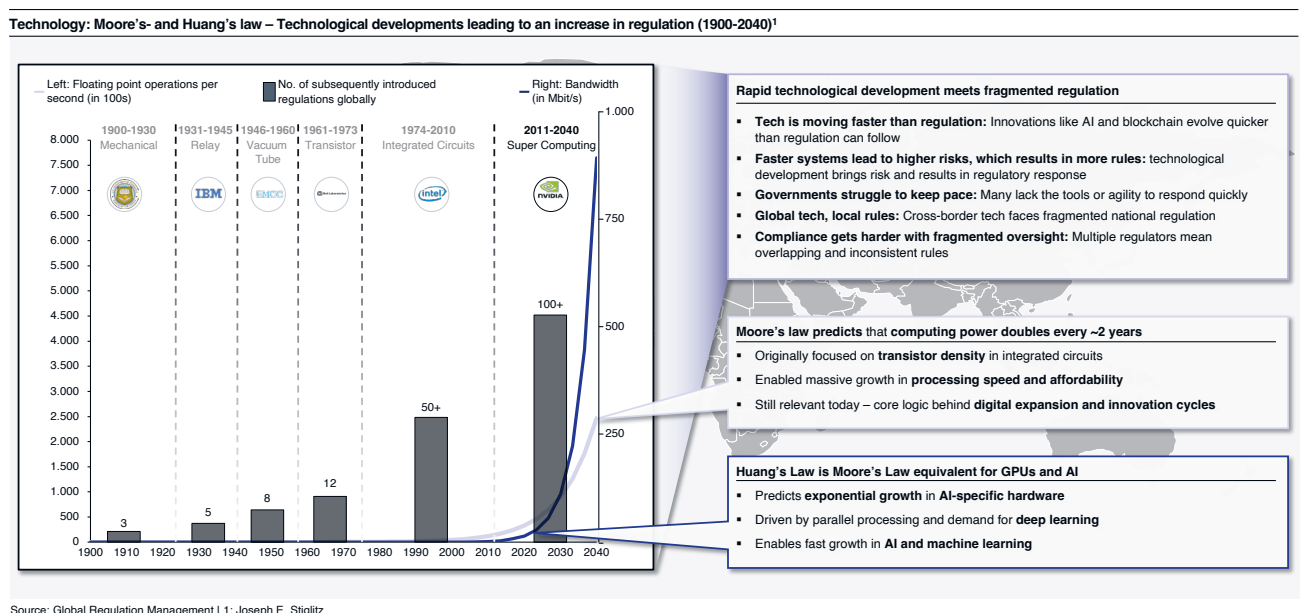
Source: Global Regulation Management

Figure 1: Tightening of regulation due to global developments

Huang's Law can now be added as an optional supplement. This law states that the performance of computer chips that power artificial intelligence more than doubles every two years, regardless of their technical design. **Jensen Huang** is a Taiwanese-American entrepreneur and CEO of Nvidia.[4,5]

Since the establishment of the International Monetary Fund (IMF) and the World Bank, based on the dominant market positions of the G7 countries, trade barriers have been continuously dismantled. Global trade grew, fuelled by neoliberal political trends.[6]

Technological advances in communication, virtual storage (5th Kondratiev cycle, 1970–2010) and supercomputing (6th cycle, 2011–2040) led to an era of **hyper globalisation**, reinforced by the dot-com bubble 30 years ago and the tech boom of the last 15 years, despite the euro crises and localised geopolitical (proxy) conflicts.[7] Even recently, with tariff turmoil, tougher sanctions and political uncertainty in the Western hemisphere, global exports continued to rise.[8]

Since the World Economic Forum in 2024 and with the actions of the second Trump administration since January 2025, it has become clear that the world is entering a phase of deglobalisation, characterised by growing nationalism, tariffs and increasing regulation.[9] Figure 1 shows a forecast of global exports that underscores this trend.

Source: Global Regulation Management | 1: Joseph E. Stiglitz

Figure 2: Technological developments influence regulation

Although not entirely independent of this, efficiencies are developing unabated globally. The biggest drivers of development are the rapid advancement of supercomputing and quantum computing, as well as the various forms of **artificial intelligence**. Figure 2 shows the **principle of efficiency gains** described by Moore's Law and Huang's Law. This remains the growth engine for global tech companies from the US (Google, Microsoft, Nvidia), the EU (ASML, SAP, Prosus), China (Tencent, Alibaba, ICBC), Japan (Sony, Toyota, SoftBank), South Korea (Samsung, SK Hynix) and Taiwan (TSMC, Foxconn, MediaTek).[10]

Technological developments are therefore necessitating further or new legal regulations in the near future. While only around 50 AI-related regulations were identified internationally between 1974 and 2010, this number is set to rise to over 100 by 2030. The EU AI Act is just one of many examples. The same applies to DORA and NIS2.[11] In summary, there are currently **two main drivers for regulation** in international business transactions: geopolitical competition and technological developments.

The US is seeking deregulation to stimulate economic growth, but due to its federal structure, it has one of the most complex legal systems in the world, with tens of thousands of laws, some of which contradict each other.[12] The EU also has thousands of regulations due to the large number of member states and their still heterogeneous political objectives.[13] The People's Republic of China, on the other hand, has only a few hundred national laws that support clearly coordinated overarching economic objectives.

The prioritisation of national interests and the disharmonisation of globally oriented value chains, right through to politically motivated attempts at deglobalisation, are forcing multinational companies to invest more rather than less in ensuring that their international business transactions comply with the rules.[14]

Manufacturers and operators of critical infrastructure are particularly affected, such as the financial market, technology manufacturers, energy companies, water companies, players in transport and logistics, telecommunications, and the pharmaceutical sector.[15]

This publication, **'Global Regulatory Framework'**, analyses current market developments and their impact on the regulatory environment. It shows how a Global Regulatory Framework, based on combinatorial methods, can help internationally active companies to manage regulatory and compliance requirements more efficiently than before. Uniform integration into guidelines, processes and control systems, supplemented by algorithms and decision support systems, ensures massive efficiency and cost advantages.

2 Situation Analysis

Fundamental changes are taking place in the modern business world. Free trade is being restricted, customs duties are being used to restructure public finances and protect national economies from competition. Economic sanctions are part of a competition between systems and technological developments are continuing to gain momentum unabated.[16] This is evident from various factors:

Free trade with structurally low tariffs in global supply chains is a thing of the past. Since 2020, tariffs between the US and China have remained steady at around 20%.[17] The US is considering imposing tariffs on each of the BRICS countries. Although Canada is a neighbour and close strategic partner of the US, aggressive tariffs have been imposed on Canada. Canada responded with retaliatory tariffs of 25% on US goods worth 20.6 billion dollars.[18,19]

The EU is also affected by the US measures, which is why counter-tariffs amounting to €26 billion on US products were announced, effective from April 2025. Furthermore, in October 2024, the EU imposed punitive tariffs of up to 35.3% on Chinese electric vehicles.[20] In response, the People's Republic of China has imposed counter-tariffs of up to 125% on US and European goods and imposed export bans on strategic goods such as rare earths. The situation is highly volatile and there is no end in sight to this trade policy uncertainty.[21]
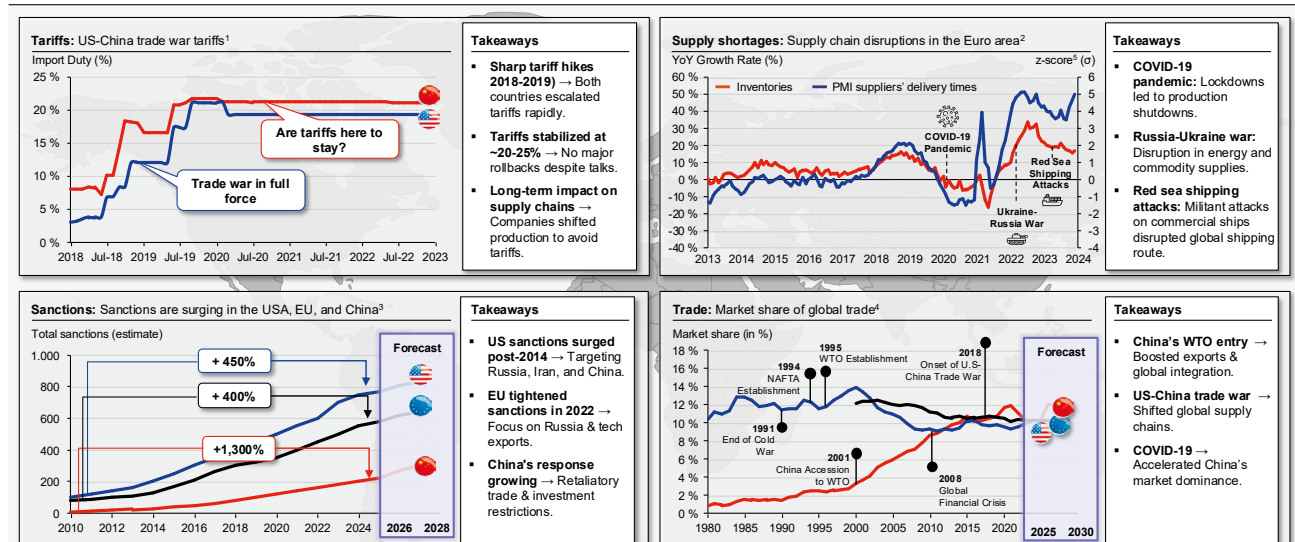
Figure 3: Tariffs, sanctions & shortages

Moreover, **free trade routes are also threatened by geopolitical tensions**. This can be seen, for example, in the 25% slump in trade through the Suez Canal due to attacks on this trade route from Yemen.[22] Another example is the dispute between the US administration and the Panamanian government over control of the Panama Canal and increased investment by the People's Republic of China in Latin America. As a result, U.S. troops were stationed in Panama and contracts with Chinese logistics providers were terminated.[23,24]

Trade routes in the Black Sea are also restricted by the Russian-Ukrainian war, which is significantly impacting global grain trade due to the export strength of Ukrainian agriculture.[25] These developments are putting pressure on highly optimised supply chains and leading to production and market disruptions, and even market failures, in producer and consumer countries.

A similar dynamic is emerging from the West's **sanctions policy**. This is resulting in a shift in trade flows and the formation of economic alliances. Trade between the Russian Federation and the People's Republic of China rose by 64% to 240 billion dollars by 2023. There are no signs of this trend levelling off.[26]

Attention should also be paid to the growing efforts to **circumvent sanctions**: states, companies, and individuals are developing strategies and putting them into practice, for example, through re-exports or shell companies. German exports to Kazakhstan rose by 268%, motivated by resales to the Russian Federation.[27,28] This dynamic is shown in Figure 3.

The final segment of the incomplete list of drivers of change is unbridled **technological momentum**. The current era is characterised by high adoption rates in the following areas: cloud and edge computing, artificial intelligence, climate technologies, bioengineering, robotics, quantum technologies, and space technologies.[29,30,31]

Technological developments are creating further fields of application, which are associated with enormous challenges. According to Moore's Law, the number of transistors doubles every two years. However, the computing power required for AI training **doubles every three to four months**, which represents a **300,000-fold increase since 2012**.[32]

Quantum computers, which are expected to reach market maturity in the next two to five years, pose a threat to encryption systems currently in use. This applies to both symmetric and asymmetric encryption. According to the BSI, **measures must be taken** now. The transition to 'post-quantum cryptography' is therefore a priority. However, only a few institutions in the EU are acting so far, even though this requirement has now become law in the US.[33]

National legislators are attempting to counteract this trend, but the inevitably **heterogeneous requirements** they impose create a level of complexity that is almost impossible for internationally active institutions to manage. Examples of these unique, cross-border regulations include the **EU AI Act**, the **NAII Act** in the United States, and supplementary AI regulations in the People's Republic of China.[34] Figure 4 lists laws from various countries, illustrating the complexity of the legislation.

The People's Republic of China has accepted the competitive challenges posed by the West and is continuing to regulate the use of AI technologies, such as biometric classification and the so-called 'alignment problem', i.e. the ethical behaviour of AI systems.[35,36]

In order to slow down the creation of infrastructure for development in the People's Republic of China, the US has subjected the **semiconductor industry** to increasing regulation. In April 2024, the US government published a 166-page document on import regulations for Chinese semiconductor companies.

Although the US officially pursues a policy of deregulation ('Unleashing Prosperity Through Deregulation'), a closer look reveals a contrary trend. The EU also formulates debureaucratisation as a political goal at the highest level. However, random samples show that the number of pages in the text of data protection law has risen from 100 pages in 2016 to almost 600 pages in 2024, one of many examples of growing complexity.[37,38]

Book of law in select jurisdictions across five domains

Jurisdiction (GDP rank) / Domain	U.S. (1.)	China (2.)	EU (3.)	Japan (4.)	India (5.)	UK (6.)	Brazil (8.)	Mexico (12.)	...	Singapore (22.)	Hong Kong (31.)
Anti-Money Laundering	• AMLA of 2020 • Money Laundering Control Act of 1986	• Anti-Money-Laundering Law PRC (2006, ammended 2025)	• 6AMLD • 5AMLD • EU AML Directives	• Organized Crime Punishment Act • AML-related Measures	• Prevention of Money Laundering Act	• Money Laundering Regulations 2017	• Law No. 9,613/1998 (Art. 1, 9–14) • No. 12,683/2012 – Reporting to COAF	• LFPIORPI (2013) Art. 17–25 + Banxico Circular 3/2012		• MAS AML/CFT Guidelines	• HKMA Supervisory Guidelines (covers AML/CFT topics)
Risk Management	Complexity Score¹: 5.19	Complexity Score: 2.73	Complexity Score: 5.70	Complexity Score: 5.19		Complexity Score: 5.19	Central Braz… Risk (Nor… prudenci… instituições)	Complexity Score: 5.19		Complexity Score: 4.66	Risk …ment …nes
Data Protection	• California CCPA • HIPAA (HHS) • GLBA (FDIC PDF)	• Personal Information Protection Law (PIPL)	• GDPR	• Act on the Protection of Personal Information (APPI)	• Information Technology Act, 2000	• Data Protection Act 2018	• General Data Protection Law (LGPD), Law No. 13,709/2018 – Art. 7	• Federal Law on the Protection of Personal Data (2010) – Art. 6–16		• Personal Data Protection Act (PDPA)	• Personal Data (Privacy) Ordinance (PDPO)
Cyber Security	• Cybersecurity Information Sharing Act (CISA) • FISMA • NIST Cybersecurity Framework	• Cybersecurity Law	• DORA • NIS2 • Cybersecurity Act	• Basic Act on Cyber-security / NISC	• IT Act (2000) • National Cyber Security Policy	• Network and Information Systems Regulations 2018 • Cyber Essentials Scheme	• Marco Civil da Internet (Law No. 12,965/2014) – Art. 10–13: Data privacy & retention obligations	• Law for the Protection of Critical Infrastructure – Draft law targeting cybersecurity		• Cybersecurity Act 2018	• Protection of Critical Infrastructure Bill
Supply Chain Management	• Executive Order on America's Supply Chains • Supply CHAIN Act	• Interim Measures for the Administration of Supply Chain Finance Business	• EU Conflict Minerals Regulation • EU Corporate Sustainability Due Diligence Directive	• Japanese Supply Chain Mgmt Guidelines (Non-binding)	• Indian Supply Chain Management Guidelines (Draft/Non-binding)	• Modern Slavery Act 2015	• Access to Information Law (Law No. 12,527/2011) – Transparency obligations	• General Law Transparency and Access to Public Information (2015)		• Singapore Supply Chain Management Framework (Guidelines)	• Trafficking in Persons Ordinance (Cap. 200)

Complexity Score (1 to 10)

Source 1: Estimated regulatory complexity of AML regimes (proxy via inverted Basel AML index)
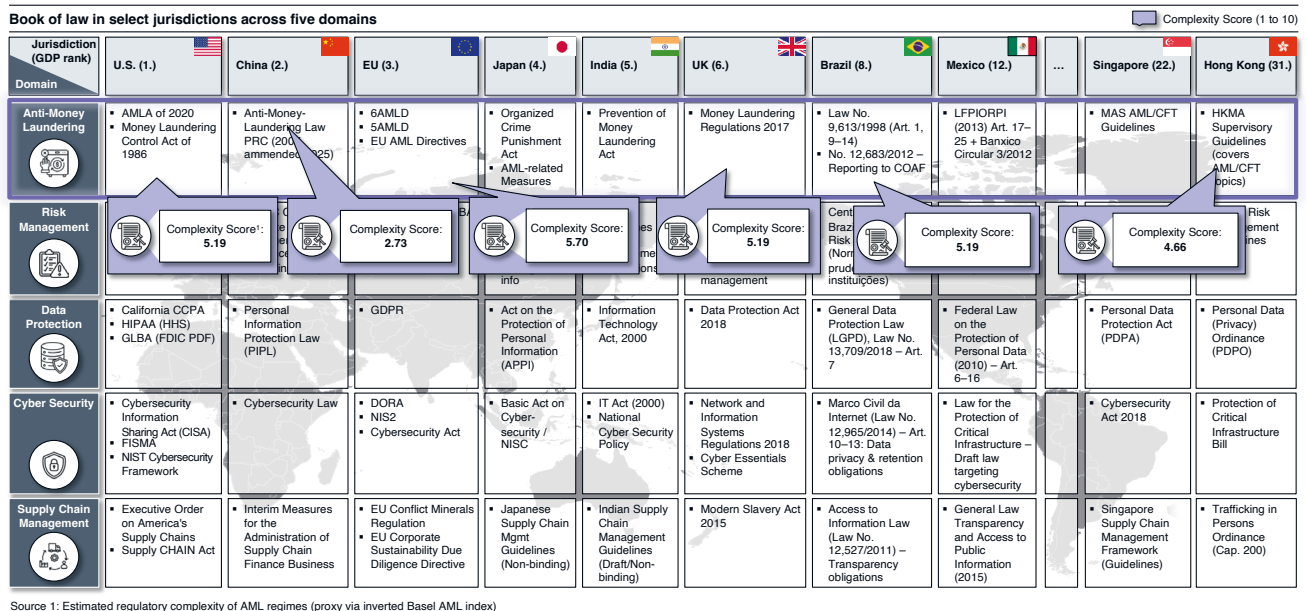
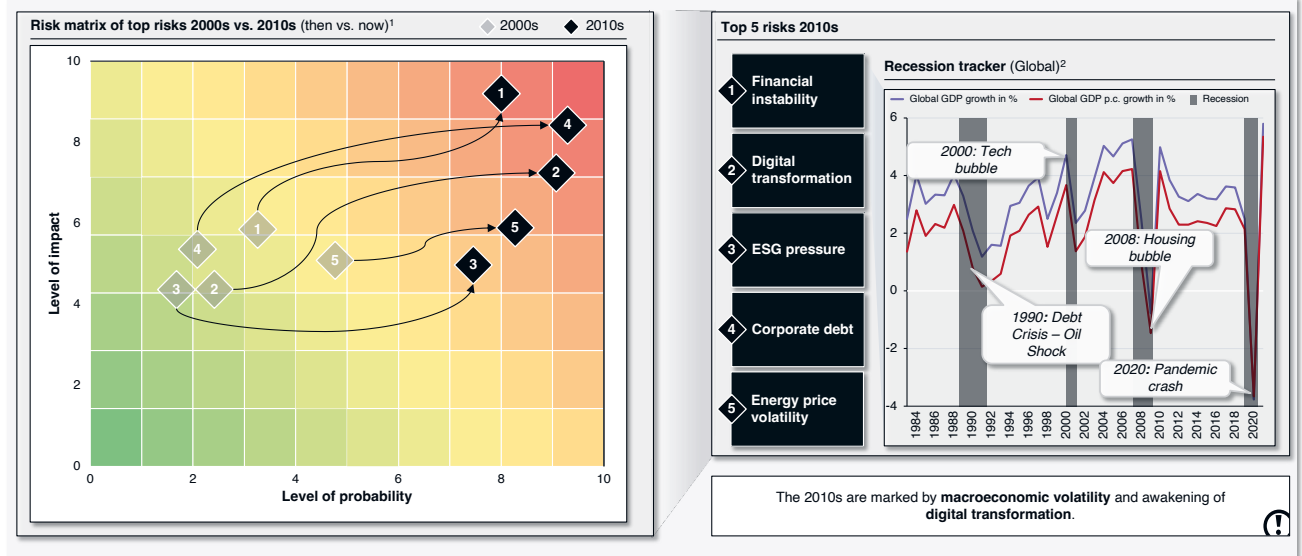*Figure 4: 'Book of Law' for the world's largest jurisdictions*

Responsible management must therefore assume that deglobalisation will lead to more government intervention sooner rather than later. Data will have to be stored more locally than before, capital controls will increase, and fewer IT service providers will be able to be commissioned. Take DORA, for example. The management of IT service providers will become so complicated that financial companies will simply reduce the number of service providers they use. As a result, stricter regulatory requirements will hamper innovation and efficiency, the most important drivers of value for companies.[39,40] As bitter as this conclusion may be for strategic investors and shareholders, it is becoming a reality.

Managements must face up to these new realities. Risk assessments need to be adjusted in light of sanctions-related trade barriers, regulatory obstacles to innovation, hybrid conflicts and **contradictory local laws**.[41,42,43]

Otherwise, structural competitive disadvantages will arise, manifesting themselves in companies' inability to respond to trade policy measures in a prepared manner, their inability to compensate for innovation deficits, and their high probability of being unable to withstand hybrid attacks.

Nevertheless, this development is to be welcomed. Even if stricter regulation causes higher costs in the short term, it can lead to more stable markets and **greater confidence among investors and consumers** in the long term.
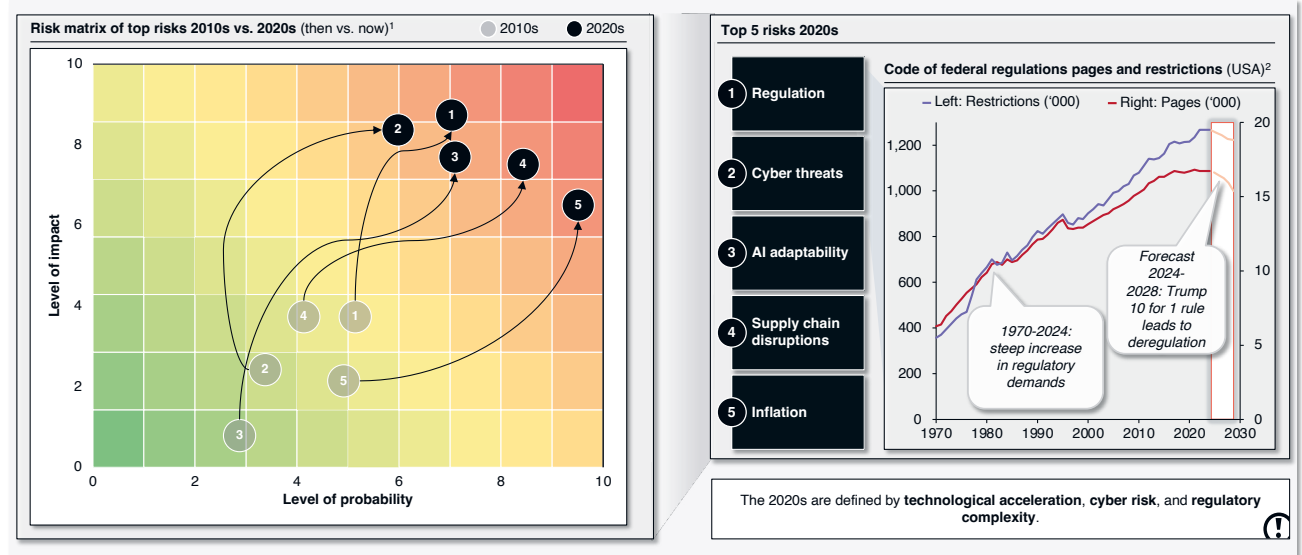
Global risk shifts

Risk matrix of top risks 2000s vs. 2010s (then vs. now)[1]   ◆ 2000s   ◆ 2010s

Level of impact (y-axis: 0 to 10)
Level of probability (x-axis: 0 to 10)

Top 5 risks 2010s

1 Financial instability
2 Digital transformation
3 ESG pressure
4 Corporate debt
5 Energy price volatility

Recession tracker (Global)[2]

— Global GDP growth in %   — Global GDP p.c. growth in %   ▨ Recession

2000: Tech bubble
2008: Housing bubble
1990: Debt Crisis – Oil Shock
2020: Pandemic crash

(x-axis: 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020)

The 2010s are marked by **macroeconomic volatility** and awakening of **digital transformation**.

Source 1: Global Regulation Management I 2: International Monetary Fund

Figure 5: Oil crisis and digital transformation – 2000 to 2010

Following the financial crisis of 2008, **Basel III** introduced stricter capital requirements. This halted the erosion of confidence in the capital markets in the short term and enabled markets to prosper. Figures 5, 6 and 7 show the changes in risk clusters from 2000 to 2030 because of the developments mentioned above.

Global risk shifts

Risk matrix of top risks 2010s vs. 2020s (then vs. now)[1]   ● 2010s   ● 2020s

Level of impact (y-axis: 0 to 10)
Level of probability (x-axis: 0 to 10)

Top 5 risks 2020s

1 Regulation
2 Cyber threats
3 AI adaptability
4 Supply chain disruptions
5 Inflation

Code of federal regulations pages and restrictions (USA)[2]

— Left: Restrictions ('000)   — Right: Pages ('000)

1970-2024: steep increase in regulatory demands
Forecast 2024-2028: Trump 10 for 1 rule leads to deregulation

(x-axis: 1970 1980 1990 2000 2010 2020 2030)

The 2020s are defined by **technological acceleration**, **cyber risk**, and **regulatory complexity**.

Source 1: Global Regulation Management I 2: National Archives and Records Administration's

Figure 6: Technological acceleration and regulatory brakes – 2010 to 2020

Another example of inadequate regulation is provided by the **energy market in California in the 2000s**. It led to manipulation, price explosions and considerable instability in the grid supply. Only after stricter regulations were introduced did stability return, which has continued to this day.[44,45]

Global risk shifts
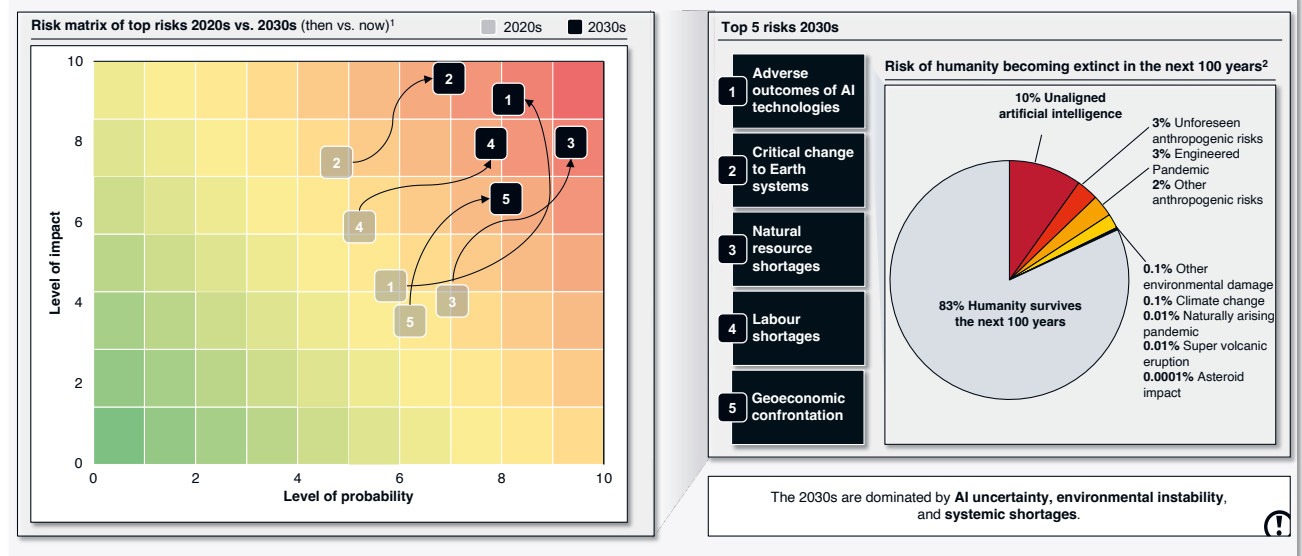
Figure 7: AI risks and system crises – 2020 to 2030

In summary, it can be said that companies will not face new risk combinations and exposures in 2025, but rather different ones. Regulatory requirements represent a significant and growing part of this risk exposure. Regulation is not primarily a legal challenge but is becoming a strategic imperative for responsible corporate action.

3   Operational Challenges in Managing Regulatory Requirements

Inadequate management of geopolitical, technological, and regulatory risks leads to competitive disadvantages in developed, global markets. Tighter regulation as a result of trade conflicts can prove costly, stifle innovation and put further pressure on margins. At the same time, short-term expenses incurred to comply with stricter regulations will be more than offset in the long term by a higher level of maturity in the business organisation. They strengthen the business model, as higher barriers to market entry protect existing market shares from potential new competitors. The laws listed in Figure 8 clearly illustrate the steady tightening of the regulatory environment.

Following the financial crisis of 2008, the Dodd-Frank Act in the US and Basel III in the EU were introduced to enforce higher capital requirements. The aim was to reduce systemic risks, but this also meant that new market participants in the financial industry could only enter the market at considerable expense. As a result, only a few financial technology companies that started out promisingly were able to survive against the established institutions. The Cambridge Analytica scandal in 2018 also led to stricter data protection laws, resulting in tighter GDPR regulations. Massive hacker attacks such as WannaCry, NotPetya, SolarWinds and FTX led to new laws to secure critical infrastructure.[46]

At the same time, however, barriers to the exchange of information are rising. Another sign of economic divisions and thus partial deglobalisation is the increasing restriction of the free internet. Information control and the barricading of knowledge prevent the

free exchange of information. One example of this is the 'Great Firewall' of the People's Republic of China, which massively regulates data traffic to and from China.[47]

As a result, scientific exchange is reduced and international researchers have increasingly less access to Chinese studies. More importantly, the development of regulatory requirements between mainland China and special economic zones such as Hong Kong is becoming less transparent and predictable.[47]

Achieving regulatory compliance in business organisation in this volatile environment is complex and expensive. Companies face a three-way conflict: **complying with local requirements** in the respective jurisdiction, **complying with international requirements, and maintaining economic operations**.
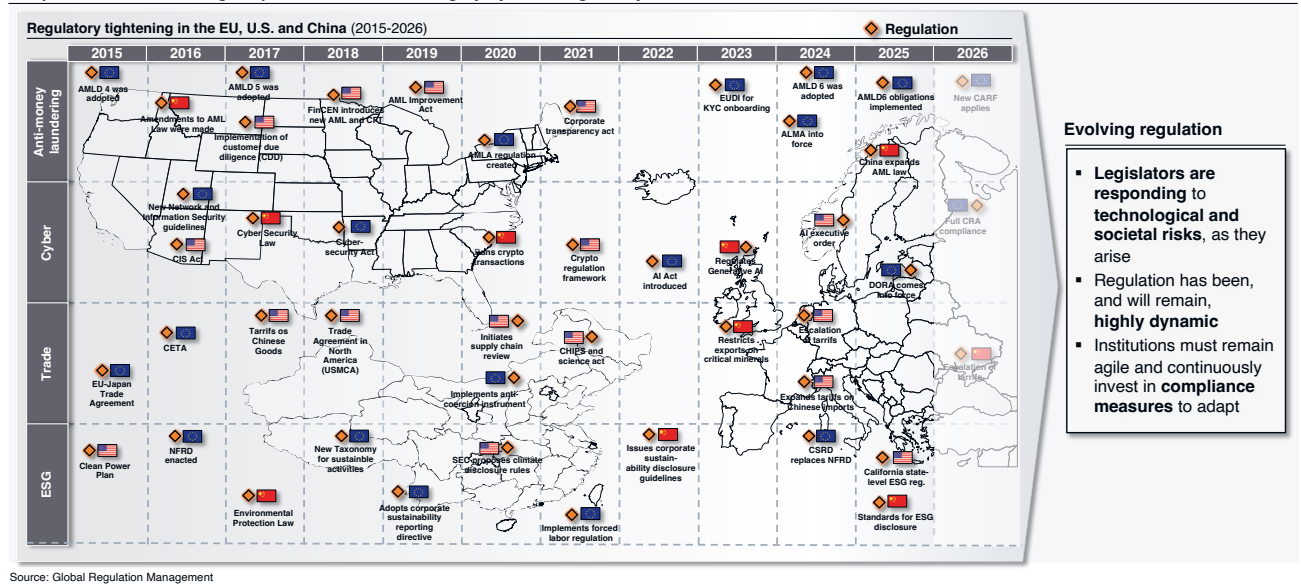
Figure 8: Global regulatory change

Negligence in maintaining compliance can have drastic consequences and result in significant costs. These can include heavy fines, damage to reputation, operational restrictions, and even interruptions to business operations.

Examples of sanctioned violations include the PayPal incident involving a data leak in the sensitive customer data segment, accompanied by a two million dollar fine imposed by the New York Department of Financial Services financial supervisory authority in January 2025, and Glencore's admission of guilt to bribery and market manipulation in the USA, Brazil and the UK, resulting in a fine of 1.1 billion dollars and an 18% drop in its share price in the same year (see Figure 9).[48,49] Some industry sectors are more heavily regulated and therefore face greater challenges. These include aviation and avionics, the pharmaceutical industry, energy suppliers, and particularly the financial sector.[50]

These increased requirements not only result in high costs, but also often slow down the market entry of new providers, which in turn strengthens the market power of established companies in the financial industry.[51] As a result, compliance costs have risen dramatically

over the past five years and will continue to rise. In the EMEA region, regulatory spending amounted to $85 billion in 2023, an increase of 98% over the previous year.[52] Figure 10 shows the compliance costs of four globally leading banks.

Personnel costs for compliance also rose sharply: starting salaries range from €50,000 to €65,000, with management positions starting at €130,000 per year. 72% of financial institutions report increased personnel costs for full-time and part-time compliance staff.[53]

These increases in costs are also due to regulations that are not specific to the industry. The cyber security regulations in the US, the EU, China, India, Singapore, and Hong Kong comprise 641 pages in the main documents alone, not including appendices. The European DORA regulation comprises 79 pages plus 14 documents specifying the regulation (technical and implementing regulatory standards (RTS, ITS) and guidelines).[54,55,56,57]

Consequences of non-compliance with regulations and their protection elements

Common protective elements	Consequences of non-compliance of regulatory protection elements	Subsequent impact on the company's share price[1]
Extended risk management concept	**1 Non-monetary effects** ▪ **Negative impact** on **reputation** and the trust of customers and **investors**. ▪ **Increased** security **risk** due to weaker **cyber** security **infrastructure**. ▪ **Impaired** business **relationships** due to inadequate **security standards**.	MGM resorts share price after data leak[1] (in USD) -37%
Reporting of security incidents	**2 Monetary effects** ▪ **Important facilities** (e.g. financial institutions): Fines of up to €7 million or 1.4% of annual global turnover (Art. 34 (4)). ▪ **Critical facilities** (e.g. chemistry): Fines of up to €10 million or 2% of annual worldwide turnover (Art. 34 (5)).	PayPal share price after anti-money laundering fine[2] (in USD) -23%
Strict supervisory measures	**3 Legal effects** ▪ **Legal sanctions** such as **orders** to remedy **violations**. ▪ **Increased monitoring** and **scrutiny** by regulatory **authorities**. ▪ **Criminal liability** for e.g. the company management or individual responsible persons.	Glencore share price after bribery fines[3] (in USD) -27%
Management of cyber security risks in the supply chain		

Source: Global Regulation Management I 1: CNN I 2: NY State Department of Financial Services I 3: UK Government
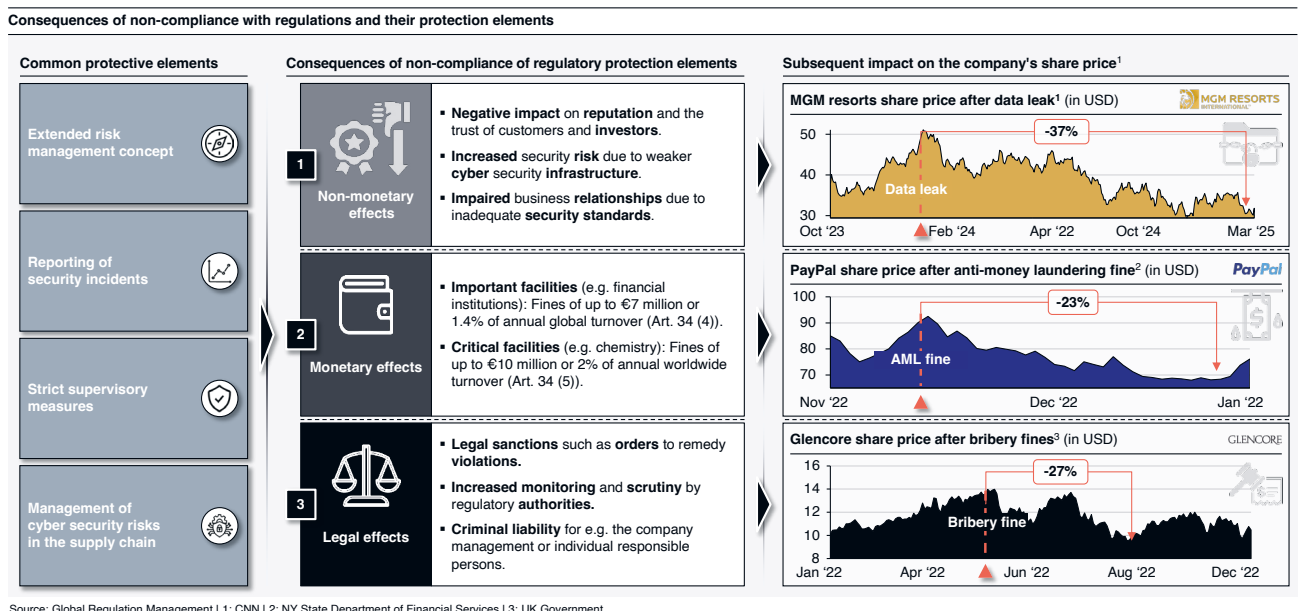
Figure 9: When regulatory risks materialise

Each document contains dozens of individual requirements. The number of broken-down requirements is therefore in the tens of thousands to hundreds of thousands if companies operate globally. In summary, **cross-market compliance is complex**.

Harmonising requirements (e.g. between the EU, the US and China) is a key issue for any institution operating internationally. There are many similarities, many differences and some unique requirements. This means that institutions need access to highly specialised knowledge about local regulations and how they interact with international markets. In addition, different interpretations of laws, linguistic and cultural differences, and varying control mechanisms make planning and implementation difficult.[59]

Even though many companies try to manage their compliance strategy centrally, they often must rely on local branches for implementation. The sheer volume and dynamic nature of the regulations overwhelm traditional, manual approaches.[60]

To avoid this foreseeable dilemma, providers and institutions are experimenting with technological solutions that use AI-supported methods, in particular, natural language processing (NLP) and machine learning. The aim is to manage the increasing complexity. Automated extraction and categorisation of requirements, summarisation of regulations by subject area, and identification of overlaps, contradictions and unique selling points are the means of choice.[61] Figure 11 illustrates the advances in the legal competence of large language models and their growing performance range in different task classes relevant to compliance applications.

Compliance Costs: Hidden Billions in Global Banking

Top 4 Banks – Compliance Spending
Annual Compliance Spending

1 JPMorgan Chase & Co[1]
Estimated annual compliance spending: **$2.5 billion**
$350 million fine in 2023 for the failure to monitor trades
Over **10,000 employees** in risk and compliance roles

2 HSBC Holdings plc[2]
Estimated annual compliance spending: **$2.0 billion**
$120–150 million estimated **additional** regulatory **cost burden** in 2023
Over **7,000 employees** in compliance and legal departments

3 Deutsche Bank AG[3]
Estimated annual compliance spending: **$1.6 billion**
$200 million estimated **additional spending** on regulatory enforcement and remediation in 2023
Over **6,000 employees** in AML, fraud prevention and RegTech

4 Bank of America[4]
Estimated annual compliance spending: **$1.2 billion**
$186 million fine by the U.S. Fed for failing to fix money laundering controls in 2023
Over **5,000 employees** in compliance and control functions

Source: Global Regulation Management I 1: JPMorgan Chase Annual Report 2023 I 2: HSBC Annual Report 2023 I 3: Deutsche Bank Compliance Report 2023 I 4: Bank of America 2023 Supervisory Filing

Figure 10: Compliance costs of the world's largest banks

Results are evident in the development of an efficient global regulatory framework that avoids duplication, reduces redundancy and responds flexibly to change.[62]

Initial industrial experience with these approaches reveals considerable regulatory differences. A comparison of legal requirements in China, Russia, Uzbekistan, the European Union and the United States therefore reveals some surprising findings.[63]

Although there are common core issues (e.g. data protection, consumer protection, environmental standards), the detailed requirements and enforcement mechanisms vary considerably. As a result, the supporting systems must be fragmented, creating a patchwork of regulations with conflicting, overlapping or unclear requirements. These contradictions can only be resolved at great expense in terms of human and financial resources.[64,65,66]

It is becoming clear that locally optimised approaches or bilateral agreements are no longer sufficient. They do not provide efficient solutions that are free of overlaps for the challenges facing global markets.[67]

In today's geopolitical reality, a harmonised global consensus on legal and regulatory standards is further away than ever. The reasons for this can be found in political tensions, which reflect increasing economic competition and rapid technological development.[68] In addition, national and regional authorities are increasingly attempting to implement

locally limited regulatory approaches in order to mitigate the unintended consequences of conflicting established requirements. However, this often results in even more conflicting or redundant requirements on top of existing regulations.[69]

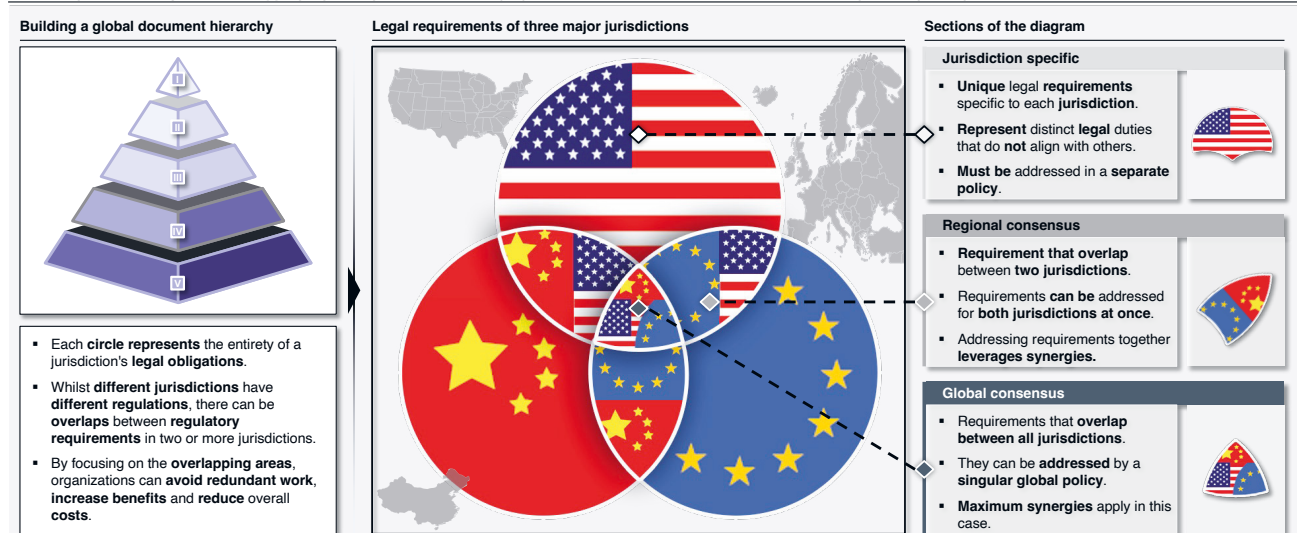**Advancement of AI models in the MBE exam – ChatGPT-4 vs. other LLMs**

AI outperforms students in the Multi-State-Bar-Exam (MBE)

- **ChatGPT-4 outperformed the average student on the Multi-State Bar Exam in 2024**, demonstrating its advanced reasoning and legal analysis capabilities.
- Various other LLMs have surpassed Chat-GPT-4 since then. **AI's growing capabilities raise discussions on its role in education**, legal practice, and decision-making
- The rapid progress of AI models in the MBE exam highlights their **increasing capability to handle complex legal reasoning tasks**.

Performance progression of GPT models on the MBE exam[1]

Category		Rank 1 ChatGPT o3	Rank 2 Gemini	Rank 3 deepseek	Rank 4 OpenAI ChatGPT4.0	Rank 5 MISTRAL AI_
Reasoning	Web_of_lies	93	91.3	80	41.7	35
	Zebra_Puzzle	87	83.3	73.8	50.8	34.5
	Spatial	100	88	76	54	32
	Average	93.3	87.5	76.6	48.8	33.8
Instruction Following	Paraphrase	85.9	80.9	87.1	73	69.9
	Simplify	89.4	81.6	80.5	76.2	68.2
	Story-gen.	84.1	81.6	80.3	73.8	70.3
	Average	86.2	80.6	79.5	72	68
Language	Connections	97	81.8	67.5	37.3	28.8
	Plotscramble	51	60.1	38.8	41	36.5
	Typos	80	66	58	70	56
	Average	76	69.31	54.8	49.4	40.5
Aggregate Average		81.6	77.4	67.5	55.8	43.6

Source: Global Regulation Management | 1: Royal Society Publishing | 2: LiveBench AI (scores are as of 23 April 2025)

Figure 11: AI results in standardised tests

The starting point for standardisation should be to focus on existing commonalities. These can be found in consumer protection, data protection and environmental standards.[70,71] Figure 12 shows these commonalities schematically.

Visualizing how the unique and overlapping legal obligations of three major jurisdictions can be harmonized into an efficient, global regulatory framework

Building a global document hierarchy

- **Each circle represents** the entirety of a jurisdiction's **legal obligations**.
- Whilst **different jurisdictions** have **different regulations**, there can be **overlaps** between **regulatory requirements** in two or more jurisdictions.
- By focusing on the **overlapping areas**, organizations can **avoid redundant work**, **increase benefits** and **reduce** overall **costs**.

Legal requirements of three major jurisdictions

Sections of the diagram

Jurisdiction specific
- **Unique** legal **requirements** specific to each **jurisdiction**.
- **Represent** distinct **legal** duties that do **not** align with others.
- **Must be** addressed in a **separate policy**.

Regional consensus
- **Requirement that overlap** between **two jurisdictions**.
- Requirements **can be** addressed for **both jurisdictions at once**.
- Addressing requirements together **leverages synergies**.

Global consensus
- Requirements that **overlap** between **all jurisdictions**.
- They can be **addressed** by a **singular global policy**.
- **Maximum synergies** apply in this case.

Source: Global Regulation Management

Figure 12: Schematic illustration of regulatory similarities

A company that operates in different jurisdictions (MNE) is therefore faced with the challenge of meeting requirements that are identical, similar or contradictory between different jurisdictions.
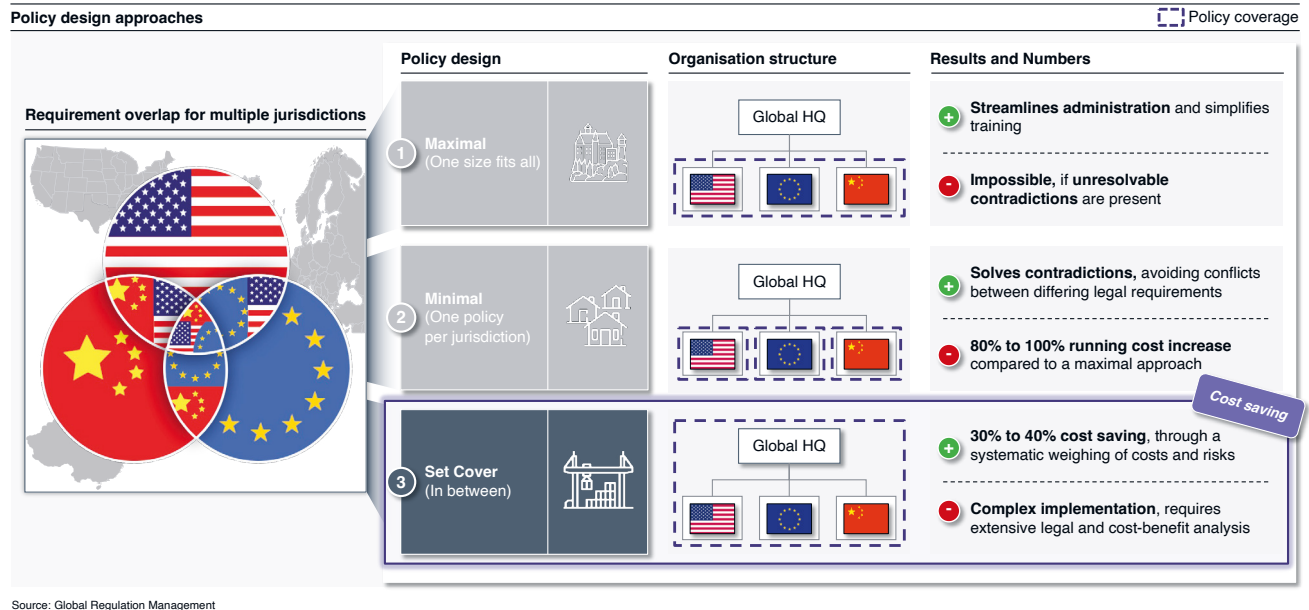
Figure 13: Three approaches to leveraging regulatory commonalities

Three approaches can therefore be identified (see Figure 13) to cover this set of global requirements through guidelines:

1) Maximum approach – one size fits all

A comprehensive policy is being rolled out worldwide to cover legal requirements in all countries. A single, globally applicable guideline that treats all jurisdictions equally often seems to be the best way to deal with the complexity involved. It seems centralised, making it easy to administer and train people on.

However, this approach is not feasible. As explained above, there are recurring, irresolvable conflicts of law between jurisdictions that would undermine the effectiveness of such a regulatory and organisational framework.

2) Minimum approach – individual policies in each jurisdiction

Several policies tailored to each jurisdiction and therefore legally compliant are introduced. This ensures locally optimised conflict avoidance. Apart from the fact that transitions to conflicting regulations in other jurisdictions must be supplemented, there is a glaring disadvantage: operating costs are around 80% to 100% higher due to the operation of parallel sets of rules.

3) Set-Cover-Ansatz – a mathematically optimized global regulatory framework

The consolidation of specialist and legally similar requirements into clusters of different jurisdictions as core policies helps to map the vast number of requirements efficiently. These are supplemented by addenda that reflect the specifics of individual or different jurisdictions, enabling cost savings of approximately 30 to 40%, as demonstrated by the simulation results in Figure 18. This requires regular comprehensive legal and economic analyses to be carried out to reflect changes.

4 Covering and Fulfilling Requirements

Policies are the structural basis for ensuring that legal requirements can be implemented within a company. Each policy covers a clearly defined part of the overall regulatory requirements, ideally without covering any contradictory areas. Think of it as a collection of rules, for example, data protection, IT security, or human resources. A set of rules is fulfilled when a corresponding policy is implemented.

Not all legal requirements can be translated word for word into policies. Some regulations are too general, too context-dependent or require individual legal case-by-case assessments. Nevertheless, **written policies** form a stable foundation for the practical implementation of a large part of the regulatory requirements. They create binding commitments, traceability and repeatability, which are central elements of any functioning compliance architecture. Even if policies cannot cover every eventuality, when embedded in a GRF, they enable systematic compliance with requirements.

It is not only possible but often sensible to combine similar international requirements in a single policy. Many regulatory provisions in different jurisdictions are based on the same fundamental principles, for example in data protection, occupational safety, or anti-money laundering. Even if the specific wording differs, they often require similar measures at their core, such as securing personal data, conducting risk analyses, or training employees.

A cost function that captures the cost of policies based on the requirements they cover

Example overlap factor for various AML laws

	PATRIOT Act	MLR	AML6	CDSA	AML PRC
PATRIOT Act	100%	95%	90%	66%	40%
MLR	95%	100%	88%	61%	43%
AML6	90%	88%	100%	64%	44%
CDSA	66%	61%	64%	100%	65%
AML PRC	40%	43%	44%	65%	100%

Equation for policy costs based on the legal requirements they address

$$\cong \underbrace{\sum_{i=1}^{n} \text{Individual Cost}_i}_{\text{Sum of individual requirement costs}} - \underbrace{\sum_{i=1}^{n} \sum_{j=1}^{n} (\text{Overlap Factor}_{i,j} \times \text{Individual Cost}_i \times \text{Individual Cost}_j)}_{\text{Additional cost increase or reduction from overlaps}}.$$

Net costs of policies can be approximated based on the requirements they cover. They include implementation costs, recurring costs and risk reductions. (!)

Source: Global Regulation Management

Figure 14: Optimising policies by maximising synergy effects

When such common requirements are consolidated into a single, well-structured policy, there is a clear advantage: companies avoid duplication, increase clarity and reduce administrative effort. At the same time, implementation becomes more consistent and efficient, as employees do not have to deal with slightly different sets of rules for each jurisdiction. Instead, the policy follows a common denominator that meets the requirements of several countries at the same time. This makes it possible to meet international standards without bloating the rulebook and creates a **uniform basis for global compliance**.

GRM Global Regulation logo top-right

This fundamental consideration can be viewed mathematically: The costs (expenses) associated with a policy can be modelled in relation to the legal requirements it fulfils. If the requirements covered are similar, synergy effects arise, and the price does not increase by the full cost of the second requirement, but proportionally to the degree of conformity. More complex effects, such as declining returns, can also be modelled. Figure 14 shows the quantification of synergy effects based on similarities in legal requirements.

The aim of GRF design should be to maximise these synergy effects: to cover as many similar, non-contradictory requirements as possible together, so that exceptions are rare. This consideration can be formalised mathematically as an optimisation problem.

5 Structural Support Through a Global Regulatory Framework (GRF)

In order to cope with the complexity of global regulatory requirements, it is advisable to establish a Global Regulatory Framework (GRF). This framework enables companies to cover all legal requirements in all jurisdictions while minimising implementation, maintenance and audit costs as well as potential fines and reputational damage, and to set risk-based priorities if desired.

The GRF follows the principle of 'jointly where possible, specifically where necessary'. It consists of two module levels:

- Basic modules bundle globally applicable core requirements, such as basic data protection settings.
- Country-specific modules cover local peculiarities, such as reporting obligations in the EU or ESG reporting in Switzerland.

This modular structure maximises the reuse of proven regulations, reduces redundancies and makes the entire work transparent and clear. Figure 15 lists the document types in a GRF.

The GRF relies on a data-driven optimisation process to select the proper policies. First, in a semi-automated step, all relevant requirements from the laws of the jurisdictions involved are collected and grouped into clusters according to theme. Then, for each cluster of requirements, the possible implementation and audit costs as well as potential fines, reputational risks and opportunity losses are estimated. A decision-making model then selects the clusters that cover all requirements while keeping the overall costs for the company as low as possible.

Companies have two strategic implementation options:

1) Full compliance ensures that every requirement is met in full form the outset. This approach is particularly necessary in highly regulated areas.
2) Risk-based transition prioritises requirements whose non-compliance would result in highest fines. Full regulation will then be phased gradually in consultation with regulators.

Both options can be flexibly combined depending on the business area and jurisdiction in order to take advantage of positive arbitrage effects.

A Global Regulatory Framework (GRF[1]) aims for a comprehensive approach that encompasses all applicable laws and standards along a logical document hierarchy

Technical regulatory dimension		Geographical dimension
Guideline — Overarching management's letter of commitment., that must be brought to the attention of all employees.	I	**Global** — Applies to the entire group of companies (e.g. group guidelines). These often contain framework requirements for subsidiaries worldwide.
Policy — Includes roles and responsibilities as well as requirements. Contains security controls of the 2nd LoD.	II	**Regional** — Specific requirements for a geographic region where regulatory or operational requirements are similar.
Process — Description of an individual activity as a process that is implemented as part of the 1st LoD activity.	III	**Local** — Documents relating to national laws, regulatory authorities, or a specific subsidiary.
Work Instruction — Specific step-by-step instruction for effective implementation of procedures and controls.	IV	**Entity-specific** — Documents that are only valid for a specific entity, branch, or legal entity (e.g., London branch).
Evidence Document — Records and documents to prove compliance with legal requirements.	V	**Department/Function Specific** — Operational implementation at departmental level, often for work instructions and evidentiary documents.

Source: Global Regulation Management

Figure 15: The Global Regulatory Framework contains an ideal written order for an MNE. It optimally covers all legal requirements of different jurisdictions.

The technical core of the GRF consists of:

▪ Requirement extraction supported by NLP tools that convert legal texts into structured requirements.

▪ Assessment of policies according to predefined criteria (e.g. implementation costs, running costs).

▪ Regular optimisation cycle that semi-automatically updates policy selection in response to new legislation or audit results.

The final decision on the scope and pace of implementation remains with management or the relevant authorities. Algorithms can provide data-driven recommendations.

A clear migration plan accompanies the transition from existing regulations to the new GRF by closing gaps and eliminating duplicate regulations. Continuous updates and internal and external audits ensure sustainability and guarantee that new requirements are incorporated into the framework in a timely manner. Performance metrics measure savings achieved, reduced violations and improved audit results, making the success of the GRF transparent and manageable.

6 The Four Steps in Developing a GRF

Figure 16 shows the four steps involved in creating an optimised GRF.
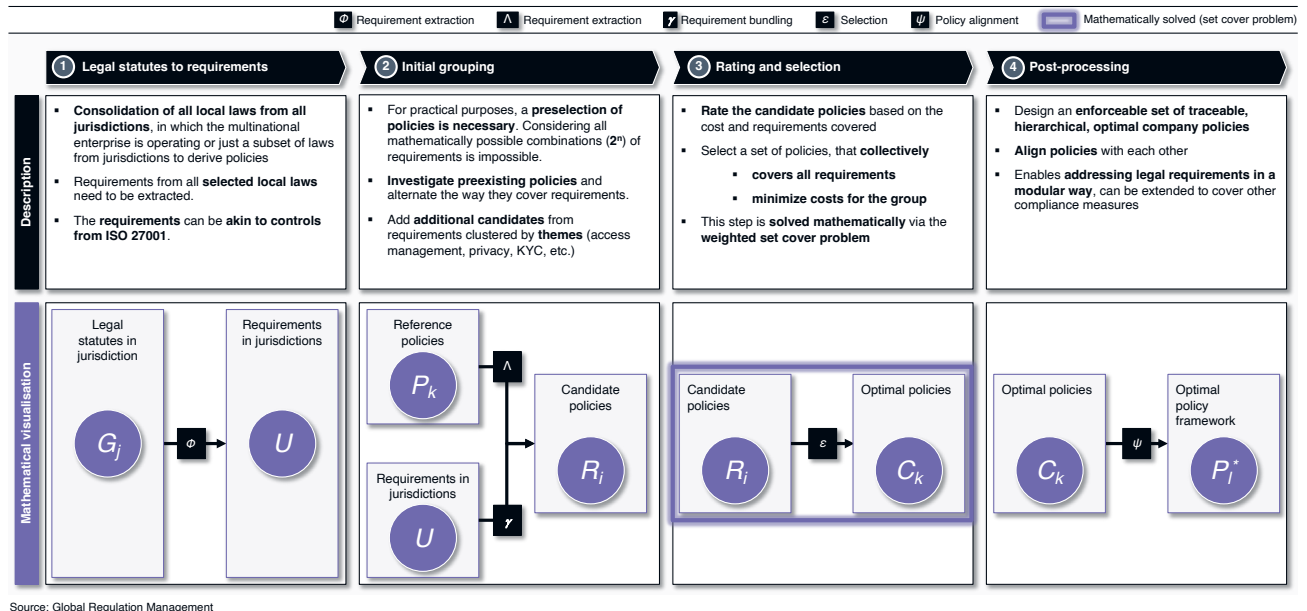
Figure 16: Systematic optimisation of policies through a combinatorial approach

Step 1: Translate legal statutes to requirements

The first step is to consolidate all local laws from all relevant jurisdictions and systematically analyse their content. Then, the specific requirements are extracted, comparable to the controls in ISO 27001. Each individual legal provision is converted into a standardised, verifiable requirement.

Step 2: Initial grouping

Based on these requirements, a manageable pool of policy candidates is preselected. Existing policies are examined to determine which requirements are already covered and then supplemented with additional suggestions from thematic clusters, such as access control, data protection or KYC. Optimised and altered versions of existing policies are added to the pool of policy candidates.

Step 3: Rating and selection

In the third step, the policy candidates are evaluated in terms of their costs (implementation, maintenance, audit, penalties for breach of regulations). The set of policies that meets all requirements and minimises the **total costs for the group** is then selected. Alternative objectives are also possible. Technically, this is done using a **weighted set-cover model**, implemented as a mixed-integer linear programming approach with binary decision variables, cover constraints and a cost objective.

Step 4: Post-processing

Finally, an enforceable, hierarchically structured policy catalogue is created and the selected policies are standardised with each other. At the same time, the modularity of the framework is ensured so that it can be easily expanded with additional compliance measures in the future.

A clearly defined migration plan accompanies the transition from existing regulations to the GRF by closing gaps and eliminating duplication. Continuous updates and internal and external audits ensure that new requirements are incorporated into the framework in a timely manner. Performance metrics, such as percentage cost savings, the number and severity of violations, and the proportion of audits with no findings, make savings, risk reductions and audit successes transparent and manageable.

7 Efficiency Gains Through Algorithmic Optimisation

Regulatory requirements can be understood as elements of a common list of requirements. There are three types of relationships between them: neutrality (no overlap), agreement (partial agreement) and contradiction (incompatibility). Policies cover specific requirements and can thus be understood as subsets of this whole.
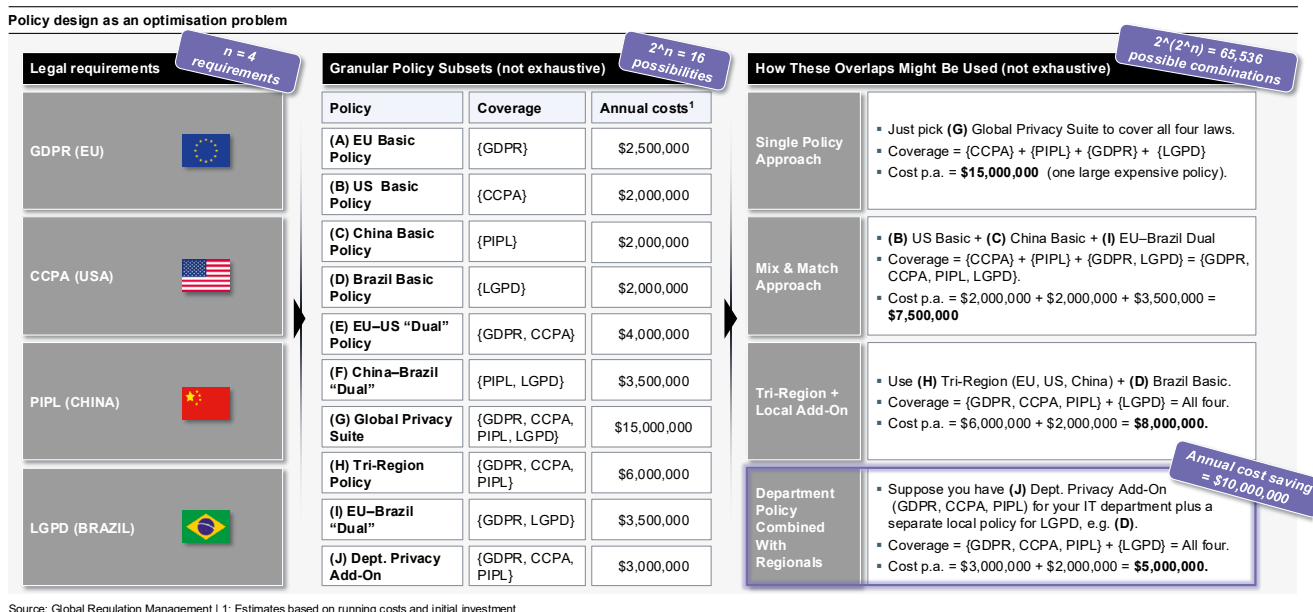
Figure 17: Selecting the best set of policies from 65,000+ options

The optimisation approach seeks to identify the mix of policies that covers all legal requirements while minimising overall costs. A schematic example is shown in Figure 17. Costs and benefits are quantified: a policy incurs implementation, maintenance and training costs, but its coverage effect reduces the risk of fines and the effort required for audits.

Figure 18 shows how the annual compliance costs of a multinational company develop with an increasing number of operating countries using three different policy design strategies. The red line symbolises the minimum approach, in which a completely separate policy is created for each jurisdiction. This curve rises almost linearly and very steeply. Below it is the grey line, which represents the maximum approach. Here, a central basic policy is supplemented by country-specific additions, due to the impossibility of covering all conflicting requirements with the same policy, which leads to higher costs than with the optimised procedure, but lower costs than with the minimal approach. The green line, which represents the set-cover-optimised approach, is the lowest. It flattens out significantly and shows that selecting an optimal combination of policies can greatly reduce the cost increase per additional country.

With coverage of 30 countries, the set-cover-optimised approach results in annual savings of around $300 million (approximately 30% of total costs) compared to the maximum approach. This simulation shows that, especially as the number of jurisdictions increases, the economic benefits of a set-cover-based compliance framework grow significantly and that this approach offers MNEs the highest cost efficiency.

Cost comparison[1] of different global policy frameworks based on model simulations
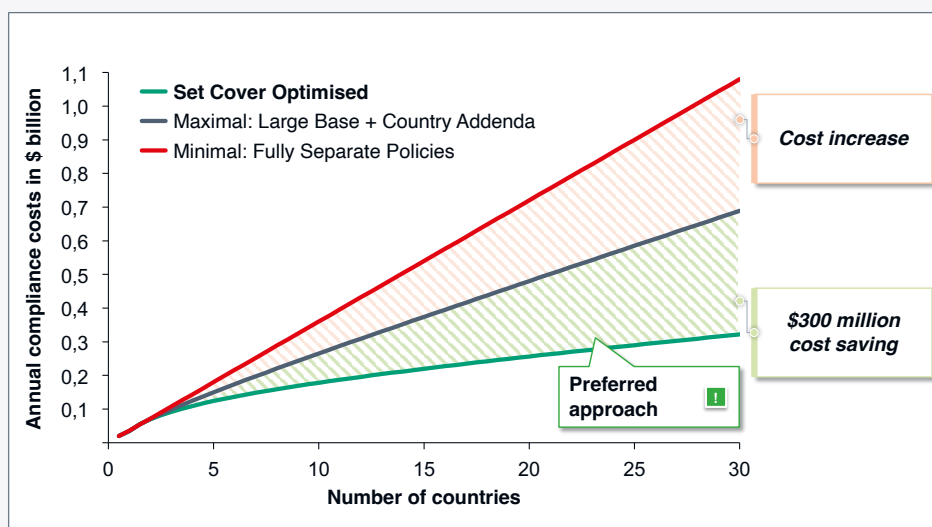
Source: Global Regulation Management | 1: Estimates assumes a lower bound approximation for the average number of requirements shared between countries and territories at 50%

Figure 18: Set cover optimisation provides a cost-efficient global regulatory framework.

These results are based on the following effects:

- Reduced labour costs due to less duplicate processing.
- Reduction of risks, such as lower fines or damage to reputation.
- More efficient audits, as clearly structured rules simplify documentation.

All in all, algorithmic optimisation not only creates a more accurate picture of global requirements but also lays the foundation for a resource-efficient and strategically coherent compliance architecture with demonstrable economic benefits and high adaptability in a dynamic regulatory landscape.

Summary

In view of the increasing **fragmentation of global regulation** and **rapid technological developments**, multinational companies are faced with the challenge of **meeting regulatory requirements efficiently, non-contradictory** and **cost-effectively**. This white paper has shown that traditional approaches, whether a one-size-fits-all approach or complete decentralisation by jurisdiction, are reaching their limits and leading to significantly higher operating costs and increased risks.

The set-cover approach presented here offers a **pragmatic alternative** by enabling a **modular Global Regulatory Framework (GRF)** through combinatorial optimisation and NLP-supported requirement extraction. By aggregating similar requirements in base modules and mapping local specifics in supplementary modules, **synergy effects** can be leveraged, compliance costs reduced by approximately 30%, and flexibility for future legislative changes ensured. Algorithmic optimisation ensures that the GRF can be continuously adapted to new framework conditions without significantly increasing administrative overhead.

A pragmatic, step-by-step approach is recommended for successful implementation:

1) **Build a database**: complete recording of all relevant laws and regulations, both global and local, in a central compliance database.
2) **Pilot project**: Testing the set cover model in a narrowly defined business area to demonstrate validity and process efficiency.
3) **Rollout plan**: Development of a phased roadmap for expansion to other jurisdictions and business areas, accompanied by clear milestones and KPIs.
4) **Governance & Monitoring**: Establishments of a regular review and update loop, supported by automated audits and performance metrics for monitoring success.
5) **Change-Management**: Accompanying training and communication measures to promote acceptance and a sense of responsibility in all organisational units.

With this combination of mathematical precision, technical automation and clear governance, companies can master regulatory complexity, sustainably reduce costs and secure strategic competitive advantages in an increasingly fragmented environment.

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List of abbreviations

Abbreviation	Description
AI	Artificial Intelligence / Künstliche Intelligenz
ASML	Advanced Semiconductor Materials Lithography (Niederländischer Chipmaschinenhersteller)
BCBS	Basel Committee on Banking Supervision
BRICS	Brazil, Russia, India, China, South Africa
BSI	Federal Office for Information Security (Germany)
DSGVO	General Data Protection Regulation (GDPR)
DORA	Digital Operational Resilience Act
EMEA	Europe, Middle East and Africa
ESG	Environmental, Social, Governance
EU	European Union
FTX	Cryptocurrency Exchange FTX
GDP	Gross Domestic Product
GRF	Global Regulatory Framework
GRM	Global Regulation Management
ICBC	Industrial and Commercial Bank of China
IWF	International Monetary Fund
ITS	Implementing Technical Standards
KI	Artificial Intelligence (Deutsch: Künstliche Intelligenz)
LLM	Large Language Model
MNE	Multinational Enterprise
NAII	National AI Initiative (USA)
NIS2	Network and Information Security Directive 2
NLP	Natural Language Processing
RTS	Regulatory Technical Standards
SAP	Systems, Applications, and Products in Data Processing
TSMC	Taiwan Semiconductor Manufacturing Company
USA	United States of America
US	United States
UK	United Kingdom

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