Institute and Faculty of Actuaries

Independent thinking from the IFoA

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Hidden corridors: risk, dependency and fragility in the systems that underpin modern life

by **Cat Drummond, Daniel Sacks and Charl Cronje**

Independent thinking from the IFoA

Part of the IFoA's purpose is to promote debate within and beyond the profession, and to position our members as leading voices on the biggest public policy challenges of our time.

We aim to showcase the diverse range of expertise and critical thinking both within and outside the profession.

Our 'think' series seeks to promote debate on topics across the spectrum of actuarial work, providing a platform for members and stakeholders alike and sharing views that may differ from the IFoA's house view. In doing this, we hope to challenge the status quo, question the orthodoxy, and shine a light on complex or under-examined issues, thereby stimulating discussion and dialogue to help tackle issues in a different way.

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Preface

Modern life depends on systems that are deeply interconnected, globally distributed and increasingly concentrated. Food, water, energy, communications and finance all rely on the continuous movement of resources, information and capital through a relatively small number of routes, infrastructures and networks.

In this paper, we describe these routes and systems as *corridors*. Corridors may be physical, such as shipping lanes, pipelines and subsea cables, or institutional, such as payment systems, clearing mechanisms and financial infrastructure.

Many of the risks explored in this paper have the potential to become systemic, affecting entire economic and social systems. Our focus, however, is not on systemic risk in general, but on how disruption propagates across corridors and shared dependencies.

The purpose of this paper is not to predict specific events. Rather, it is to help organisations, policymakers and risk professionals think more clearly about how disruption spreads across interconnected systems, and how those disruptions can affect economic activity and social stability.

We hope the paper encourages more explicit consideration of corridor dependencies within public policy, risk management, operational resilience and long-term decision-making.

The corridors explored here are not exhaustive. Other systems, including institutional, legal and governance frameworks, also underpin societal and economic stability.

Disruption to critical corridors ultimately affects far more than just infrastructure and trade. It affects households, businesses and financial systems. Food and energy disruption can increase inflation and reduce affordability. Connectivity failures can interrupt payments, communications and commerce. Water stress can affect agricultural output, migration and industrial activity.

These impacts can, in turn, feed through into inflation, economic growth, credit quality, investment performance, asset values and the functioning of financial markets themselves.

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Introduction

Society depends on complex and interconnected systems.

Food appears on shelves. Water flows from taps. Energy powers homes and industry. Data moves instantly across borders. Payments clear in seconds. These systems are so embedded in daily life that they can be taken for granted – until they stop working.

Many of these systems are not as well-distributed or resilient as we might think. Instead, they can depend on a small number of physical routes, assets and infrastructures – *corridors* – through which goods, resources, information and capital flow. These are often highly efficient, shaped by decades of investment and optimisation. But they can also be highly concentrated.

The push for greater efficiency has driven consolidation. Supply chains have been streamlined. Global infrastructure has been built around the most effective routes. This reduces redundancy and increases dependency on an ever-smaller number of pathways, bringing lower costs, faster delivery and greater connectivity. But when disrupted, the consequences can be disproportionate.

Recent events have put this in the spotlight. Climate-related events, geopolitical disruption and the Covid-19 pandemic have highlighted how quickly local issues can have global consequences.

In each case, the impact has been shaped not just by the availability of resources, but by how those resources move, who controls the routes through which they flow, and where multiple systems depend on the same corridors or infrastructure.

This paper highlights these corridors, with the aim of making their role and vulnerabilities more visible, and the systemic risks they drive easier to understand.

Throughout, we use "what if?" scenarios to explore how disruption might arise and spread across systems.

We consider the corridors through the lens of everyday life:

- **Food** and how it is produced and moved across global trade routes
- **Water** and how access is shaped by geography, infrastructure and control
- **Energy** and how it powers homes, industry and the systems that depend on it
- **Connectivity** and how data moves through physical networks that underpin communication and digital activity
- **Finance** and how money flows through banking and payment systems that enable economic activity

A first step in gaining a better understanding is to identify where risk is concentrated, i.e. where supply depends on a small number of routes, assets or providers, and where disruption would have a disproportionate impact.

From there, the focus shifts to interconnection. These systems do not operate in isolation; disruption in one can quickly affect others, particularly where they share infrastructure, inputs or dependencies.

Understanding how these links behave under stress is essential, especially where multiple pressures occur at the same time.

The aim of this paper is not to predict specific events, but to highlight where fragility and dependency exist and how it can propagate systemically.

Only then can we build a clearer picture of what is at stake and where weaknesses may need to be addressed in future.

These systems do not operate in isolation; disruption in one can quickly affect others.

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Food: battle for the breadbasket

As Maslow observed[1], when food is scarce, it dominates both present decisions and future hopes. A stable food supply is not only about nutrition; it underpins social stability, economic security and, ultimately, human survival.

But the way we feed the world today is anything but local or self-contained. Modern diets are built on global supply chains that stretch across continents, connecting producers and consumers through a relatively small number of routes. What appears abundant and resilient is, in reality, more concentrated and more dependent than it first seems.

Did you know?

- 51% of global calorific intake comes from just three cereals: maize, rice and wheat[2].
- In the poorest countries, cereals can be as much as 80% of calorific intake[3].

For many parts of the world, the dependence on cereals is direct, with these crops forming the bulk of daily diets. In western economies, the connection is less visible, but no less important. Cereals underpin much of the food system: as feed for livestock, inputs into processed foods and a key driver of global food prices.

As a result, disruptions to these crops do not just affect what people eat; they affect the cost and availability of a wide range of everyday products, from bread and pasta to meat and dairy.

Concentration of supply

These crops are not grown evenly across the world: their production and export are concentrated in a limited number of regions, which creates concentrations that are easy to miss in times of regional stability.

Wheat: Russia accounts for around 21% of global exports and Ukraine a further 8%[4]. This means more than a quarter of internationally traded wheat comes from two countries currently at war with each other. Much of this trade moves through the Black Sea, a critical corridor linking producers to global markets.

Rice: Nearly 3 billion people depend on rice for survival and, in some countries, it provides up to 70% of daily caloric intake[5]. Production and export are heavily concentrated in Asia, with major flows moving through the South China Sea. This is one of the most strategically important maritime regions in the world.

Recent examples of these risks crystallising include in 2010, when a severe heatwave devastated the Russian wheat harvest. In response, Russia imposed an export ban to protect domestic supply. The decision was understandable from a national perspective, but from a global perspective, it was destabilising.

Countries heavily reliant on Russian wheat (e.g. Egypt and Turkey[6]) were forced back into international markets at short notice, and faced sharp price increases. At the time, Russian President Medvedev argued there were "no objective reasons"[7] for rising prices because global supply was sufficient.

In practice, the sudden loss of a major exporter put pressure on markets at short notice, driving up prices as countries competed to secure supply.

The 2008 Global Rice Crisis was a combination of rising oil prices and export restrictions from key producers such as India and Vietnam, causing rice prices to triple in less than four months[8].

As panic spread, countries imposed further export bans and consumers began hoarding. Riots broke out across multiple countries, from the Philippines to Morocco.

In Haiti, where much of the population lived on less than $2 a day and relied heavily on imports, unrest turned deadly, with several people killed and dozens more injured as protests escalated[9].

> ***"People panicked everywhere... rice markets got cleaned out in two days."***
>
> Timmer, on the 2008 rice crisis[10]

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The national interest paradox

These episodes point to a shift where food security is no longer about agriculture and trade. It is increasingly a matter of national security.

Disruptions to food supply can trigger cascading effects; from hoarding and rationing through to civil unrest and rioting.

In response, governments are placing greater emphasis on protecting domestic supply, even where that comes at the expense of global markets[10].

This is the national interest paradox. Actions that are rational at a national level (e.g. restricting exports, stockpiling supply, prioritising domestic demand) can make the global system less stable.

When disruption occurs, these responses amplify volatility rather than contain it: what begins as a local shock can quickly become a global one.

What if?

The global food system is often described in terms of production and consumption. But its real vulnerability lies in how food moves.

A relatively small number of routes carry a disproportionate share of the world's staple crops. These routes sit at the intersection of geography, economics and politics. When they function, the system appears seamless. When they are disrupted, the consequences are immediate and far-reaching.

Climate-related shocks, such as droughts and heatwaves, can further concentrate pressure on key production regions.

The fragility of the system becomes clearer when considered through plausible disruptions:

- What if shipping through the Black Sea became unviable, restricting wheat exports from Russia and Ukraine?
- What if tensions in the South China Sea escalated, disrupting the flow of rice across Asia?
- What if extreme weather affected multiple crop-producing regions at once, reducing global supply at the same time?
- What if export bans cascaded across countries, as governments moved to protect domestic supply?
- What if an energy shock fed through to food, disrupting fertiliser production and transport?

None of the scenarios considered here or in later chapters are far-fetched; variations of each have already occurred or are currently occurring.

Food may be the most basic of human needs, but the system that sustains it is anything but simple.

It is built on concentration, dependent on movement, and exposed to disruption that can manifest very quickly.

And food is only the starting point. The same patterns of dependency run through other systems we rely on every day; often with consequences that are less immediately obvious, but no less significant.

Disruptions to food supply can trigger cascading effects; from hoarding and rationing through to civil unrest and rioting.

Water: weaponising the flow

Water is easy to take for granted. It is ever-present in daily life; flowing from taps, embedded in food and sustaining systems around us.

Humans can survive for weeks without food, but only days without water.

Beyond personal consumption, water underpins agriculture, energy and industry. Crops depend on irrigation. Livestock require consistent supply. Power generation, from hydroelectric dams to cooling systems, relies on it too. In that sense, water is not just a basic need; it is also a shared input across multiple critical systems.

Unlike food, water is far less mobile and inherently tied to geography, e.g. rivers, aquifers and rainfall patterns.

As a result, access is uneven, which means control over supply becomes strategically important. Where water crosses borders, this creates concentrations, dependencies and, at times, tension.

One of the earliest recorded conflicts over water occurred around 2500 BC between the Sumerian city-states of Umma and Lagash, disputing access to irrigated land[11].

Today, some of the most significant water systems in the world are shared across multiple countries.

Rivers without borders

The Euphrates and Tigris rivers originate in Turkey and flow through Syria and Iraq before reaching the Gulf. For much of the region, they provide a critical share of freshwater supply. Upstream control sits largely with Turkey.

Turkey's Anatolia Project (a network of 22 dams designed to generate hydroelectric power and irrigate farmland) has significantly altered the flow of water downstream. Iraq's supply from the two rivers has fallen by 30–40%, and Syria's by around 40%[12].

To date, these reductions have not led directly to conflict, but they have raised tensions and increased fragility across the region.

While water stress alone may not cause state failure, when combined with poverty, political instability and weak governance, it can contribute to wider disruption.

The situation is further complicated by competing actors. The Kurdish regional government has built additional dams in recent years, using control over water as leverage in its relationship with Iraq[12].

Upstream and downstream

A similar dynamic plays out in the Indus River basin, which supports hundreds of millions of people across India and Pakistan.

The six main tributaries of the Indus originate in India before flowing into Pakistan. For Pakistan, the river is critical: it provides around 75% of renewable water supply[13], supports 94% of agricultural use[14], and underpins a significant share of the economy and employment. Major cities, including Karachi and Lahore, depend on it for drinking water, while around 20% of electricity comes from dams within the basin[14].

Did you know?

In Pakistan:

- **94%** of water use is for agriculture[14].
- **23%** of GDP comes from agriculture[14].
- **37%** of employment is related to agriculture[14].
- **20%** of electricity comes from hydropower generated in the Indus basin[14].
- **90%** of agriculture is dependent on the Indus[15].
- **Hundreds of millions** depend on a single river system.

For India, control over upstream flows presents both an opportunity and a source of leverage. For Pakistan, it represents a structural vulnerability.

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This imbalance has long been recognised. The Indus Waters Treaty, signed in 1960, was designed to manage access and reduce conflict, but the underlying tension has never disappeared.

In April 2025, that tension crystallised. Following an attack in Indian-administered Kashmir that killed at least 26 people, India suspended the treaty, stating it would remain "in abeyance"[16] until certain conditions were met. Pakistan warned that any attempt to disrupt water flows would be considered an act of war.

Indian PM Modi announced in May 2025 that *"India's water will flow for India's benefit, it will be conserved for India's benefit, and it will be used for India's progress"*[17].

While the situation continues to evolve, it highlights how quickly water systems can move from background infrastructure to a source of geopolitical tension.

Systems under pressure

Water risks are not limited to access and control. Even where supply exists, the systems that deliver and make water safe are themselves vulnerable.

Modern water treatment depends on a combination of infrastructure, energy, chemicals and digital control systems. Treatment plants rely on power to operate pumps and filtration processes.

They depend on a steady supply of chemicals to ensure water remains safe to drink. Increasingly, they are also managed through automated systems that monitor and regulate quality in real time.

Disruption to any one of these can have immediate consequences.

A power outage can halt treatment and reduce water pressure in distribution networks, increasing the risk of contamination. Shortages of key chemicals can limit the ability to treat water to safe standards.

> In 2021, a cyber-attack on a treatment facility in Florida attempted to alter chemical levels in the water supply[18], highlighting how digital vulnerabilities can translate into physical risks.

Water security depends not just on where water comes from, but on the systems that support it, and those systems are themselves interconnected and exposed.

What if?

A relatively small number of river basins support a disproportionate share of the world's population and economic activity. Over half of the world's population lives in river systems that cross national borders[19], many of which underpin major agricultural and energy systems.

When these systems are disrupted, the consequences can extend far beyond the regions directly affected.

The impacts become clearer when we consider a few plausible "what ifs":

- What if upstream controls were used more aggressively, reducing water flows to downstream countries?
- What if prolonged drought affected multiple major river systems at once?
- What if political tensions escalated around shared water systems, disrupting agreements and coordination?
- What if water shortages reduced agricultural output, impacting food supply and prices?
- What if a cyber-attack or infrastructure failure compromised a major water treatment system, affecting water quality for millions of people?

Water may appear local, but the systems it supports have global implications. It underpins food production, energy supply and economic activity. Disruption in one area can cascade into others.

Unlike food, which can be traded and rerouted, water is often fixed in place. Access depends on rivers, rainfall and the infrastructure that surrounds them. Where these systems are shared across countries, dependencies can develop quickly, and credible practical alternatives are limited.

This makes water risk harder to diversify and, in some cases, harder to manage.

The effects are not always immediate, and systems can take time to recover when water availability or infrastructure becomes constrained.

Water security depends not just on where water comes from, but on the systems that support it.

Energy: fuelling modern life

Modern economies depend on continuous access to energy. It powers homes, enables industry, supports transport and sustains the digital systems we rely on every day.

Unlike food or water, energy is embedded across almost every other system we rely on.

Agriculture depends on fuel and fertiliser. Water systems depend on power for treatment and distribution. Communication relies on data centres and networks that require constant electricity. In that sense, energy is less a standalone need and more an enabling one.

This makes the way it is produced and transported particularly important.

Pipelines and dependency

Much of the world's energy flows through infrastructure (i.e. pipelines, shipping routes and terminals) that link producers to consumers. These networks are highly developed, but they are not evenly distributed. In many cases, supply depends on a relatively small number of sources and routes.

Before Russia's invasion of Ukraine in 2022, the EU relied on Russia for 45% of its natural gas, 27% of its oil and around 50% of its coal [20].

This reliance was not evenly spread. Some countries, including Germany, Slovakia and Hungary, were particularly exposed.

Much of this supply moved through fixed infrastructure with pipelines that had been developed over decades and were difficult to replace quickly.

Did you know?

- Japan's net energy imports are 87% of its total energy supply [24], with around 95% of its crude oil coming from the Middle East [25] and, therefore, passing through the Strait of Malacca.
- Around 25% of global seaborne oil trade and 20% of global LNG passes through the Strait of Hormuz [26], making it one of the most critical energy corridors in the world.
- Slovakia relies heavily on the Druzhba pipeline for crude oil. When flows were disrupted in 2026, it declared a national energy emergency and released 250,000 tonnes of crude oil from its strategic reserves [22].
- Ghana, Togo and Benin depend on a single regional gas pipeline from Nigeria [23].

Across Europe, there are over 202,000 kilometres of oil and gas pipelines [21]. These networks were built over decades, largely around Russian supply. When that supply was disrupted, the infrastructure did not disappear, but its usefulness changed overnight.

Pipelines are fixed and capital-intensive, and the supply chains built around them take years to develop. As a result, infrastructure tends to reflect historical dependencies rather than current needs, and when supply shifts, systems cannot adjust quickly.

When supply becomes leverage

The consequences of this dependency became clear following the invasion of Ukraine.

By 2025, Europe had significantly reduced its reliance on Russian fossil fuels, with gas imports falling to around 13% and oil to 3%, while coal imports dropped to zero [20].

But this transition came at considerable cost, both financially and in terms of system stability.

In some cases, dependency created difficult trade-offs. Slovakia and Hungary, both heavily reliant on Russian oil transported via Ukraine, faced direct risks to domestic supply.

As a result, they were granted exemptions from EU sanctions, allowing them to continue importing Russian energy.

They were also reluctant to support further measures against Russia, given the potential impact on their own energy supply.

This vulnerability became clear in 2026, when disruption linked to the Druzhba pipeline forced Slovakia to draw on strategic reserves to maintain supply.

Replacing supply is not straightforward

In theory, Europe could reduce its reliance on external suppliers by increasing domestic production or accelerating the transition to renewables. In practice, both options are constrained.

Energy infrastructure takes time to build and significant investment to deliver. New supply cannot be brought online quickly, particularly at scale.

Political cycles add another layer of complexity because projects often take longer to complete than the time horizons of those approving them.

There are also trade-offs. Increasing domestic fossil fuel production raises environmental concerns. Expanding renewable capacity requires new infrastructure, storage solutions and grid upgrades.

As a result, Europe has turned to alternative suppliers. Norway has increased exports. The United States has expanded LNG shipments, although further increases risk pushing up domestic prices. North Africa remains an important exporter of energy, and countries such as Azerbaijan have become more prominent.

New routes, new risks

Azerbaijan and the wider South Caucasus region illustrate how quickly strategic importance can shift.

The region is significant not only because of its own oil and gas reserves, but because it provides a route for energy to reach Europe without passing through Russia, connecting Central Asian producers like Kazakhstan and Turkmenistan via the Caspian Sea.

The region sits between Russia to the north and Iran to the south, both of which have their own geopolitical interests. As reliance on these routes grows, so too does exposure to the risks surrounding them.

Infrastructure tends to reflect historical dependencies rather than current needs.

What if?

Energy systems are often discussed in terms of supply and demand. But a key vulnerability lies in how energy is moved, and how difficult it is to replace when flows are interrupted:

- What if a major pipeline were disrupted, cutting off supply to multiple countries at once?
- What if tensions escalated in key transit regions, restricting the flow of energy across borders?
- What if a major exporter reduced supply, forcing countries to compete for alternatives?
- What if infrastructure failures or attacks affected multiple energy assets simultaneously, reducing capacity?
- What if energy shortages fed through to other systems, disrupting food production, water supply and industrial output?

A small number of sources and routes supply a large share of global energy, supported by infrastructure that is costly to build and slow to adapt. When conditions change, systems cannot adjust quickly. As a result, disruption does not stay contained, but spreads across other systems, with effects that are not easily predictable.

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Connectivity: our wired world

Modern life depends on the ability to communicate instantly across distance. From financial transactions to supply chains, emergency services to everyday messaging, digital connectivity underpins how economies function and how societies operate.

The physical internet

The internet is often described as intangible. In reality, it is built on physical infrastructure that moves information around the world.

The UK provides a good example of how concentrated this infrastructure is in practice. It is a key landing point for international subsea cables, with major sites along the Cornish coast, including Bude and Porthcurno. These connect the UK to North America and Europe and support a significant share of transatlantic data flows.

This complements extensive offshore infrastructure in the North Sea, where pipelines and cables support both energy supply and connectivity.

Recent reporting has highlighted increased hostile surveillance of seabed infrastructure, including pipelines and cables.

In a news conference on 9 April 2026, the UK's Defence Secretary, John Healey, noted that the seabed to the North of the UK carries 99% of the UK's international telecoms and data traffic, over half of the UK's gas supply and trillions of pounds of trade each day [27].

This highlights a broader feature of these systems: multiple critical services often share the same physical routes. As a result, disruption to one can affect others.

Did you know?

- Around 99% of global internet traffic is carried by subsea cables [28].
- A small number of routes carry a disproportionate share of global data. Corridors through the Red Sea carry nearly 17% of global internet traffic, and over 90% of data flows between Europe and Asia [29].
- In some regions, multiple cables follow the same seabed paths and landing points, creating shared points of failure.
- In 2008, damage to just a few cables in the Mediterranean disrupted connectivity to 75 million people across parts of the Middle East and South Asia [30].
- The three largest cloud providers account for 70% of global cloud computer market [31].
- Many organisations rely on a single provider and region for critical services.
- Extreme solar storms can disrupt satellites, GPS and radio communications, affecting multiple systems simultaneously [32].

Control and concentration

Alongside physical infrastructure, digital systems are shaped by control.

Different models of governance have emerged, broadly reflecting approaches in the United States, China and Europe. These range from open, market-led systems to more controlled and sovereign models.

While these differ in philosophy, they share a common concern: security.

Cyber risk is often discussed in terms of attacks, and these are increasing. But the more structural vulnerability lies elsewhere.

Much of the digital system also depends on a small number of providers and a limited number of regions. The global cloud market is dominated by a handful of firms, with Amazon Web Services, Microsoft Azure and Google Cloud together accounting for 70% of global infrastructure capacity [31].

At the point of use, services such as mobile networks appear local and distributed, but depend on underlying connectivity, power supply and centralised systems.

Disruption to these layers can quickly affect large numbers of users.

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The materials behind connectivity

Digital systems depend on physical inputs.

Semiconductors, fibre optics and high-performance electronics rely on a range of critical minerals.

Among these, germanium and gallium play an important role in enabling high-speed data transmission and advanced computing.

Supply is concentrated. China produces around 60% of global germanium and 90% of gallium [33].

Recent export controls have demonstrated how quickly access can become constrained, with prices responding sharply to geopolitical developments.

The same pattern exists further along the supply chain.

Semiconductor manufacturing itself is highly concentrated, with advanced chip production dominated by a small number of facilities globally.

These facilities are capital-intensive and take years to build, limiting the ability to respond quickly to disruption.

Cobalt, a key component of lithium-ion batteries used in devices, data centres and energy storage, is heavily concentrated in the Democratic Republic of the Congo, which accounts for roughly 70% of global supply [34].

The vast majority of this is then processed and refined in China, creating further concentration within the supply chain.

These materials sit far upstream from the end user, but they are essential to the functioning of the system.

Connectivity depends on concentrated supply chains

- Critical minerals are sourced from a small number of countries.
- Processing and refining are often even more concentrated.
- Semiconductor production is limited to a small number of facilities globally.
- Disruption can affect production, cost and availability of technology.

Not all risks to connectivity are geopolitical.

Extreme space weather, such as solar storms, can disrupt satellite systems, GPS and radio communications, and in severe cases affect power infrastructure.

Analysis by Lloyd's [32] suggests that a severe solar storm could cause up to $2.4tn of economic losses over a 5-year period, reflecting the extent to which modern economies depend on interconnected digital and energy systems.

What if?

These dependencies are not always visible in normal conditions, but they become clearer when stressed:

- What if a small number of subsea cables were disrupted, affecting connectivity across entire regions?
- What if a severe solar storm disrupted satellites, GPS and power systems simultaneously, affecting communications, navigation and financial systems that rely on precise timing?
- What if access to key chokepoints were restricted, limiting the flow of global data?
- What if export controls reduced access to critical materials, constraining production of key technologies?
- What if a small number of providers experienced disruption, affecting large parts of the digital economy?
- What if connectivity failures affected other systems, disrupting finance, logistics and public services?

A relatively small number of routes, providers and underlying supply chains support a large share of global connectivity. While the system appears resilient, it is built on infrastructure and supply chains that are slow to diversify.

When disruption occurs, the effects are not confined to communications. They can impact payments, logistics, healthcare systems (including access to medical records, diagnostics and time-critical services) and wider public services that rely on continuous connectivity

While the system appears resilient, it is built on infrastructure and supply chains that are slow to diversify.

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Finance: the hidden network

From cash to code

The way money is accessed and used has changed significantly.

In the UK, cash now accounts for a small share of payments, with the vast majority of transactions taking place electronically. Contactless payments dominate everyday spending, and mobile payments continue to grow rapidly.

More than half of UK adults[35] now use mobile wallets such as Apple Pay or Google Pay, with many using them regularly. For a large proportion of consumers and businesses, access to money at the point of transaction is mediated through digital platforms.

The plumbing of global finance

Most payment infrastructure is domestic or regional. Each country operates its own systems for high-value and retail payments. Cross-border transactions are achieved by linking these systems together, often through correspondent banks and global messaging networks such as SWIFT.

At the centre of the system sit a small number of currencies. The US dollar accounts for around 50% of global payment value, with the euro accounting for about 20%[36]. Together, they underpin the majority of global trade invoicing[36]. Central bank reserves show a similar pattern, with over half held in US dollars.

With much of this system anchored in Western jurisdictions, access to key currencies, clearing systems and financial infrastructure is shaped by Western legal and regulatory frameworks.

Financial corridors in practice

In the UK, financial flows run through a small number of payment systems.

High-value transactions are processed through CHAPS, which handles less than 1% of payment volumes but over 90% of total value, settling around £300–400 billion each working day[40]. It is used for wholesale financial flows and time-critical payments such as house purchases.

Everyday transfers are routed through Faster Payments, which processes billions of transactions each year, while salaries and direct debits rely on BACS, which underpins payroll and household billing across the economy.

While these systems are designed to be resilient, they are concentrated corridors. When one is disrupted, the effects are immediate and visible.

On 31 July 2024, a technical issue affecting CHAPS delayed high-value payments[41], including house completions, leaving transactions unable to settle on the day and forcing some to be deferred.

Earlier, in August 2023, a separate outage affected the Bank of England's RTGS system[42], delaying CHAPS payments for several hours and creating a backlog across the system.

Disruption to other payment systems would have similarly tangible effects.

Issues with BACS would delay salary payments and direct debits across millions of households, while disruption to Faster Payments would interrupt everyday transfers between individuals and businesses.

Did you know?

- SWIFT supports roughly half of high-value cross-border payments[37].
- Global cross-border payments exceed $1 quadrillion annually[38].
- SWIFT cross-border payments can take anywhere from seconds to days to settle depending on the route[39].

The interface to finance

Technology platforms play a critical role in accessing financial systems.

Payments are routed through mobile devices, authenticated through platform ecosystems and integrated into operating systems.

This creates a new layer of concentration:

- a small number of platforms mediate access to payments
- these platforms are tied to device ecosystems
- disruption at this layer can affect large volumes of everyday transactions.

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Settlement and timing risk

Cross-border payments often take 1-5 days to settle, depending on the currencies and systems involved.

During this period, funds may be recorded as sent but are not yet final or fully available. Payments rely on chains of intermediary banks, compliance checks and aligned systems across jurisdictions.

Disruption – e.g. through sanctions, liquidity stress or operational issues - can delay payments significantly, sometimes for weeks, or make them fail altogether. Funds may be held in transit or rejected, creating uncertainty and pressure on cash flow.

Financial systems do not need to stop entirely to cause disruption. Delays and uncertainty alone can have material effects.

Fragmentation and alternatives

Alternative systems are emerging, in part as a response to restrictions on access to global financial infrastructure.

Following its exclusion from SWIFT, Russia accelerated the rollout of its domestic messaging network, SPFS. Originally launched in 2014, SPFS expanded to more than 550 institutions across 24 countries by 2022[43].

China's CIPS continues to grow, processing trillions of dollars in transactions annually, and bilateral currency arrangements are becoming more common across emerging markets.

At the same time, crypto and other digital asset networks are increasingly being used for cross-border transfers and settlement, offering faster movement of funds outside traditional banking infrastructure.

However, these alternative systems are not always designed to work together seamlessly.

Differences in standards, currencies and regulatory frameworks introduce friction into the movement of money.

Case study

Following Russia's invasion of Ukraine in 2022, a large share of the Central Bank of Russia's foreign reserves, which was held in institutions across Europe and Japan, was frozen.

Seven major Russian banks were also excluded from SWIFT.

These banks represented around 1–1.5% of SWIFT's daily traffic, equivalent to an estimated $700–800 billion in annual cross-border flows[43].

The immediate effects included a depreciation of the rouble of over 30%[43], restricted access to international payments and disruption to trade and financial flows.

What if?

Where could these financial corridors fail in practice?

- What if access to a major payment network was restricted, preventing firms or countries from settling international transactions and forcing a rapid shift to less established alternatives?
- What if assets held in foreign jurisdictions were frozen or ring-fenced, limiting access to liquidity and constraining the ability to fund operations or trade?
- What if geopolitical tensions caused financial systems to fragment into competing blocs, reducing interoperability and leading to delays, failed transactions and trapped liquidity across borders?
- What if access to the US dollar clearing became more restricted or conditional, limiting the ability of firms to settle transactions in the dominant global currency?
- What if disruption to digital payment platforms prevented access to funds at the point of sale, affecting large volumes of everyday transactions?
- What if stress in settlement systems caused payments to be delayed, queued or rejected, creating liquidity pressures that cascaded through supply chains and financial markets?

In a system that is increasingly digital, the risk is not just whether money is there, but whether it can be used when needed.

Financial systems do not need to stop entirely to cause disruption.

When systems collide: cascading effects

In the preceding chapters, we have considered the systems that underpin modern life individually. Each relies on a relatively small number of routes, assets and infrastructures, through which goods, resources, information and capital flow.

In practice, these systems are interconnected and often depend on the same underlying corridors.

Beyond frequency and severity

Risk is often assessed in terms of how likely an event is and how severe its impact might be. This provides a useful starting point, but it does not fully capture how disruption unfolds in interconnected systems.

In practice, the impact of an event is also shaped by how quickly it occurs, how it interacts with other disruptions, and how far it spreads across systems.

Three additional dimensions are particularly important:

- **Speed** – how quickly disruption unfolds. Rapid events leave little time to respond, reducing the ability to adapt or reroute.
- **Sequencing** – whether events occur in succession, before systems have recovered. A second disruption can compound the effects of the first.
- **Spread** – how far disruption propagates across systems, particularly when it affects multiple corridors or shared infrastructure.

These factors determine whether disruption remains contained or becomes systemic.

In this context, the concept of corridor blocking becomes important. When one route is disrupted, alternatives may exist, but when multiple corridors are constrained, systems can begin to stall, and options for response become limited.

The most significant risks are not always those that are most likely or most severe in isolation, but those that move fastest, interact most strongly, and spread across multiple systems.

Where are we now?

We are currently in a time of heightened geopolitical tension (May 2026), with key corridors already under strain. Disruption and increased risk in the Strait of Hormuz has reduced shipping flows, increased insurance costs, and driven ongoing volatility in global energy markets.

This has already significantly raised costs for production, transport and households.

What if further disruption occurs before systems have time to stabilise?

The following scenario is illustrative, intended to explore how disruption could unfold across interconnected systems.

Step 1:
Additional disruption in East Asia
State-linked GPS interference intensifies around Taiwan and its surrounding sea lanes. With 92% of maritime vessels dependent on satellite connectivity[44], vessels slow, reroute or queue offshore as port authorities impose safety restrictions.

Step 2:
Maritime congestion and physical risk
Congestion builds across key shipping routes. Prolonged anchoring increases the risk of anchor dragging (responsible - together with fishing activity - for an estimated 70–80% of subsea cable faults[45]), damaging cables concentrated around Taiwan.

Step 3:
Connectivity and infrastructure impact
Disruption to subsea cables affects regional and international data flows. Financial systems, payment platforms and logistics coordination are impaired.

Step 4:
Financial and trade stress
At a time when energy costs are already elevated, payment delays and reduced connectivity slow trade and increase working capital pressure. Semiconductor supply chains are also affected, further constraining production.

Step 5:
Longer-term pressures continue to build
Water stress and extreme weather reduce agricultural output, while higher energy costs increase the cost of food production and transport.

The result is overlapping pressure on food, water and energy systems at the same time that trade, connectivity and financial systems are disrupted.

When shocks occur on top of existing strain, impacts can escalate quickly across multiple systems.

The bigger picture: making systemic risk more visible

Traditionally, risk management has involved assessing defined systems e.g. insurance portfolios, financial markets and operational processes. These approaches are well-established and effective where risks can be understood in isolation.

But the systems explored in this paper do not behave in this way.

They are interconnected, dependent on shared infrastructure and often concentrated in a small number of critical corridors. Disruption in one area can affect others, sometimes quickly, and not always in a way that is immediately obvious.

This creates a different type of challenge and a broader role for risk management.

Seeing concentrations

The first step is visibility.

Across food, water, energy, connectivity and finance, a pattern emerges: dependency is often concentrated in a small number of routes, assets or providers. These are not always obvious, particularly where systems appear global or distributed.

Identifying these concentrations is a core part of risk management. It requires understanding not just what a system does, but how it works in practice: where flows occur, where they converge, and where alternatives are limited.

In some cases, these dependencies are physical, such as pipelines or cables. In others, they are structural, such as reliance on a small number of cloud providers or financial intermediaries. In both cases, the risk is similar: limited alternatives when things go wrong.

Assessing fragility

Once these points of concentration are understood, the next step is to assess fragility.

Not all concentration leads to vulnerability. Some systems are well-managed, with contingency plans and resilience built in.

Others are more exposed, particularly where infrastructure is difficult to replace, supply chains are slow to adapt, or credible substitutes are limited.

This is where structured analysis can play an important role. Scenario testing, stress testing and reverse stress testing can be used to explore how systems behave under pressure.

The “what if” scenarios throughout this paper are a simplified version of this approach.

They are not predictions, but tools to help understand how disruption might unfold and where it could have the greatest impact.

Understanding interconnection

Traditional risk frameworks often treat risks independently or rely on simplified assumptions about correlation.

In practice, the relationships between global systems can be more complex.

Disruption can propagate through shared dependencies (e.g. energy affecting water systems, connectivity affecting financial transactions, or digital infrastructure affecting healthcare and public services).

These linkages are not always linear and may only become clear under stress.

Understanding these interactions requires a combination of data, judgement and experience, as well as a willingness to look across systems, not just within them.

Interconnection creates amplification

- Systems share infrastructure, supply chains and dependencies.
- Disruption in one area can affect others.
- Impacts may compound when multiple systems are under pressure.

Considering multiple stresses

Much of risk management focuses on single events.

However, the most challenging scenarios may involve multiple pressures occurring at the same time; e.g. disruption to energy supply alongside constraints on connectivity or financial systems.

These situations can lead to compounding effects, where the combined impact is greater than the sum of individual events.

Exploring these scenarios requires moving beyond traditional approaches and considering how different systems interact under stress.

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Supporting better decisions

The role of actuaries and risk professionals is not to predict specific events, but to support better decisions where there is material uncertainty.

This includes:

- **Identifying concentrations of risk** where dependency is greatest
- **Assessing potential impacts** using models, scenarios and expert judgement
- **Testing resilience** by exploring how systems respond under stress
- **Highlighting trade-offs** between efficiency, cost and resilience

In practice, this often involves combining quantitative analysis with qualitative insight. Data alone may not capture the full picture, particularly where dependencies are evolving or not fully observable.

Building broader understanding

Understanding these risks should not sit solely with specialists.

Many of the systems described in this paper are embedded in everyday life, yet the dependencies that underpin them are not widely known.

This can make it difficult for wider society to appreciate the potential impacts of disruption, or the trade-offs involved in managing them, until the risks start to crystallise.

Improving this visibility has value in itself. Building clearer pictures of how these systems function, where they are concentrated and how they may respond under stress can support better decisions.

This applies both within organisations and, more broadly, across society.

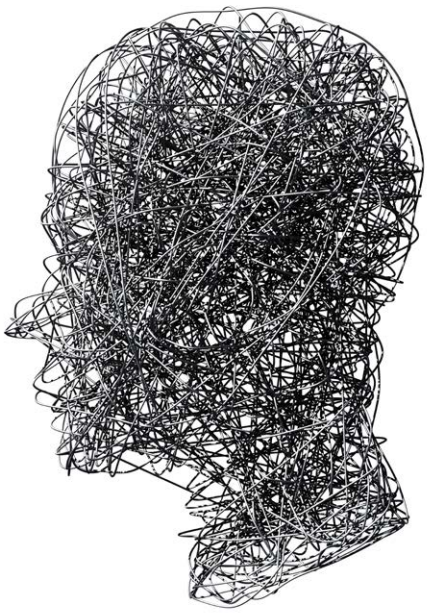
While many dependencies cannot be removed entirely, understanding where concentration exists can support more resilient decision-making, including diversification, redundancy and contingency planning.

Actuaries and risk professionals can contribute by helping to communicate these risks in a way that is accessible, grounded and relevant, making clear what is at stake.

Risk does not sit neatly within individual systems.

It emerges from how those systems connect, and how they behave under pressure.

Building clearer pictures of how these systems function, where they are concentrated and how they may respond under stress can support better decisions.



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