Price Analysis Is Necessary for Global Large Projects

And the market only prices half of what they buy

Karan Singh Bagavathinathan

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This paper draws entirely on public information: company filings, national audit reports, price-reporting-agency assessments and exchange settlements, together with the megaproject database assembled by Bent Flyvbjerg and colleagues at Oxford. The project census, the pipeline snapshot and the cost decompositions behind the hedgeable-share estimates are set out in Appendix A. Commodity and component prices are exchange settlements and assessments as at 31 July to 1 August 2026; they move continuously, and the late-July energy and metal levels carry a Strait of Hormuz supply spike rather than a settled baseline, so figures drawn on them should be re-verified before citation. The hedgeable shares are the author's own engineering estimates, good to about five percentage points. The author has no financial interest in any project, contractor or supplier named here, and received no funding for this work.

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ABSTRACT

Large-project cost overruns are not new. Roughly nine in ten megaprojects have overrun on cost or schedule for the better part of a century, a base rate that has not improved despite decades of reform. This paper argues that the inflationary window that opened in 2021 changed the character of the risk behind that base rate rather than the rate itself, and that the change is legible in prices. Drawing on a census of about 97 megaprojects, each above one billion dollars, active over 2020 to 2024 across more than forty countries, on a focused snapshot of the 24 largest projects now running or committed, and on a live reading of commodity and component prices in mid-2026, it makes three linked claims. First, the world is building an unusual number of the largest projects at the same few years, and a large part of that build is insensitive to interest rates, so the demand it adds cannot be cooled by the standard tool. Second, only a minority of any project's cost, on the order of 10 to 35 per cent, can be laid off in a financial market, and that fraction is smallest exactly where projects are most complex, because the forward market covers the raw commodity and abandons the finished part. Third, when a cost shock can be neither hedged nor passed on, it does not disappear. It travels down the finance chain until it reaches a party that cannot pass it on, and at the bottom it is absorbed by the physical quality of the asset itself. The central finding is that inflation did not create these delays; it exposed a latent design flaw, an incomplete market whose gap is invisible in ordinary times and lethal under a common shock.

Keywords: megaprojects; construction cost inflation; cost overruns; incomplete markets; market completion; systematic risk; risk allocation; hedging; forward and futures markets; commodity prices; critical minerals; supply chain chokepoints; project finance; infrastructure; monetary policy

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Part I. The Build and the Shock

1. Long builds, interlinked cycles

Why length, more than size, is what puts a megaproject at price risk.

A megaproject is an investment above one billion dollars that takes many years to build, and that length is its defining economic feature. A build running five or ten years passes through several business cycles, and usually through political and geopolitical ones too. Each turn changes the environment the project was costed for, so the institution running it has to adapt as conditions shift, taking on a new interest rate, a new government or a new trade barrier without halting the work. Macroeconomic policy is meant to lean against these cycles, but it cannot steer a project already committed and half-finished. When a cost shock lands mid-build, the project has only two ways to take it: pay the higher price, or overrun.

Since 2022 the environment has been unfavourable for an unusually long stretch, and it has shown up in prices worldwide. For megaprojects the price risk is higher than in earlier cycles, and the reason lies in what they buy. The critical inputs of a modern grid, fabrication plant or data centre are thin, specialised and slow to supply, and that is the risk this paper traces.

The scale committed right now is unusual. The two dozen largest infrastructure and industrial projects running or committed worldwide as of mid-2026 carry headline costs of roughly 5.9 trillion US dollars, about 5 per cent of 2025 world output, which the International Monetary Fund (IMF) estimates at roughly 117 trillion US dollars. Read it as an order of magnitude rather than an exact accounting, since several of the figures are multi-year programme envelopes rather than single projects.

The striking feature of the current pipeline is how many of the largest projects fall in the same few years. Grid capital expenditure, semiconductor fabrication plants, hyperscale artificial-intelligence (AI) data centres, defence and munitions expansion, giga-cities, liquefied natural gas (LNG) terminals and mega-dams are all in construction or freshly committed between 2024 and 2026. The geography splits by type. The United States holds roughly a third of the pipeline, mostly AI data centres, semiconductor fabs, grid capital expenditure and LNG. Asia's share is semiconductor clusters, where the Korean mega-cluster runs to 2047, mega-dams such as Medog, under construction from July 2025, and new capital cities such as Indonesia's Nusantara. The Gulf's share is giga-cities, chiefly NEOM under Saudi Vision 2030, and LNG, chiefly Qatar's North Field expansion to about 2027. Europe's incremental pipeline is dominated by rearmament: the ReArm Europe, or Readiness 2030, framework, an enabling ceiling of about 800 billion euros, roughly 860 billion US dollars, over 2025 to 2030.

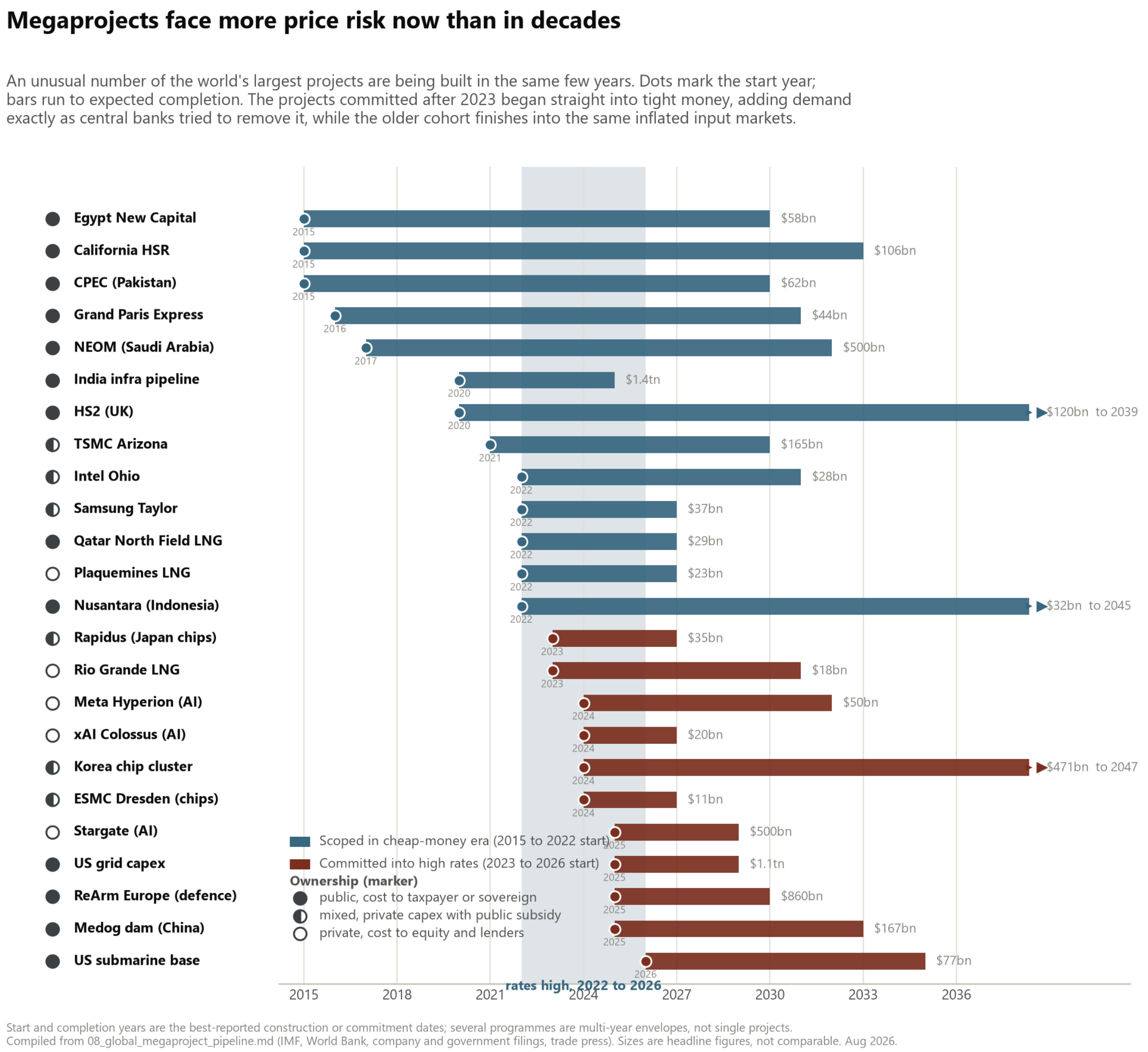

Figure 1. Timeline of the world's largest megaprojects by start year, split into a cheap-money and a high-rate cohort, with an ownership marker showing public, mixed and private financing

The timeline separates two cohorts, and the separation is the argument. The older projects, in steel, were scoped between roughly 2015 and 2022, when both money and materials were cheap. They are now delivering into a world where neither is, which is why almost every one of them, HS2, California's high-speed rail, NEOM, Nusantara, the delayed Intel and Samsung fabs, shows overrun, descoping or stall. The newer projects, in rust, were committed from 2023 onward, straight into the shaded high-rate window. They went ahead anyway, because they are state-directed, sovereign, or strategic corporate bets that do not answer to the cost of capital.

One cohort is trapped by inflation it did not price; the other chose to ignore the rate rise entirely. That second cohort is the first reason the standard tool is blunt. A central bank raises rates to cool investment, but the rate only reaches the flexible margin: housing, small firms, discretionary spending. The committed megaproject sails straight through, because it is sunk, backed and often financed by a government or a sovereign fund that does not flinch at the cost of money. Tightening removes demand from where it was already responsive and misses the demand that is actually bidding for the transformers and the copper.

2. Delay is expected. Is 2026 any different?

The base rate of overruns, and the increment the early 2020s added.

Before blaming inflation, be honest about the baseline. The most authoritative evidence is the database Bent Flyvbjerg and colleagues at Oxford have built over decades, now more than sixteen thousand projects across twenty-odd asset types and over a century of records. Roughly nine in ten megaprojects overrun their budget, their schedule, or both. Only about half a per cent come in on budget, on time and with the benefits promised, and the record has not improved in ninety years, which is why Flyvbjerg calls it the Iron Law of Megaprojects. The overruns rise with complexity and are fat-tailed, running from around 1 per cent for solar and 13 per cent for wind to roughly 20 for roads, 37 to 45 for rail and tunnels, 120 for nuclear and over 150 for the Olympic Games (Flyvbjerg 2014; 2023). None of this is caused by inflation. It is the settled product of optimism bias, strategic misrepresentation, scope change and the difficulty of coordinating a decade-long build. So the first discipline is not to blame the macroeconomic shock for what is simply how these projects have always behaved. What matters is the increment the early 2020s added, and in what form.

The main reason the estimate is always wrong is duration. Length, more than size, is what drives the cost risk on a megaproject. A ten-year build is a ten-year bet that the world stays as it was on the day the cost was set, and over a window that long it becomes close to certain the project crosses at least one regime it was never costed for, an inflation, a war, a closed strait, a sanctions wave. So the estimate is revised, and the revision is not the estimator's failure. A number set in 2016 is a photograph of 2016, projected across a decade no forecaster can see; marked up in 2023, it turns out to have been a hope dressed as a measurement. Once the shock lands mid-build the project cannot outrun it, since it moves at the speed of concrete and steel, and it cannot stop, since stopping costs more than finishing, so it absorbs the shock as extra years of delay or as cheaper material quietly substituted in. Because the final cost cannot be forecast, this paper does not try. Refusing to guess the cost of the dam forces the argument onto the price of the copper the dam will need, which we can actually see.

3. The systematic turn

The correlation structure of the shock, and why it changed after 2021.

What changed in the early 2020s was the correlation structure of the shock rather than its magnitude, and that distinction is the organising idea of the paper.

Consider the risk that a project's real construction cost exceeds its budget. Historically the biggest drivers have been specific to each project. One tunnel hits harder rock or more groundwater than the survey predicted. One semiconductor plant has to compete for scarce skilled labour in a single local market. One sponsor's team set the first cost estimate too low out of plain optimism. Such risks are close to independent across projects, and that independence is what makes the industry's three standard defences work. Contingency reserves are self-insurance sized to a project's own tail, adequate when overruns are drawn independently, because most projects carrying a reserve do not need it at once. Fixed-price transfer moves cost risk to a contractor and works only if the contractor is solvent when the risk crystallises, which, for an idiosyncratic shock, it usually is, because its other projects are unaffected and can cross-subsidise the loss. Portfolio diversification, underneath insurance and lenders' project-by-project pricing, depends on losses not arriving together.

A systematic shock invalidates the assumption all three share. Construction-cost inflation is systematic almost by construction, since it moves the price of steel, cement, copper, diesel, freight and labour, the inputs common to every project, in the same direction at once and across borders. The signature of 2021 to 2023 was exactly this synchronisation. Cost indices in North America, Europe and Asia rose together, and single inputs such as steel and shipping spiked worldwide rather than in one market. Global construction-cost inflation ran near 9.5 per cent in 2022, and closer to 12 per cent for US non-residential building, against a roughly 3 per cent norm, with individual inputs moving far more (Turner and Townsend 2023; Construction Analytics 2023).

The shock was common rather than local because the early 2020s delivered a knot of shocks, each feeding the next. The pandemic disorganised production and shipping. Russia's invasion of Ukraine in 2022 cut European gas and drove energy prices across the continent to records. The United States and China raised tariffs and export controls on each other, and on the chips, metals and equipment that projects everywhere rely on. Recurring European heat dried the rivers: the Rhine fell too low in 2022 for barges to run full, throttling German coal, chemical and fuel transport for months, and French nuclear output was cut when river water ran too warm to cool the reactors, while in other years the same climate brought the opposite, floods that closed sites and routes. The cost of this is measurable. The 2018 Rhine low-water episode cut German industrial output enough to shave a few tenths of a point off that year's growth (Ademmer et al. 2023), the 2022 heat and drought cut hydro and nuclear generation across Europe and helped push power prices to records, and the European Central Bank finds that extreme heat raises inflation, mainly through food, on a scale future warming could lift toward one to three points a year (Faccia et al. 2021; Kotz et al. 2024). Military budgets climbed to levels not seen since the Cold War. Attacks in the Red Sea from late 2023 pushed container traffic around the Cape of Good Hope, adding weeks and cost to shared sea lanes, and a confrontation at the Strait of Hormuz in 2026 did the same to oil and gas. No one of these is a construction shock. Together they are, because they land on the same energy, water, shipping and industrial inputs that every large project draws on.

What ties them together is the shared infrastructure that made globalisation cheap: a few sea lanes, a handful of gas and grid corridors, concentrated suppliers of chips, metals and equipment, and rivers serving as both coolant and highway. That plumbing once kept inputs cheap, and it is now the channel through which a local shock becomes a global one. Researchers have begun to name this entanglement directly, as a "polycrisis" in which crises in separate systems interact and amplify each other (Lawrence et al. 2024), and as a "geoeconomic fragmentation" that raises the cost of the very inputs economies had come to depend on (Aiyar et al. 2023). For prices the implication is plain. When separate shocks share the same chokepoints, they push the same prices at the same time, on inputs that are globally traded and thin, which is exactly the set no national central bank can reach. This is why the shock is systematic rather than local. The world's projects are wired into the same few pipes, and in the early 2020s those pipes came under strain at once.

The rate of increase then cooled, but the price level did not come back down, and that persistence is the part that matters. The Turner Building Cost Index stood at about 1,177 in 2020 and reached about 1,552 by the second quarter of 2026, roughly a third higher, and it was still rising at about 5 per cent year on year in mid-2026 (Turner Construction, Q2 2026 Building Cost Index). The commodity pressure is not spent either. The World Bank's April 2026 Commodity Markets Outlook forecasts global commodity prices about 16 per cent higher on average in 2026 than in 2025, the first annual rise since 2022, led by energy at around 24 per cent on the Middle East supply disruption discussed in Section 5, with its precious-metals index up about 42 per cent. A shock that lifts the cost base by a third and holds it there, then adds a fresh geopolitical leg four years on, is a change in the level that stays, which is what the systematic reading predicts and a purely transitory reading missed.

When the shock is common, the three defences fail together and for the same reason. Contingencies calibrated to independent draws are exhausted in the same year. Fixed-price transfer collapses because contractors are hit simultaneously, so the counterparty is insolvent exactly when called upon, and its other projects, also under water, cannot cross-subsidise. The 2022 to 2024 wave of UK contractor insolvencies, with construction posting the highest insolvency count of any sector in 2022 and Buckingham Group, the largest failure since Carillion, collapsing in 2023 on fixed-price contracts priced before the surge, is the direct footprint of correlated counterparty default, not one contractor failing on one bad job. Diversification offers no shelter, because a systematic shock is the one risk a portfolio cannot diversify away.

We read the 97 projects one by one and recorded the single main reason each was delayed or ran over, from company filings, national audit reports and reporting at the time. This is a count of named causes rather than a controlled study: the projects sit at different stages, and we cannot see how long each has been under price pressure, so it describes the record rather than proves a cause. Inflation was the single main reason in only 6 or 7 of the 97, a named contributing factor in about 30, and not the binding reason in the rest, which were named to other things: first-of-a-kind engineering failure at Flamanville, Olkiluoto and Berlin Brandenburg; contractor bankruptcy, with Westinghouse sinking Vogtle's schedule and Zachry's insolvency hitting Golden Pass LNG; security and war at Mozambique LNG; the withdrawal of financing and insurers, as at the East African Crude Oil Pipeline; and, in the most fragile economies, currency collapse and sovereign default in Egypt, Pakistan, Sri Lanka and Zambia, a balance-of-payments crisis rather than input-cost inflation.

Taken together that is roughly a third of the 97, a large share for a shock rarely blamed directly. And a common shock is not meant to stand alone as the single cause; it acts on every project at once and lowers the threshold at which each one's own weakness gives way. Where it was not named it did not vanish, it was absorbed: by equity writing off the loss, by cheaper material and thinner quality, by pass-through where a supplier had pricing power, or by a state paying on where the project was a point of national pride. The shock reappears in those channels rather than in the cause-of-failure column, and those channels are the subject of Parts II and III.

Part II. What the Market Prices, and What It Does Not

4. The hedgeability ladder

Why the forward market thins as the product finishes.

When input costs threaten a project, the response comes at two levels. At the macro level the authorities act: a government can work the supply side, through strategic stockpiles, easier imports or price caps, and a central bank works the demand side, raising rates to cool the bidding. At the micro level the firm acts on its own book, buying a forward or a future to lock a price before it needs the input. This section is about the two instruments trusted specifically to manage price risk, the central bank's rate and the firm's hedge. One is public and blunt, the other private and precise, and both work through price. The rate leans on price to ration demand; the hedge fixes a price to remove risk. Each needs the input to have a market price to act on, and the part of a megaproject that actually constrains it has none.

A forward market can only exist for something with three properties. It has to be storable, so that holding it today and delivering it later is meaningful. It has to be fungible, so that one unit is interchangeable with another and a single price can describe them all. And it has to be traded continuously, so that a price exists at every moment to settle against. These are close to the conditions Carlton (1984) identified behind the futures contracts that survive and the many that fail: a standardised, storable underlying and an active cash market to price it against. Raw commodities have all three. Engineered components have none.

Finance hedges the raw commodity and goes blind at the finished part

Hedging needs storability, fungibility and continuous trading. All three hold for raw commodities and fade to nothing for built-to-order components. As you move down the chain the forward market thins out, and supply stops clearing by price and starts clearing by queue. The scarce part of a megaproject sits at the bottom, where no instrument prices it.

raw to finished

WHERE IN THE CHAIN	EXAMPLES	CAN FINANCE HEDGE IT	HOW IT CLEARS
Raw commodities *storable, fungible, continuously traded*	Crude oil, natural gas, copper, aluminium, nickel, wheat, gold	**Deep** Exchange futures and options, multi-year forward curve	**Price**
Bulk intermediates *processed, semi-standardised*	Hot-rolled steel, iron ore, ammonia, urea, ocean freight	**Thin** Some futures or OTC swaps, short curve, wide spreads	**Price, then queue**
Engineered components *built to order, each unit different*	Power transformers, HVDC cable, EUV tools, GPUs, turbines, magnets	**None** No forward market exists; price only assessed, if at all	**Allocation and lead time**

The project's binding constraint is almost always the bottom row, the part finance cannot hedge and a rate cannot reach.

Framework chart. Hedgeability by market structure; see data/10_hedgeability_prices.md for the per-item market status, venues and current price levels. Aug 2026.

Figure 2. The hedgeability ladder: financial hedging is deep for raw commodities, thin for bulk intermediates, and absent for engineered components

Read the ladder from top to bottom and the market thins as the product finishes. At the top sit the raw commodities, crude oil, natural gas, copper, aluminium, wheat, gold. They are storable, fungible and traded every second on the London Metal Exchange, the Chicago Mercantile Exchange and the Intercontinental Exchange, with forward curves that run years out and options on top. A buyer can lock the price of copper cathode in 2028 today. In the middle sit the bulk intermediates, hot-rolled steel, iron ore, ammonia, urea, freight. A hedge exists but it is thinner, the curve is shorter, the spreads are wider, and much of it trades over the counter rather than on a screen. You can take the edge off, not the whole risk. At the bottom sit the engineered components, the large power transformer, the high-voltage cable, the lithography tool, the advanced graphics processing unit (GPU), the turbine, the propellant, the rare-earth magnet. For these there is no forward market at all. Each unit is built to order and differs from the last, so there is nothing fungible to trade and no curve to settle against.

Three structural features push the same way, and they matter because they cap the hedgeable share of a whole project, not just an input. The dominant input often has no market: in rail, metro, dams, airports and buildings the largest material is cement and concrete, which has no liquid futures market anywhere, being regional, perishable, and cheap relative to transport cost. The materials line understates the true exposure by two to five times, because steel and copper mostly enter as fabricated equipment, reactor forgings, monopiles, transformers, line pipe, locked inside bespoke, long-lead, single-sourced orders a commodity future cannot track. And much of the metal is the wrong metal, specialty alloy priced on nickel, chrome and molybdenum surcharges and on order books rather than on any exchange, leaving standard futures with large basis risk, the gap between the contract a firm can trade and the thing it actually buys, which limits how much risk any hedge removes (Ederington 1979).

The chart below ranks the archetypes by the share of capital cost that is cleanly hedgeable within the roughly 18 to 24 month horizon over which commodity futures stay liquid. It is our own estimate, not a sector-validated figure, and anyone who builds these for a living will have firmer numbers for their own projects and may well contest ours. Read it as a ranking of the pattern, and the pattern is uncomfortable.

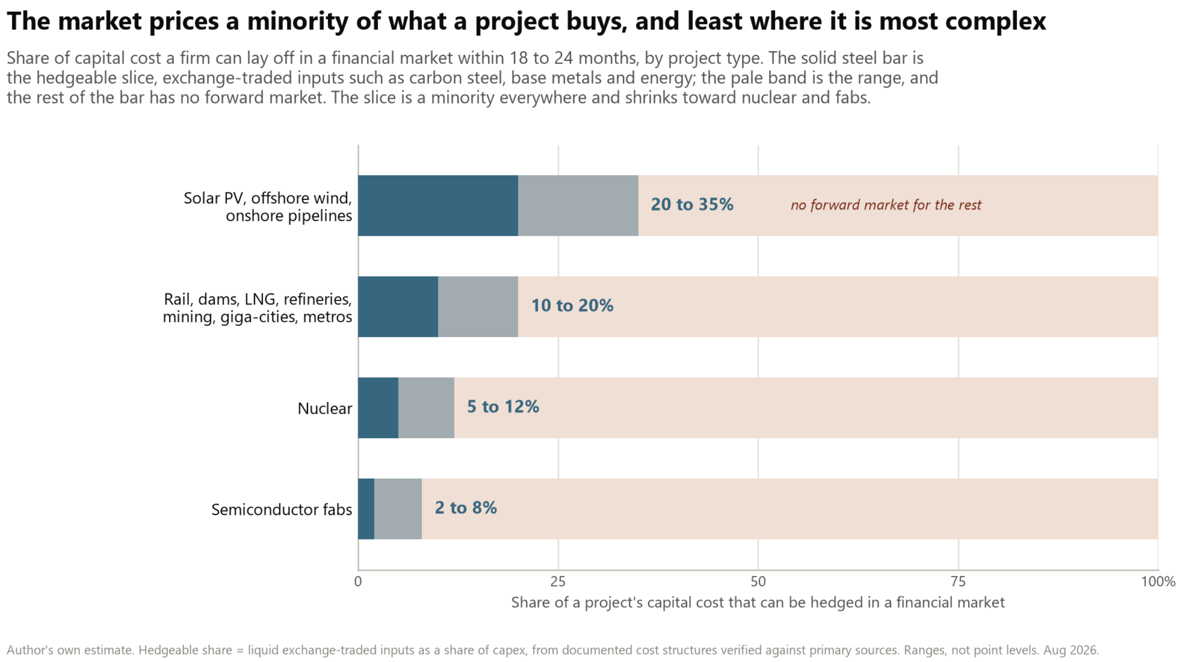

Figure 3. Hedgeable share of capital cost by project type, shown as ranged bars against a full-width bar for total capital cost, sorted from most hedgeable (solar, offshore wind and onshore pipelines at about 20 to 35 per cent) down to semiconductor fabs at about 2 to 8 per cent, with the remainder of each bar carrying no forward market

These shares are estimates rather than audited figures, and should be read as a ranking, not as precise levels. Each is built by decomposing an archetype's typical capital cost into its lines, steel, concrete, fabricated equipment, labour, land and financing, then counting only the part that is exchange-traded and liquid to hedge within the 18 to 24 month window, meaning carbon steel on the CME, copper and aluminium on the LME and the Commodity Exchange (COMEX), and energy. The component splits behind them come from named industry sources, among them the World Nuclear Association and MIT for nuclear, NREL for solar, BVG Associates for offshore wind, the Oxford Institute for Energy Studies for LNG, Oil and Gas Journal for pipelines, the World Bank for high-speed rail and ORNL for hydropower. They are good to about five percentage points. The cost structures for solar, offshore wind, onshore pipelines, nuclear, LNG, high-speed rail and hydropower have since been checked against the primary source documents listed in the References, and six of the seven held. The solar figure was revised down, from an earlier 25 to 40 per cent, after the NREL utility-scale benchmark showed the higher number reflected a commercial rather than a utility-scale cost profile, with more labour and less commodity than we had assumed. A specialist in solar, nuclear or semiconductor fabs will reasonably dispute any single figure here, and their project-specific number is likely better than ours. The claim the table carries is the shape, that the hedgeable share is a minority everywhere and thinnest where projects are most complex, rather than the precise level in any one row.

Two features carry the argument. The hedgeable share is a minority of cost for essentially every archetype, before even adding that commodity futures cover only the first two years of a five to ten year build. And the share is smallest exactly where projects are most complex and most prone to catastrophic overrun, nuclear and fabs, whose cost is dominated by bespoke forgings, monopoly-supplied tools priced on technology rather than metal, on-site labour, and multi-year financing. Markets can hedge the easy fraction of the easy projects. The fraction that breaks the hard projects has no market. This is an incomplete market in the technical sense, with no tradable claim for some payoff-relevant states, and infrastructure risk is not spanned by traded assets (Newbery 2016; Ben Ammar and Eling 2015). It is the structural condition on which the systematic shock acted.

A longer trend sits underneath the ladder. James Rauch (1999) sorted internationally traded goods into three types that line up with its rungs: goods traded on an organised exchange at a single world price, reference-priced goods with a widely known but unexchanged price, and differentiated goods that come in too many varieties to carry a standard price at all. Differentiated goods are the largest of the three in world trade, and the long-run rise of manufactures in the merchandise mix has kept enlarging that share (Our World in Data). A modern grid, data centre or fabrication plant is built disproportionately from that differentiated end, the large power transformer, the lithography tool, the advanced GPU, the rare-earth magnet, each with no exchange and no world price. As the technology has advanced, the exchange-traded fraction of what these projects buy has shrunk, and the unpriced share of the bill has grown. The input mix has been drifting down the ladder into the part no instrument reaches.

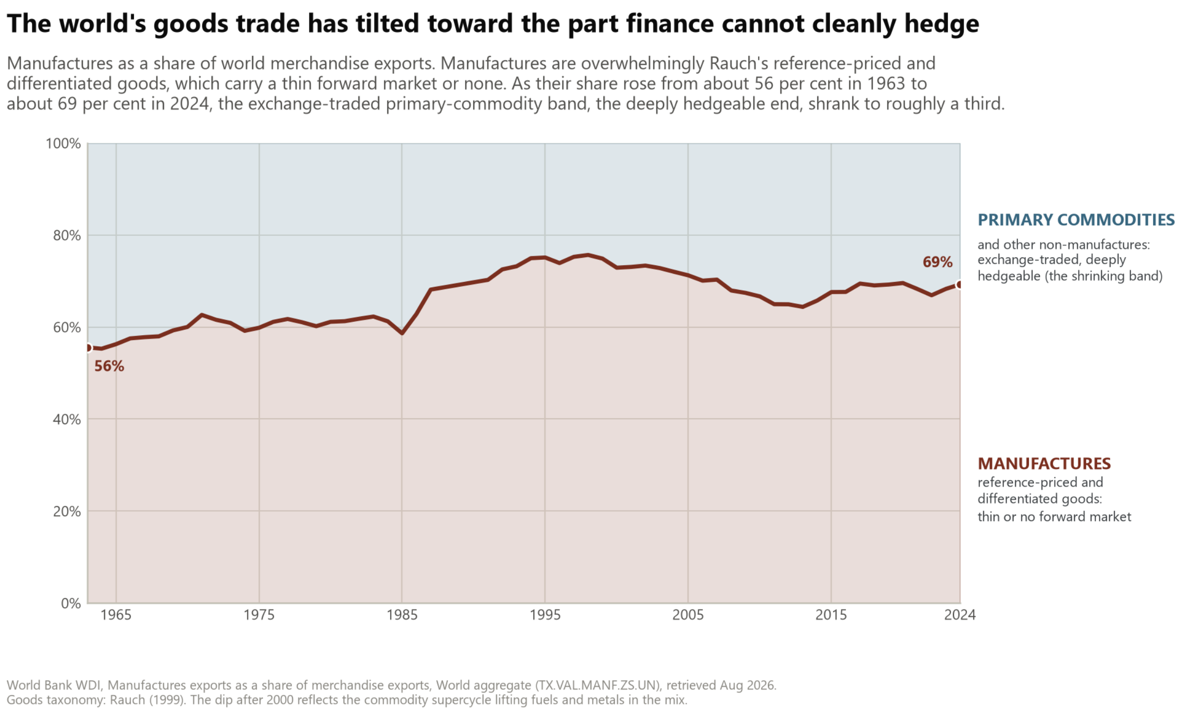

Figure 4. Manufactures as a share of world merchandise exports, 1963 to 2024. The share rose from about 56 to 69 per cent, so the exchange-traded primary-commodity band, the deeply hedgeable end, shrank to roughly a third

The long series makes the drift concrete. Manufactures were about 56 per cent of world merchandise exports in 1963, peaked near 76 per cent in the mid-1990s, and sat at about 69 per cent in 2024, the dip after 2000 tracking the commodity supercycle that lifted fuels and metals. Manufactures are dominated by Rauch's reference-priced and differentiated goods, the middle and bottom of the ladder, so the exchange-traded, deeply hedgeable band has thinned from roughly 45 per cent of traded goods to about 31 over sixty years. The mapping is not exact, since some manufactures such as ordinary steel are reference-priced and partly hedgeable, but the direction is clear and it runs the wrong way for anyone hoping to hedge.

5. Price discovery, and where it stops

What a price looks like at each rung of the ladder, mid-2026.

The previous section sorted inputs by whether a market exists to hedge them. This one takes that ladder as given and asks a narrower question from the buyer's seat: at each rung, what does a price actually look like right now, and what can you do with it?

At the top rung the answer is clean. Copper, aluminium, oil, gas and the grains clear continuously, so each carries a live quote and a forward curve. The market does the buyer's price discovery for them and prints the result on a screen, and a project can read its future cost off that curve and buy it.

At the bottom rung there is no clean answer, and that is the point. A large power transformer has a queue rather than a price. What moves is a lead time, now measured in years rather than months, and a premium negotiated bilaterally on top of an assessed base. Grain-oriented electrical steel, the specialised metals, the propellant chemicals are the same: a price-reporting agency surveys a few participants and publishes an assessment, but there is no depth behind it, no forward curve, and no way to lock it. The plain statement about the price level of the scarce parts is that there is no single market price, only an assessment and a waiting list.

The table sets out what a price looks like at each rung, mid-2026.

Input	Forward market	Price level, mid-2026
Raw commodities		
Brent crude	Exchange futures, full curve	about 88 dollars a barrel (31 Jul)
Gas: TTF, Henry Hub	Exchange futures, full curve	about 59 euros a MWh, roughly 64 dollars; about 2.70 dollars a MMBtu
Copper, LME	Exchange futures, full curve	about 13,800 dollars a tonne (up about 47 per cent on the year)
Gold	Exchange futures, full curve	about 4,050 dollars an ounce (1 Aug)
Hot-rolled steel, CME	Exchange futures	about 1,156 dollars a short ton
Iron ore, 62 per cent	Futures and swaps	about 98 dollars a tonne
Dry-bulk freight	Cleared FFAs	Baltic Dry index 2,673
Bulk intermediates		
Urea, dry-bulk freight	Yes, thinner	genuinely hedgeable
Ammonia	Nascent futures plus OTC	Tampa bilateral plus assessment
Electrical steel (GOES)	None, assessment only	no confirmed spot
Engineered components		

Input	Forward market	Price level, mid-2026
Power transformer	None	no price; multi-year queue, up about 77 per cent since 2019
Extreme-ultraviolet (EUV) tool, advanced GPU	None	allocation and prepayment
Antimony	None, assessed	about 15,900 (China), 23,000 (Europe) a tonne
Tungsten (ammonium paratungstate)	None, assessed	above 3,000 dollars an MTU, up about 200 per cent this year
Germanium	None, assessed	roughly 6,250 to 8,600 dollars a kilo
Nitrocellulose, TNT	None	no published price

Sources and timing: exchange settlements as at 31 July to 1 August 2026 (ICE Brent and TTF, the Dutch Title Transfer Facility gas hub; NYMEX, the New York Mercantile Exchange, for Henry Hub; LME copper; COMEX gold; CME hot-rolled steel; SGX, the Singapore Exchange, for iron ore; the Baltic Exchange dry index). In the table, FFAs are cleared forward freight agreements and MTU is the metric tonne unit used to price tungsten. The figures for antimony, ammonium paratungstate and germanium are price-reporting-agency assessments rather than exchange prints, and the transformer lead time and its rise since 2019 are from pv magazine USA (2026) and POWER (2026). The late-July energy and metal levels reflect a Strait of Hormuz supply spike rather than a settled baseline, a caveat carried through to Section 13.

Two things to read from it. The prices that exist are moving hard: a US-Iran confrontation around the Strait of Hormuz in mid-2026 has pushed oil, gas and copper up sharply, which is precisely the kind of shock a long project is built long enough to meet. And the further down the table you go, the less there is to quote at all, until at the bottom the entry is a word rather than a number: “queue,” “allocation,” or “no published price.” The scarce inputs are the ones the market cannot even show you a price for, let alone let you lock one.

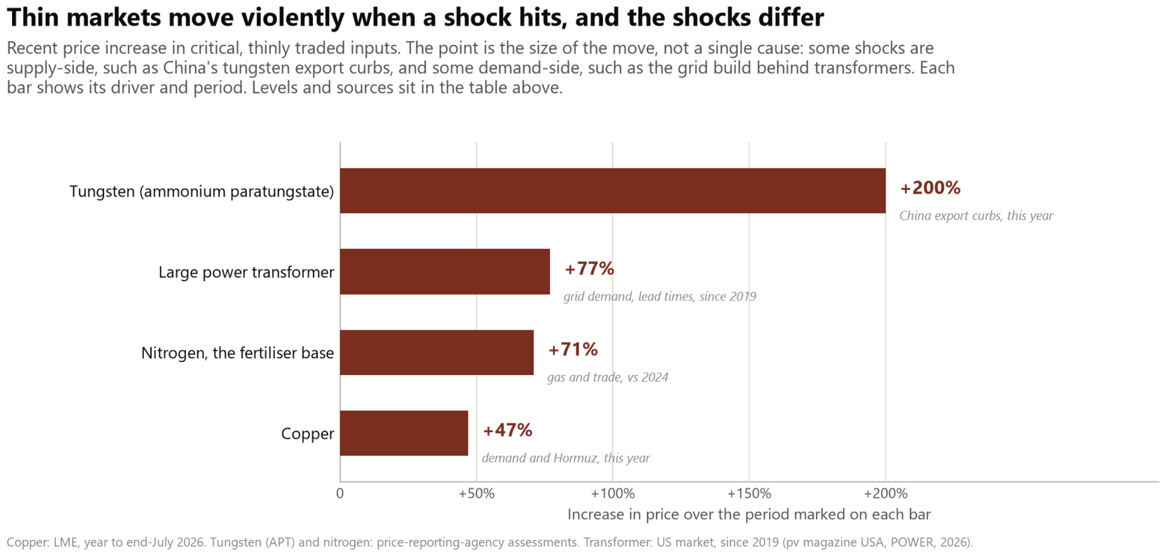

Figure 5. Recent price increases in critical, thinly traded inputs, sorted largest first, with each bar's driver and period marked: tungsten about 200 per cent this year on China's export curbs, the large power transformer about 77 per cent since 2019 on grid demand and lead times, nitrogen about 71 per cent versus 2024 on gas and trade, and copper about 47 per cent on the year on demand and the Hormuz spike. The chart shows the size of the moves in thin markets, not a single common cause

The forward curves make the split visible. For a commodity with a market you can read both the price now and the price the market will sell you the future at, and lock it. Most of these curves slope down today, which is the market pricing the mid-2026 spike to fade, so a buyer can fix a lower price ahead rather than pay the spike. For the engineered inputs at the bottom of the table there is no curve to read at all, only a lead time.

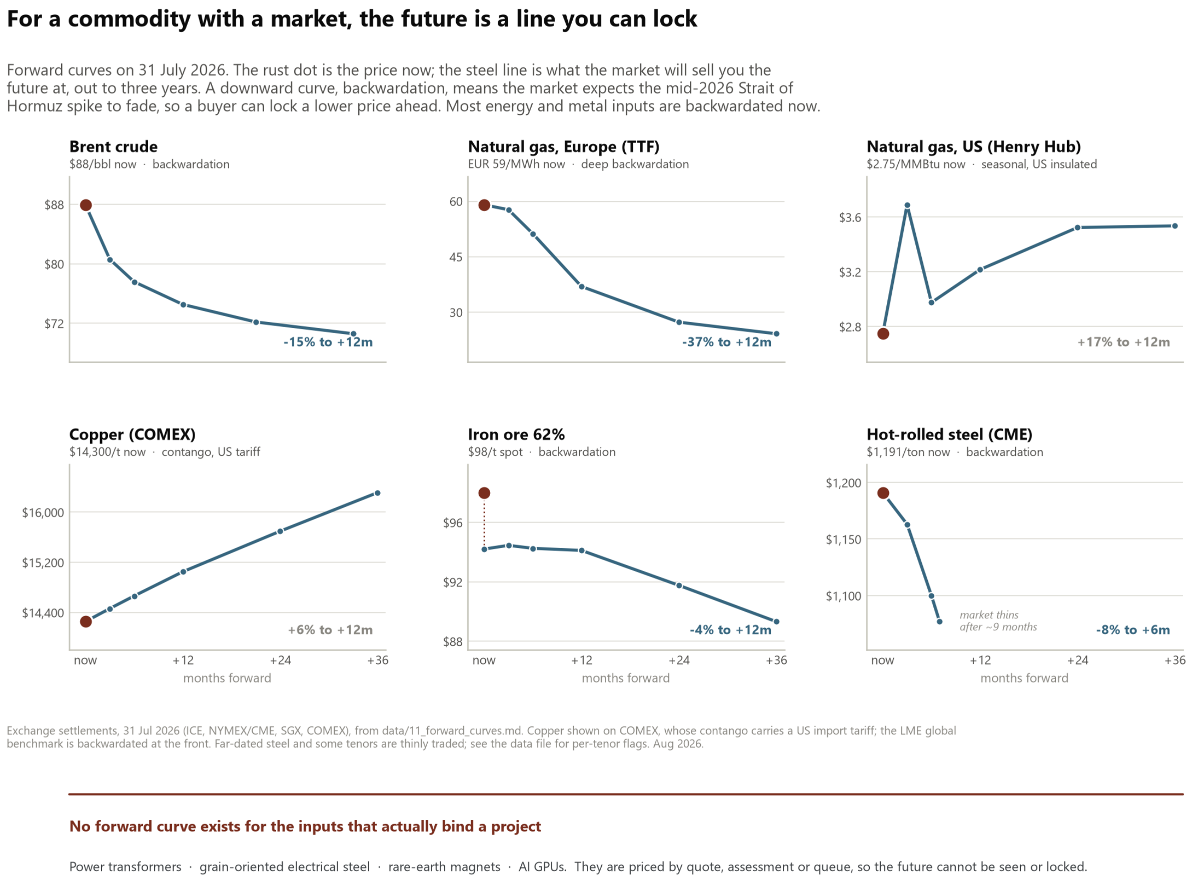

Figure 6. Forward curves for the commodities that have a market, showing spot and futures to three years, with a footer noting the engineered inputs that have no curve

If a transformer has no forward market, where does it compete for supply? Not on price, or not on price alone. It competes in the order book. Supply of engineered components is allocated by lead time, by long-term supply agreement, and by relationship, so the buyer who wins is the one who booked the slot earliest or signed the offtake, not the one who bid the most on a given morning. The market clears on time, not on a cleared price. This is the lesson a medium-sized firm competing for the same inputs should draw: hedge what clears on price, pre-book what clears on time, and do not wait for a spot market to catch the announcement of a new project, because for these inputs there is no spot market to catch it.

6. Big buyers, thin markets

Concentrated demand meeting a thin market, from China to the current build.

This section is about the goods a megaproject actually competes for, and what moves their price. The mechanism is concentrated demand meeting a thin market, and China is the one clean proof at country scale: not a single project but a whole economy's build acting as one giant buyer.

Through the 2000s its construction boom made it close to half the world market for iron ore and copper, and prices followed, iron ore from around 30 dollars a tonne to roughly 180 at its 2011 peak, copper from under 2,000 to about 10,000. What moved the price was not China's size in the world economy but its share of those particular markets. Mines take most of a decade to build, so until new capacity landed, price did the adjusting.

A megaproject inherits that rule at smaller scale. A single large build becomes, for a few years, a major share of the market for the one input it leans on hardest, a class of transformer, a grade of electrical steel, a specialised cable, and holds its price up until the build is done. What is new is that many such builds have arrived at once, leaning on the same narrow set of inputs.

Three current waves show it. The grid rebuild across the United States, Europe and India has stretched delivery of large power transformers to three or four years and lifted their price by more than 70 per cent since 2019. The data-centre build behind artificial intelligence, including the Stargate programme announced in 2025, bids for those same transformers and for grid power, alongside advanced chips and high-bandwidth memory. The new semiconductor fabs, TSMC in Arizona, Intel in Ohio, Samsung in Texas, all depend on a single maker of extreme-ultraviolet lithography tools. None is large enough to move the world price of steel. Each is easily large enough to move the thin market it depends on.

Which markets are thin enough to move? They fall into four groups.

- The energy and grid chokepoints: large power transformers, grain-oriented electrical steel, copper, high-voltage cable.
- The broad build materials: structural steel, cement, and above all skilled construction labour.
- The technology chokepoints: EUV lithography tools, advanced GPUs, high-bandwidth memory.
- The thin strategic markets: antimony, tungsten, gallium, germanium, the rare earths, and the nitrogen and propellant chemicals that defence draws on.

Arms expansion is another claimant on the same thin markets. The Korean War is the clean historical case: rearmament in 1950 and 1951 sent rubber, tin and copper sharply higher within months. Europe's build-up today is far smaller in tonnage, so it will not move the deep markets, but it does not have to. Its sharpest reach is a shared chokepoint: natural gas makes ammonia, ammonia makes nitric acid, and nitric acid makes both nitrogen fertiliser and military explosives, so a defence buildup and a fertiliser bill draw on the same nitrogen base and compete upstream. The limit is that defence is a marginal claimant here, not the driver of the recent fertiliser spike, which owes more to gas prices and trade; the argument holds one step up, at the shared ammonia and nitric-acid level.

One feature of these inputs makes them worth watching. Unlike a project's final bill, they carry a visible price, so they are the observable face of a pressure the consumer price index (CPI) never shows cleanly. A project's cost ledger and its change-orders act as a live, disaggregated index of critical-commodity inflation that the CPI hides.

Part III. Where the Risk Comes to Rest

7. What firms use instead, and why none of it is a hedge

The substitutes for the missing market, and where each one gives way.

Faced with a risk they cannot trade away, project sponsors reach for a familiar toolkit. None of it is a price hedge. Each tool is a substitute for the missing market, a way of relocating the risk rather than neutralising it, and each one fails, visibly, somewhere.

The fixed-price engineering, procurement and construction (EPC) contract is the most common and the most misunderstood. When an owner signs a lump-sum turnkey contract, the contractor promises to deliver for a fixed price, and the inflation risk moves across to it. But transfer is not absorption. If the shock is large enough, the contractor cannot honour the price, and then the risk bounces straight back, now wearing the mask of a counterparty default. Westinghouse's bankruptcy detonated the schedule and cost of the Vogtle nuclear plant. Areva's fixed-price turnkey contract at Olkiluoto collapsed into years of arbitration. Zachry, the lead contractor on Golden Pass LNG, went bankrupt in 2024 trying to build through the cost surge. A hedge that defaults in precisely the state of the world you bought it to protect against is really a bet that the shock will be small.

Contingency reserves are self-insurance, and they are the first thing to be exhausted. Grand Paris Express carried a seven-billion-euro risk provision and overran anyway. Export-credit and concessional loans did the heavy lifting across Asia and Africa, but they hedge the cost of financing, not the cost of building, and they transfer the currency and repayment risk onto the host sovereign, which is why the blow-ups in those economies traced to foreign-exchange (FX) and default rather than to input prices. Government subsidy de-risks capital cost politically, and it is conditional and discretionary, not contractual; it worked at TSMC's Dresden and Kumamoto fabs and failed at Intel's Magdeburg fab and at Britishvolt. Revenue indexation, the Contract for Difference (CfD) and the inflation-linked power-purchase agreement, is the one tool that genuinely worked when it was locked in before the 2022 spike, but as Norfolk Boreas proved, revenue indexation never touches build cost. It protects the money coming in over the asset's operating life and is silent on the money going out during construction.

So the answer is blunt. Overwhelmingly, projects have contingency plans and contractual risk-transfers dressed up as instruments. A genuine cost-side inflation hedge covering the whole basket of what a project consumes does not exist. And when a risk can neither be hedged nor passed through in the contract nor absorbed by a contingency that has already been spent, the pressure does not vanish. It has to go somewhere.

8. Incidence: who is left to bear it

How an un-hedgeable shock travels down the finance chain.

A systematic, un-hedgeable shock cannot be diversified away or laid off to the market. It can only be pushed down the finance chain until it reaches a party that cannot pass it on. The loss comes to rest, in turn, on five parties.

Business owners and equity sponsors. The residual claimant is, by design, the project's equity. When cost overruns exceed contingency and cannot be transferred, equity absorbs the loss first: as an impairment (Vattenfall's 5.5 billion kronor on Norfolk Boreas; Ørsted's roughly 4 billion dollars), as an equity top-up, or as outright cancellation and sunk-cost write-off (Britishvolt, Intel Magdeburg). For a private business owner this is the cleanest incidence, the party that took the upside bears the downside, and it is also the discipline that makes owner-operators build durably. But equity's capacity is finite. Past a threshold the loss punches through the sponsor.

This is the cohort worth watching most closely, because it is the most exposed and the least discussed. A private strategic sponsor, the firm building a fab or a battery plant on its own book, is exposed in four ways at once that a public owner is not. It lacks any financial instrument to hedge the engineered inputs that bind it. Its own equity and cash are at stake rather than a taxpayer's. It often cannot pass the cost through to a customer under a signed offtake. And it runs against an obsolescence clock, the risk that a newer technology strands the asset before it has paid back. That combination, not size, is what makes the private strategic build the sharpest case in the whole distribution.

EPC contractors. The fixed-price turnkey contract exists to move construction-cost risk onto the contractor, and under an idiosyncratic shock it works. Under a systematic shock it becomes the chain's most dangerous link, because a common shock impairs all contractors at once. The 2022 to 2024 result was a correlated wave rather than isolated failures, and once a contractor fails the risk does not vanish; it bounces back up the chain to the owner, lenders and supply chain, dragging delay and re-procurement cost with it. Carillion is the canonical demonstration that a single contractor's failure distributes losses across lenders, suppliers and the taxpayer simultaneously. The top of the market failed the same way: Westinghouse's bankruptcy detonated the Vogtle nuclear schedule, Areva's fixed-price turnkey contract at Olkiluoto collapsed into years of arbitration, and Zachry walked away from Golden Pass LNG in 2024, each throwing the risk back onto an owner who thought it had transferred it.

Lenders and development banks. Project-finance lenders do not intend to bear cost-overrun risk; they contract it back to sponsors through completion guarantees and standby facilities. These defences also assume an independently solvent sponsor and contractor. When the shock is systematic, the standby facility is drawn just as the sponsor is stressed and the contractor is failing, and the lender's contracted-away risk returns. In the export-credit and development-bank channel that financed most of Asian and African infrastructure, the lenders bore financing risk while transferring FX and repayment risk to the host sovereign, which is why the blow-ups in that cohort surfaced as sovereign distress. Rosatom lent about 90 per cent of the cost of Bangladesh's Rooppur nuclear plant. Chinese policy banks financed Sri Lanka's Hambantota port, which was handed to a Chinese operator on a 99-year lease once the debt could not be serviced, and Kenya's Standard Gauge Railway. Zambia, carrying Chinese-financed projects including the Kafue Gorge Lower dam, defaulted on its sovereign debt in 2020. In each of these the loan built the asset and the repayment became the country's crisis.

Governments and taxpayers. Government is the bearer of last resort, and it absorbs the shock three ways. Directly, as owner, where state-funded projects put overruns straight onto the public budget or the ratepayer, as with Canada's Trans Mountain pipeline, Crown-owned and risen from about 7 to 34 billion Canadian dollars, California's high-speed rail, Mexico's Tren Maya and Dos Bocas refinery, and British Columbia's Site C dam recovered through electricity rates. Contingently, through guarantees that are cheap to grant, hard to value, and largely invisible in public accounts until they are realised as public debt. And residually, by rescuing a failed chain, as when the US Department of Defense and the General Services Administration (GSA) issued emergency economic-price-adjustment guidance in 2022 to keep fixed-price public contractors solvent. In the war and balance-of-payments-stressed cohort the government is the only bearer from the outset, because no private counterparty will price the risk at all.

The public. When the loss exceeds even what budgets and guarantees absorb, the residual is borne by the public in a non-financial form. Sometimes it is an asset never delivered, as when HS2's northern leg to Manchester was cancelled in 2023 and the capacity it had promised the north of England simply vanished. Sometimes it is a service delayed for years, as with the repeatedly slipped fabs and rail lines. And sometimes, as Sections 9 and 10 argue, it is a delivered asset whose quality has been quietly reduced to defend a margin, so the public pays again over the asset's life. That last channel is a forecast rather than an observed fact for the assets built in this cycle, with the mid-century failures of reinforced autoclaved aerated concrete

(RAAC) now closing British schools standing as its historical analogue. The pattern across all five is one direction of travel. A systematic shock moves down the chain, from the party that can hedge or absorb to the party that cannot pass it on, and comes to rest on whoever holds the un-indexed, un-hedged margin.

9. Quality: the shock absorber of last resort

What absorbs the loss when it reaches a party that cannot pass it on.

The bottom of the chain is not always a balance sheet. Consider a contractor midway through a fixed-price public contract in an economy where the currency has weakened and the price of imported cement and reinforcing steel has jumped. The contract price is fixed and not indexed. There is no futures market for the cement, and even if there were, this contractor has no treasury desk to run a hedging book. It faces three options and only three: absorb the loss and risk insolvency; stop work, delay, or default; or preserve the margin by quietly reducing the quality of what is built.

The third option is the one the client cannot see. Thin the reinforcing bar by a gauge. Reduce the cement content and add water and sand. Substitute a cheaper aggregate. Shorten the curing time. Each defends the margin, and none shows up at handover, because the strength of concrete and the chemistry of steel are what economists call credence attributes: qualities the buyer cannot verify at the point of sale, and may not discover until the structure is under load, years later.

This has a name. The economist Greg Rosalsky christened it skimpflation, the degradation of quality while the price holds, the industrial cousin of the shrinkflation shoppers notice in a smaller chocolate bar. Its lineage runs back to George Akerlof's 1970 Market for Lemons, which showed that when sellers know quality and buyers do not, quality can be silently degraded. And it is documented. A 2023 study by Daniel Goetz and Alexander Rodnyansky, using microdata from a large Russian retailer, showed that currency devaluations caused firms to reduce the material quality of their goods, and identified the driver as rising import costs rather than falling demand. In construction the evidence is grimmer because the debased product is load-bearing: sub-standard rebar and cement in Nigeria and Kenya, sea-sand concrete in Chinese high-rises, and, in the February 2023 Turkey and Syria earthquakes, forensic assessment finding sea-sand concrete and corroded, cross-section-reduced rebar behind decades of construction amnesties.

A hard caveat is needed, and the argument is stronger for stating it. In any individual disaster, cost-cutting, corruption and weak enforcement are hopelessly entangled, and you cannot cleanly label a single collapse inflation-caused. The clean causal link, inflation shock causing quality reduction, is established at the level of firm behaviour, not at the level of the collapsed building.

The correct claim is precise: quality is the shock absorber of last resort, inflation demonstrably pushes firms toward it, and where enforcement is weak, disproportionately in poorer and high-inflation economies, that pressure translates most readily into physical risk. It does not claim that inflation caused any particular collapse. Notice what this does to the argument. It converts an invisible financial gap into a visible physical one. The missing market becomes a hidden liability cast into the foundations.

10. The delayed bill: shorter-lived public assets

The cost deferred into the durability of the asset.

If quality is the shock absorber, the cost does not disappear. It is deferred and transformed, reappearing years later as premature deterioration, early repair, shortened service life, and in the worst cases failure, disproportionately on public assets.

The physics is unforgiving. The time it takes for chloride or carbonation to reach the reinforcing steel is governed, in the standard model, by the square of the concrete cover, the depth of protective concrete over the rebar. A 20 per cent reduction in cover therefore does not cost 20 per cent of the corrosion-free life; it costs about 36 per cent. Halving the cover destroys three-quarters of it. And the economics of deferral are captured in de Sitter's Law of Fives, first stated in 1984: a dollar not spent on quality at construction becomes five dollars at the first preventive maintenance, twenty-five at the point of active repair, and one hundred and twenty-five at reconstruction.

A private owner who also maintains the asset internalises that whole-life cost and has every reason to build to last, which is why European procurement law and the UK Construction Playbook now push whole-life value over lowest price. But the typical public project does the opposite. It awards to the lowest bid, which rewards whichever contractor cut the most. Its price is fixed and not indexed, maximising the incentive to find the margin somewhere the contract does not police. Its capital budget and its maintenance budget sit in different places and different years, so the entity that builds never pays for early failure. And its enforcement of build quality is weakest exactly where currencies are weakest.

We have a matured historical analogue. In mid-twentieth-century Britain, RAAC was chosen for schools and hospitals because it was cheaper, lighter and quicker to install. It had a design life of around thirty years. It is now failing, sometimes collapsing without warning, at forty and fifty years, forcing a multi-billion-pound emergency replacement programme across hundreds of schools and hospitals and even the Houses of Parliament. It is the textbook case of build cheap, pay later.

The essential caveat, worn openly. We cannot yet observe a shortened lifespan in any asset built during the surge. Those assets are a few years old; their design lives run from fifteen to a hundred and twenty years. What we have instead is a chain in which every link is documented except the final measurement: the surge happened; it demonstrably broke non-indexed fixed-price contractors; quality is the cheapest available relief; and the physics and the lifecycle multipliers turn that relief into disproportionate future loss. The defensible statement is therefore a forecast, not a fact. The surge should be expected to produce a delayed wave of under-durable public assets, invisible today, surfacing as premature deterioration over the next five to fifteen years, concentrated in the non-indexed, lowest-bid public cohort in weak-enforcement economies. It is more credible, not less, for admitting what it cannot yet prove.

Part IV. Policy and Remedy

11. The double blind spot

The gap between what a central bank can cool and what a firm can hedge.

Put the two mechanisms together and the picture is complete. Monetary policy cannot reach the committed, rate-insensitive demand that megaprojects represent, and it cannot reach the thin global markets where their inputs are priced. A national central bank sets a national rate, but the pressure sits on globally traded, inelastic inputs, and the geography of the demand, concentrated in a few countries, is not even the geography of the binding inputs, which are a handful of global nodes: lithography from the Netherlands, chips from Taiwan, copper from the Andes, transformers from a few makers with multi-year queues. No single rate reaches a chokepoint that sits in another jurisdiction and clears by waitlist rather than by price.

Financial hedging cannot cover the engineered components that those same projects actually break on, because those components have no market to hedge in. A rate rise works by making it more expensive to hold a position, so it bites where demand is discretionary and price-sensitive; it does nothing to a four-year transformer queue a utility joined two years ago and cannot leave. A hedge works by fixing a price, so it needs a price to fix; it has nothing to grip on a market that rations by allocation. Both instruments operate on price, and the chokepoint operates on time. The pressure concentrates precisely in the gap between what the central bank can cool and what the firm can hedge. It is a blind spot shared by the two instruments most trusted to manage price risk, and it is where the scarce part of every one of these projects lives.

How would one prove this cleanly rather than assert it? Not by estimating a magnitude, which the attribution problem forbids, but by proving the fingerprint. The clean identification is a placebo or difference-in-differences design on two products that share everything except exposure to the megaproject build: grain-oriented electrical steel, which the grid and transformer build draws on, against ordinary flat steel, which it does not. If the specialised series moves and the ordinary one does not, the price mechanism has left a signature no aggregate index can show, and the claim is demonstrated on the narrow ground where it is actually true.

12. Completing the market

Instruments that pay out on a common index, and where only a public backstop will do.

If the binding risk is common rather than idiosyncratic, the useful instruments are those that pay out on a common index, not those that diversify or transfer to a single counterparty. And if the financial hedge is unavailable, the first line is a physical one. Four remedies are worth serious attention, and they divide into the operational and the financial.

The physical hedge is operational rather than financial, and it is the correct response to a market that clears on time. A buyer books the slot early and holds it, signs long-term supply agreements rather than buying spot, carries inventory of the long-lead items instead of running lean, dual-sources the single-supplier parts where a second source exists, and designs the project so that a substitute component can go in if the first choice does not arrive. None of this fixes a price. It manages a queue.

A construction-cost-index derivative would extend the existing, liquid market in CPI-linked swaps to a published construction or building-materials index. A sponsor who cannot hedge cement, labour or a bespoke transformer individually could hedge the basket synthetically, answering the two defeaters of commodity futures at once: the bespoke-basket problem, because the index is the basket, and the no-market-for-cement problem, because the index contains cement even though cement does not trade. The cost is basis risk, which for a systematic shock is second-order: a partial hedge on 100 per cent of cost beats a perfect hedge on the 15 per cent that is exchange-traded steel.

Parametric cost-overrun insurance pays out when an index breaches a trigger, with no claims assessment. Its pedigree is instructive, and it is the real bridge between microfinance and megaprojects. When smallholder farmers could not insure against drought, because verifying each farmer's individual loss was impossibly expensive and invited fraud, the innovation that worked was weather-index insurance: a policy that pays out automatically when a published rainfall index falls below a trigger, regardless of any individual farm's actual loss. It completed a market that direct insurance could never reach, precisely by abandoning the attempt to measure the un-measurable and tying the payout to an observable index. A parametric cost-overrun policy is the exact same move. What carries across from microfinance is the design principle of completing an incomplete market through an index when a direct instrument cannot exist, rather than the scale.

Tenor extension, via public backstops, development banks or standardised long-dated products, would push hedgeable horizons toward the true five to ten year life of a project. And public backstops are needed where no private market can ever exist: for the war and balance-of-payments-stressed economies, no private market will price currency inconvertibility or war risk at a level a project can bear, so the instrument must be a public facility, political and war-risk cover of the Multilateral Investment Guarantee Agency (MIGA) kind, blended guarantees, and IMF and donor backstops. Market completion is not always the market's job.

What unifies these is that each keeps the shock in the financial domain, giving the contractor a legitimate valve so relief comes from a financial counterparty rather than the concrete. The missing instrument does more than decide who bears a loss. It is the transmission mechanism deciding whether a systematic price shock stays on a balance sheet or is cast into a structure, and how far down the chain it travels before it stops.

13. Limits, and the close

What the paper does not claim, and the one sentence it comes down to.

The census is purposive and single-period. It supports classification and structural inference, not causal point estimates, and it over-weights large, internationally reported projects. Several figures are indicative pending verification against primary filings: project costs, the per-archetype hedgeable shares, which are engineering estimates good to about five percentage points, the excess-escalation magnitude, and several literature citations. The systematic-versus-idiosyncratic claim is argued from the synchronisation of cost indices and the clustering of contractor insolvencies, not from a formal variance decomposition. The durability channel is a mechanism-and-analogue forecast, not an observation, and quality debasement cannot be cleanly separated from corruption and weak enforcement at the level of any individual failure. The mid-2026 price levels move continuously and should be re-verified before publication; the late-July energy and metal prints reflect a Strait of Hormuz spike rather than a settled baseline, and the COMEX copper contango is in part a US import-tariff artefact rather than a global signal.

The through-line is one sentence. A large project is a long bet that the world holds still, and because the world never does, its cost is not so much mis-estimated as un-estimable; what we can measure instead is the mark it leaves on the way through, the price of the few critical commodities and engineered components that every one of these projects needs at the same time, on the same thin markets, in the same tight years. The reassurance that markets let firms hedge their input costs is true for the raw commodity and false for the finished component. A megaproject does not fail on the price of copper, which it can hedge, or the demand its scale adds, which a rate can cool. It fails on the transformer it cannot buy in time, and neither a hedge nor a rate can touch that. The case for financial innovation here is not a case for cleverness. It is a case for finishing an unfinished market, so that the next systematic surge is absorbed by a hedge, a clause or a public guarantee, and not, years after the ribbon is cut, by the structure itself and the people who depend on it.

Scope of the claim

What the paper claims, and what it does not.

> This paper does **not** claim that megaprojects drive headline or consumer inflation. They are far too small against total consumption to move a national price index, and no method could cleanly isolate their demand from everything else with a single number. It does **not** forecast any project's final cost, because the windows are too long and the estimates un-helpable.
>
> It **does** claim, and can show, that a simultaneous, rate-insensitive global build concentrates demand on a small, thin, inelastic set of critical commodities and engineered components; that this is where the price pressure is real, observable, and beyond the reach of any single central bank; and that the financial instruments trusted to manage price risk cover only the part of a project's cost that was never the binding constraint.

References

Price levels, cost indices and outlooks

- Turner Construction (2026). *Building Cost Index, Second Quarter 2026.* Turner Construction Company. https://www.turnerconstruction.com/cost-index (Q2 2026 index about 1,552, up about 5.2 per cent year on year; 2020 base about 1,177). Reported in Construction Dive, "Turner's building cost index surged 5.2% in Q2," https://www.constructiondive.com/news/turners-building-cost-index-q2-2026/826514/
- World Bank (2026). *Commodity Markets Outlook, April 2026.* World Bank Group. https://www.worldbank.org/en/research/commodity-markets and press release, "Middle East War to Spark Biggest Energy Price Surge in Four Years," 28 April 2026, https://www.worldbank.org/en/news/press-release/2026/04/28/commodity-markets-

outlook-april-2026-press-release (global commodity prices forecast about 16 per cent higher on average in 2026, first annual rise since 2022; energy about 24 per cent; precious-metals index about 42 per cent).

- Zarenski, E. (2026). *Construction Inflation 2026.* Construction Analytics. https://edzarenski.com/2026/05/13/construction-cost-inflation-2026/
- Turner & Townsend (2023). *International Construction Market Survey 2023.* Turner & Townsend. (Global average construction cost escalation; the source for the roughly 9.5 per cent 2022 figure.) Exact figure and edition to be confirmed before publication.
- Construction Analytics / Zarenski, E. (2023). *Construction Inflation 2023 and historical index tables.* https://edzarenski.com (US non-residential building cost escalation of roughly 12 per cent for 2022, against a long-run norm near 3 to 4 per cent.) Exact page to be confirmed before publication.
- Mid-2026 commodity and component price levels, lead times and forward curves: exchange settlements as at 31 July to 1 August 2026 (ICE, NYMEX/CME, SGX, COMEX, LME). Large power transformer lead times and prices: pv magazine USA (2026), https://pv-magazine-usa.com/2026/05/11/u-s-transformer-market-faces-severe-supply-constraints-as-lead-times-extend-to-four-years/ and POWER (2026), https://www.powermag.com/transformers-in-2026-shortage-scramble-or-self-inflicted-crisis/ The assembled price and forward-curve tables are set out in Appendix A.3.

Reference magnitudes and project pipeline

- International Monetary Fund (2025). *World Economic Outlook, October 2025.* https://www.imf.org/en/publications/weo/issues/2025/10/14/world-economic-outlook-october-2025 (world GDP about 117 trillion US dollars, 2025 estimate).
- International Monetary Fund (2025). *Currency Composition of Official Foreign Exchange Reserves (COFER), 2025 Q3.* https://data.imf.org/en/datasets/IMF.STA:COFER (official FX reserves about 13.0 trillion US dollars).
- State Administration of Foreign Exchange (2026). *China Official Foreign Exchange Reserves, December 2025.* https://www.safe.gov.cn/en/2026/0107/2382.html (about 3.36 trillion US dollars, FX only).
- The 24-project pipeline and the roughly 5.9 trillion US dollar aggregate, and the wider census of about 97 projects active over 2020 to 2024, are set out in Appendix A.1 and A.2.

Archetype cost structures, verified against primary sources (August 2026)

- Solar PV: Ramasamy et al., *Documenting 15 Years of Reductions in U.S. Solar Photovoltaic System Costs*, NREL/TP-7A40-92536 (2025), Table A-3, https://www.nrel.gov/docs/fy25osti/92536.pdf, with the Q1 2023 benchmark NREL/TP-7A40-87303, https://www.nrel.gov/docs/fy23osti/87303.pdf. Utility-scale: module about 30 per cent, structural BOS and racking about 11, electrical BOS about 15, fieldwork labour about 21, inverter about 3, soft costs about 17.
- Offshore wind: BVG Associates, *Guide to an Offshore Wind Farm* (2025 fixed-bottom update, The Crown Estate and ORE Catapult), https://guidetoanoffshorewindfarm.com/wind-farm-costs/. Turbine about 35 per cent, balance of plant about 32, installation about 29, development about 4.
- Onshore pipeline: *Oil and Gas Journal* Pipeline Economics survey (2025), https://www.ogj.com/pipelines-transportation/pipelines/article/55322093/pipeline-construction-costs-reach-record-121-million-mile. Long-run average roughly material 31 per cent, labour 40, miscellaneous 23, right of way 7.
- High-speed rail: Ollivier, Sondhi and Zhou, *High-Speed Railways in China: A Look at Construction Costs*, World Bank China Transport Topics No. 9 (2014), Table 2, https://documents.worldbank.org/en/publication/documents-reports/documentdetail/695111468024545450. Civil works about 48 per cent, rolling stock 15, track 9, electrification 5, signalling 4, land 4.
- Hydropower: O'Connor et al., *Hydropower Baseline Cost Modeling, Version 2*, ORNL/TM-2015/471 (2015), Figure 3, https://info.ornl.gov/sites/publications/files/Pub58666.pdf. Civil works about 50 per cent, electromechanical 26, engineering 16, electrical 8. US small-to-mid hydro; a large storage dam runs more civil-heavy.
- Nuclear: World Nuclear Association, *Economics of Nuclear Power*, https://world-nuclear.org/information-library/economic-aspects/economics-of-nuclear-power, and MIT, *The Future of Nuclear Energy in a Carbon-Constrained World* (2018), Table 2.2, https://energy.mit.edu/wp-content/uploads/2018/09/The-Future-of-Nuclear-Energy-in-a-Carbon-Constrained-World.pdf. Onsite labour about 25 per cent, equipment about 40, construction materials about 12; reactor and turbine equipment only 17 to 28.
- LNG liquefaction: Songhurst, *LNG Plant Cost Escalation*, OIES NG-83 (2014), https://www.oxfordenergy.org/wpcms/wp-content/uploads/2014/02/NG-83.pdf, and *LNG Plant Cost Reduction 2014-18*, OIES NG-137 (2018), https://www.oxfordenergy.org/wpcms/wp-content/uploads/2018/10/LNG-Plant-Cost-Reduction-2014-18-NG137.pdf. Construction about 32 per cent, equipment 30, bulk materials 20, owner's costs 10, engineering 8.

- Not yet checked against a primary source: semiconductor fabs, refineries and metros. The fab tools-versus-facility split of about 70 to 80 per cent tools is from secondary industry sources.

Systematic shock, polycrisis and fragmentation

- Lawrence, M., Janzwood, S. and Homer-Dixon, T. (2024). "Global Polycrisis: The Causal Mechanisms of Crisis Entanglement." *Global Sustainability* 7: e6. https://doi.org/10.1017/sus.2024.1 (separate crises interacting and amplifying across systems). Exact article locator to be confirmed before publication.
- Aiyar, S., Chen, J., Ebeke, C. and others (2023). *Geoeconomic Fragmentation and the Future of Multilateralism.* IMF Staff Discussion Note SDN/2023/001. International Monetary Fund. https://www.imf.org/en/Publications/Staff-Discussion-Notes/Issues/2023/01/11/Geo-Economic-Fragmentation-and-the-Future-of-Multilateralism-527266 (rising cost of traded inputs as trade fragments). Exact link to be confirmed before publication.

Climate extremes and prices

- Ademmer, M., Jannsen, N. and Meuchelböck, S. (2023). "Extreme Weather Events and Economic Activity: The Case of Low Water Levels on the Rhine." Kiel Working Paper, Kiel Institute for the World Economy. (The 2018 Rhine low-water period and German industrial production.) Exact working-paper number and year to be confirmed before publication.
- Faccia, D., Parker, M. and Stracca, L. (2021). "Feeling the Heat: Extreme Temperatures and Price Stability." European Central Bank Working Paper No. 2626. https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2626~e86e2be2b4.en.pdf (hot summers raise food prices in the near term).
- Kotz, M., Kuik, F., Lis, E. and Nickel, C. (2024). "The Impact of Global Warming on Inflation: Averages, Seasonality and Extremes." *Communications Earth and Environment* 5: 116, and earlier as ECB Working Paper No. 2821 (2023). (Warming could raise annual food inflation by roughly one to three percentage points by the mid-2030s.)

Base rate, incidence, quality and market completion

- Flyvbjerg, B. (2014). "What You Should Know About Megaprojects and Why: An Overview." *Project Management Journal* 45(2): 6 to 19. Free full text: https://arxiv.org/pdf/1409.0003
- Flyvbjerg, B. and Gardner, D. (2023). *How Big Things Get Done: The Surprising Factors Behind Every Successful Project, from Home Renovations to Space Exploration.*

New York: Currency. (The 16,000-project dataset behind the per-type cost-overrun ladder, from solar at the low end to the Olympic Games at the high end.)

- Akerlof, G. A. (1970). "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism." *Quarterly Journal of Economics* 84(3): 488 to 500.
- Rosalsky, G. (2021). "Meet 'Skimpflation': A Reason Inflation Is Worse Than the Government Says." *NPR Planet Money.*
- Goetz, D. and Rodnyansky, A. (2023). "Exchange Rate Shocks and Quality Adjustment." *Review of Economics and Statistics.* (Exact volume and pages to be confirmed.)
- de Sitter, W. R. (1984). "Costs for Service Life Optimization: The Law of Fives." *Durability of Concrete Structures*, CEB-RILEM Workshop, Copenhagen.
- Barnett, B. J. and Mahul, O. (2007). "Weather Index Insurance for Agriculture and Rural Areas in Lower-Income Countries." *American Journal of Agricultural Economics* 89(5): 1241 to 1247.
- House of Commons Library (2018). "The Collapse of Carillion." Briefing Paper CBP-8206; National Audit Office (2018), *Investigation into the Government's Handling of the Collapse of Carillion*, HC 1002.
- US Department of Defense, Office of the Under Secretary of Defense (A&S) (2022). "Guidance on Inflation and Economic Price Adjustments" (May) and "Managing the Effects of Inflation with Existing Contracts" (September).
- Vattenfall (2023), Norfolk Boreas suspension and impairment disclosure; Ørsted (2023), Ocean Wind 1 and 2 impairment disclosure, Q3 2023.

Hedging, futures markets and incomplete markets

- Carlton, D. W. (1984). "Futures Markets: Their Purpose, Their History, Their Growth, Their Successes and Failures." *Journal of Futures Markets* 4(3): 237 to 271. https://onlinelibrary.wiley.com/doi/10.1002/fut.3990040302 (the contract characteristics that separate successful futures markets from the many that fail: a standardised, storable underlying and an active cash market).
- Ederington, L. H. (1979). "The Hedging Performance of the New Futures Markets." *Journal of Finance* 34(1): 157 to 170. https://onlinelibrary.wiley.com/doi/10.1111/j.1540-6261.1979.tb02077.x (hedge effectiveness and basis risk; a full hedge is not always the risk-minimising position).
- Newbery, D. M. (2016). "Missing Money and Missing Markets: Reliability, Capacity Auctions and Interconnectors." *Energy Policy* 94: 401 to 410.
- Ben Ammar, S. and Eling, M. (2015). "Common Risk Factors of Infrastructure Investments." *Energy Economics* 49: 257 to 273 (infrastructure risk is not spanned by traded assets).

- Rauch, J. E. (1999). "Networks versus Markets in International Trade." *Journal of International Economics* 48(1): 7 to 35. https://econpapers.repec.org/RePEc:eee:inecon:v:48:y:1999:i:1:p:7-35 (classifies traded goods into organised-exchange, reference-priced and differentiated, the last being the largest category).
- Our World in Data. "Share of Manufactured Products in Total Merchandise Exports." https://ourworldindata.org/grapher/share-manufacture-exports (long-run rise of manufactures in the merchandise mix).
- World Bank, World Development Indicators. "Manufactures Exports (% of Merchandise Exports)," World aggregate, series TX.VAL.MANF.ZS.UN. https://data.worldbank.org/indicator/TX.VAL.MANF.ZS.UN (about 56 per cent in 1963, a peak near 76 per cent in the mid-1990s, about 69 per cent in 2024; retrieved via the World Bank API, and plotted as the Section 4 exhibit).

Appendix A. Data, sources and method

Every input is public. This appendix lists what was used, how it was assembled, and where the author's own estimates enter.

The paper rests on three bodies of evidence: a census of about 97 megaprojects active over 2020 to 2024, a snapshot of the 24 largest projects now running or committed, and a reading of commodity and component prices in mid-2026. None is a statistical panel, and the paper draws no causal point estimate from any of them. Their purpose is classification and structural inference.

A.1 The project census

The census covers about 97 projects, each with a headline cost above one billion US dollars, active at some point over 2020 to 2024, across more than forty countries. It is purposive rather than random, and it over-weights large, internationally reported projects, because those are the ones with public filings, audit reports and contemporaneous coverage to read. For each project one main reason for delay or overrun was recorded from company filings, national audit reports and reporting at the time. This is a count of named causes rather than a controlled study. The projects sit at different stages, and the length of time each has been under price pressure is not observable, so the census describes the record without proving a cause. The assembled census is held in the author's working files and is available on request.

A.2 The pipeline snapshot

Table A1 lists the 24 projects behind the timeline in Section 1 and the roughly 5.9 trillion US dollar aggregate. Start and completion years are the best-reported construction or commitment dates. Several rows are multi-year programme envelopes rather than single projects, so the aggregate is an order of magnitude and not a strict sum. Headline sizes are as first reported and are not comparable across rows, since they mix sovereign budgets, private capital expenditure and enabling ceilings. The cohort column marks whether a project was scoped in the cheap-money era, with a start year from 2015 to 2022, or committed into high rates, with a start from 2023 on. The financing column marks who carries the cost: public for a taxpayer, sovereign or ratepayer; mixed for private capital expenditure with a public subsidy; private for equity and lenders.

Table A1. The 24-project pipeline snapshot, mid-2026.

Project	Headline size	Start	Completion	Financing	Cohort
Egypt New Capital	$58bn	2015	2030	Public	Cheap money

Project	Headline size	Start	Completion	Financing	Cohort
California HSR	$106bn	2015	2033	Public	Cheap money
CPEC (Pakistan)	$62bn	2015	2030	Public	Cheap money
Grand Paris Express	$44bn	2016	2031	Public	Cheap money
NEOM (Saudi Arabia)	$500bn	2017	2032	Public	Cheap money
India infra pipeline	$1.4tn	2020	2025	Public	Cheap money
HS2 (UK)	$120bn	2020	2039	Public	Cheap money
TSMC Arizona	$165bn	2021	2030	Mixed	Cheap money
Intel Ohio	$28bn	2022	2031	Mixed	Cheap money
Samsung Taylor	$37bn	2022	2027	Mixed	Cheap money
Qatar North Field LNG	$29bn	2022	2027	Public	Cheap money
Plaquemines LNG	$23bn	2022	2027	Private	Cheap money
Nusantara (Indonesia)	$32bn	2022	2045	Public	Cheap money
Rapidus (Japan chips)	$35bn	2023	2027	Mixed	High rates
Rio Grande LNG	$18bn	2023	2031	Private	High rates
Meta Hyperion (AI)	$50bn	2024	2032	Private	High rates
xAI Colossus (AI)	$20bn	2024	2027	Private	High rates
Korea chip cluster	$471bn	2024	2047	Mixed	High rates
ESMC Dresden (chips)	$11bn	2024	2027	Mixed	High rates
Stargate (AI)	$500bn	2025	2029	Private	High rates
US grid capex	$1.1tn	2025	2029	Public	High rates
ReArm Europe (defence)	$860bn	2025	2030	Public	High rates
Medog dam (China)	$167bn	2025	2033	Public	High rates
US submarine base	$77bn	2026	2035	Public	High rates

Sizes and dates are compiled from IMF and World Bank aggregates, company and government filings and the trade press, and are held with their per-figure sourcing in the author's working files.

A.3 Prices, lead times and forward curves

The price snapshot in Sections 5 and 6 is read from exchange settlements as at 31 July to 1 August 2026: ICE for Brent and TTF gas, NYMEX and CME for Henry Hub and hot-rolled steel, LME for copper, COMEX for gold, SGX for iron ore, and the Baltic Exchange dry index. Prices for antimony, ammonium paratungstate and germanium are price-reporting-agency assessments rather than exchange prints. Large power transformer lead times and the rise since 2019 are from pv magazine USA (2026) and POWER (2026). These levels move continuously, and the late-

July energy and metal prints carry a Strait of Hormuz supply spike rather than a settled baseline, so any figure drawn on them should be re-verified before citation. The assembled price and forward-curve tables are held in the author's working files.

A.4 The hedgeable-share estimates

The per-archetype hedgeable shares in Section 4 are the author's own. Each is built by decomposing an archetype's typical capital cost into its lines, steel, concrete, fabricated equipment, labour, land and financing, and counting only the part that is exchange-traded and liquid to hedge within an 18 to 24 month window: carbon steel on the CME, copper and aluminium on the LME and COMEX, and energy. The cost decompositions come from the industry sources listed under "Archetype cost structures" in the References, verified against the primary documents for solar, offshore wind, onshore pipelines, nuclear, LNG, high-speed rail and hydropower. Semiconductor fabs, refineries and metros are not yet checked against a primary source. The component splits are planning estimates good to about five percentage points, so the shares are a ranking rather than precise levels.

A.5 Data availability and disclosure

All sources are public. The census, the pipeline snapshot, the price tables and the cost decompositions are held in the author's working files and are available on request. The hedgeable shares and the census cause-coding are the author's own judgement, flagged as such wherever they appear. The author has no financial interest in any project, contractor or supplier named here, and received no funding for this work.