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Extractive industries: recognizing and managing the risks in resource-dependent economies

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Abstract: This paper analyses the risks facing resource-dependent countries. These include: (i) economic mismanagement (the 'resource curse'); (ii) political mismanagement; (iii) environmental damage (climate change and the destruction of natural capital). It distinguishes 'risk' (which can be addressed probabilistically) from 'uncertainty' (infrequent unpredictable events). Mozambique, with its large natural gas resource, provides examples of all the component risks and uncertainties. The paper then explores the risks and uncertainties arising from the global transition away from fossil fuels to renewable energy. This shift could result in 'stranded countries' as well as 'stranded assets'. Finally, the paper explores the nature of the net-zero transition for metals, including the eventual emergence of new cheaper materials as substitutes for critical, but expensive, minerals. Overall, the paper recommends focusing on a nation's entire portfolio of natural resources in order to minimize the impact of shocks, and to mitigate risks and uncertainties.

Key words: Africa, extractive industries, debt crisis, mining, natural gas, oil

JEL classification: L71, L72, O13, F34

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1 Introduction

Just over one hundred years ago a book entitled *Risk, Uncertainty and Profit* by Professor Frank H. Knight of the University of Chicago was published.[1] This influential work drew a sharp distinction between risk (which can be assigned a probability) and uncertainty (which cannot). In the former we believe we have enough information about the likelihood of the outcome of an event, in the latter we do not. The hundred and more years since Professor Knight's book was published have seen shocks in abundance. Many were assigned too low a probability. Many were not anticipated at all.

Inherent to all economic-policy decisions is an assessment of risk, whether it is informal (making a judgement) or formal (deploying a model). These include investment decisions (whether to push the development of a promising sector) or borrowing decisions (whether to take on debt to finance the investment or the budget more generally). Successful economic development requires risks to be taken but the art of policy-making lies in balancing risk and reward.

When decisions must be made in the context of little (or conflicting) information, it might be better to admit to our uncertainty rather than to try and assign some spurious probability to the event's likely occurrence. And then proceed with caution, especially when any downside is potentially large (from overborrowing for example) and especially if it is irreversible (a particular concern when the damage is to nature). Therefore, while in this paper we shall use risk as a shorthand term, the reader should be aware that policy-making often takes place amidst what is actually high uncertainty. This is certainly the case today amid a shaky recovery from the Covid-19 pandemic, war in Europe, and an unsteady trajectory for the energy transition.

Hubris is also prevalent. Often, we convince ourselves, and others, that we have a plan to manage and contain shocks. Yet there is a danger that we underestimate not only their likelihood but also the *scale* of impact. As Mike Tyson, the boxer, bluntly put it: 'everyone has a plan until they get punched in the face'.

Just as a boxer may never get off the canvas after a punch from Mr Tyson, so economies can struggle to find their footing after a major shock. Advanced economies have more strength and ability to recover than poorer economies: the former have more diversified economies (so that a hit to one sector can be compensated by resilience elsewhere); their governments have stronger capacities to formulate and implement remedial action; and they have more fiscal space to offset the shock and initiate recovery. Poorer economies are deficient in all three, which is why development economists urge diversification, capacity-building in policy, and stronger public finances.

In this paper we focus on two sources of risk (or uncertainty), distinguished by the potential for the typical producing country to anticipate them and to effectively respond. The first are market risks. Here we amplify recent discussion of the climate and energy transition by highlighting the risks to resource economies from technological advance as well as geopolitics. Except for China, India, and some of the other large middle-income countries (MICs) the typical small developing country has almost no power to influence technological change nor geopolitical shifts (although their resource endowment may allow them to profit from one or both).

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[1] Knight (1921).

The second category of risks are distinguished from the first by the realistic chance that even a poor small county can anticipate them and respond effectively: these are the *economic, political, and environmental risks* that constitute the 'resource curse'. Our argument is that the resource curse is not a foregone conclusion—as is often assumed. We then use Mozambique as an example of a country that is in danger of the resource curse, but also one that could pull itself back given the right decisions. Mozambique also illustrates the risk posed by climate change to poorer countries—a risk to which it must adapt but one over which it has little direct influence given its tiny share of global emissions.

We then derive some policy principles for developing countries as a whole, emphasizing the need to reduce overall risk by bringing together all natural capital—both renewable and non-renewable—within a single policy framework, instead of leaving them in their respective policy silos as is largely done at present. The penultimate section argues that while there is scope for individual national action in managing risks, poorer countries will struggle without considerably more international assistance, both financial and technical. The paper ends with a plea for more capacity-building in government to strengthen the evaluation of policy and investment decisions in the context of both risks as well as uncertainties, so that countries can take full advantage of the opportunities now emerging.

2 Market risks

When peering into the future, scenarios such as those prepared by the International Energy Agency (IEA) help us anticipate and prepare. The market for fossil fuels is robust for at least a decade (and longer in the case of gas) under most scenarios, even though the latest IEA scenarios expect the demand for oil, gas and coal to peak this decade.[2] From what we know about the materials intensity of electric vehicles (EVs), renewable power infrastructure (and the necessary large-scale energy storage), together with all the other requirements of the modern economy (not least its digital foundation), metals markets appear buoyant to at least mid-century (but with the circular economy contributing an ever larger share of supply). With fossil fuels still alive and kicking for some time, and metals and materials ramping up output, producing countries can certainly see the coming decades as a significant opportunity to use their resource endowments to tackle poverty (even though, in the case of fossil-fuel producers, adding yet further to global emissions).

Nevertheless, life is full of surprises—and while scenarios are useful, overconfidence is a trap. What could lie in wait? What Knightian uncertainties might be out there? Inevitably there will be price shocks, reflecting the ups and downs of the global business cycle. Here we focus on bigger uncertainties arising from structural shifts in the markets. We begin with metals and materials, and then turn briefly to the fossil fuels. The reader should keep in mind that much of what we say is necessarily speculative.

Regarding metals and materials, sellers (producers) face less risk than buyers (commodity traders and ultimately manufacturers) over the long-term if the scenarios already discussed are reasonably correct. Sellers can supply to many eager buyers, while the buyers could face rising prices and, of equal concern, supply shortages that put a brake on manufacturing and limit the market growth, of EVs and wind turbines, for example. Manufacturers can and will seek new sources of supply but will also step up their research and development (R&D) to find cheaper materials with less

[2] IEA: https://www.iea.org/energy-system/fossil-fuels/oil. The Organization of Petroleum Exporting Countries (OPEC), not surprisingly, disagrees: https://www.opec.org/opec_web/en/press_room/7217.htm

risky supply chains. If neither provides a solution then the net-zero transition could slow or, *in extremis*, derail—a hit to the revenues of producing countries. In any event, producing countries should keep a close eye on the market's demand-side and its evolution.

Buyers have three (interacting) concerns: supply availability and price; their responsibilities as regards the quality of their supply chains (especially the environmental and human rights impacts); and geopolitical risk (is producing country subject to sanctions, for example?). And there is an added twist: thirty years ago, buyers were overwhelmingly the advanced economies of the Global North, but now they must compete with increasingly large Southern buyers, notably China since the millennium, and India (where the manufacture of EVs is also taking off). Furthermore, countries with large reserves of critical minerals such as Chile and notably Indonesia are intent on adding value to their resources by building a refining industry and then using the metals in new local manufacturing bases (including EVs) instead of exporting unprocessed ore.[3] Northern buyers therefore face more risk than previously in securing supplies of metals. The Global North's dilemma is accentuated by the decline of its own mining sector—mostly through choice in response to environmental campaigns—with mining becoming ever more concentrated in the Global South. (see Roe 2021: Figure 1).[4]

2.1 Nickel as one example

Nickel is an example of all three concerns. EV manufacturers worry about sufficiency of supply (the IEA expects nickel demand to rise 19-fold by 2040 under its net-zero scenario).[5] In July 2020 Tesla's Elon Musk said this to miners: 'Tesla will give you a giant contract for a long period of time if you mine nickel efficiently and in an environmentally sensitive way'.[6] Notable in Mr Musk's plea is the emphasis on environmental sustainability in addition to supply security and cost. Tesla and the vehicle industry need green materials given the environmental claims underpinning their own marketing. However, there is a hard-to-resolve tension with the sheer scale of their requirements for metals.

This has intensified with the geopolitical risk that now attends contracts for nickel (and other metals) supplied by Russia which is the world's fourth largest nickel producer (supplying 20 per cent of the category one (high purity) nickel required for batteries). While Russian metals are not yet sanctioned, entering a contract with Russian suppliers poses a distinct risk to Western manufacturers of supply disruption. It also risks their reputation: by in effect providing revenue that ultimately helps Russia fund its war on Ukraine.

Tesla has now turned to Indonesia the world's biggest nickel miner (and a country that has also built a large refining industry). Tesla signed US$5 billion worth of deals with Indonesian companies in August 2022. This could be problematic as Indonesia's nickel mining has been beset by deep water sea pollution from tailings run-off which has poisoned local fisheries.[7] Tesla has said that

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[3] Bolivia, DRC and Zambia also share this ambition but need to overcome some fundamental obstacles (see Roe 2022a, 2022b).

[4] Roe (2021) discusses the shift of mining out of the Global North.

[5] IEA (2022).

[6] '"Please Mine More Nickel", Musk urges as Tesla boosts production', *Reuters*, 23 July 2020.

[7] Nicola Niarchos 'Making the Ocean Bleed Red: How the Race for Clean Power is Poisoning Indonesia's Coastal Waters', *The Nation*, 6 March 2023.

due diligence will be followed but critics worry that the EV industry will ultimately emphasize security of supply over environmental sustainability. Such tensions are intensifying more generally.

Clearly, EV companies need to convince investors with an environmental, social, and (corporate) governance (ESG) mandate as well as 'green consumers' of the battery's superiority over the internal combustion engine but must also press for environmental responsibility—not just emissions but also pollution—in the material supply chain. Indonesia is having to face difficult dilemmas in its development road. The government has provided considerable support to the nickel sector not only to build out refining but also to encourage the country's own nascent EV manufacturing capability (with investment incentives for both Chinese and Western companies).[8] However, coal accounts for 60 per cent of the country's electricity generation, and newly built coal plants power its nickel refining. Does Indonesia continue down these high emissions (and high pollution) pathways, with the risk that its nickel is placed at a competitive disadvantage relative to countries with cleaner mining and refining, or does it take the net-zero (and zero pollution) pathway instead? (thereby slowing its progress towards more nickel-based manufacturing but preserving its longer-term supply chain reputation). Powerful coal interests will lobby for the former, but big metals buyers like the EV industry will push for the latter. The winner is yet to be decided.

In sum, these trends give a competitive edge to countries that have reserves with a high metal yield (thereby requiring less energy in refining with fewer resulting emissions) but are also able to deploy renewable energy and other technologies to minimize emissions in both mining and refining, and strictly avoid local pollution. Some big investors have certainly taken note of this and so are looking for projects with such characteristics, but which were previously deemed to be too risky—because of their remote location together with a lack of transport and energy infrastructure and, sometimes, country risk.

The Kabanga project in remote north-west Tanzania is an example. Kabanga is the world's largest development-ready high-quality nickel deposit (with smaller amounts of cobalt and copper as well). It was discovered half a century ago and has passed through a succession of owners, none of whom could bring the project to fruition, due to the site's lack of transport connectivity and power supplies but also country risk (Barrick and Glencore exited after being stripped of their license in 2018 by Tanzania's President Magufuli).[9] Recent years have seen more stability in Tanzania's mining investment regime, a buoyant nickel price and, critically, a hydrometallurgical technology developed by Lifezone metals to separate the metal from the rock: this water-based solution uses far less energy than traditional smelting processes (with an emissions footprint only 10 per cent of that of Indonesia's smelters). The project, a US$1.3 billion investment, is now underway and BHP, the world's biggest mining company, will eventually contribute millions of dollars to its financing.[10] This represents a turnaround for BHP which had previously exited African mining to concentrate on investments with minimum country risk. Now to meet its goal for 'future facing commodities' to provide half the company's revenues by 2030, BHP is willing to manage the risks of investing in countries which it labels 'tougher jurisdictions'.[11]

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[8] Indonesia is also restricting the export of unprocessed nickel. In November 2022, a World Trade Organization (WTO) panel ruled against Indonesia's nickel export ban after a complaint from the European Union (EU). Indonesia has appealed the decision.

[9] 'Kabenga Nickel Not Waiting to Compete Feasibility, Expects Surging Demand: CEO', S&P Commodity Global Insights, 6 May 2022.

[10] 'BHP Re-Enters Africa with Tanzania Nickel Investment', Reuters 10 January 2022.

[11] 'BHP to Look to "Tougher Jurisdictions" in Hunt for Metals', Financial Times, 7 October 2021.

Countries like Indonesia that remain on a high emissions pathway therefore face the risk of losing at least some investment and market share to countries like Tanzania willing and able to take the low-emissions route. And the material needs of the net-zero transition incentivize more companies to take on more country risk when the commercial logic, which is increasingly influence by ESG concerns, warrants it. Ideally, countries with a high-risk investment profile should aim to lower it: a more stable tax and regulatory regime is a good place to begin. However, success often depends on first achieving greater political stability—a tough ask in the fragile states of the Global South, but one that yields immense benefits if successful.[12] A low-emissions pathway for mining and refining, investment in transport and communications infrastructure, and an improving country risk profile is a winning combination for future investors.

2.2 Uncertainty and the advance of science

Scientific discovery and technological innovation invariably lead to the substitution of cheaper materials for the more expensive. For the world economy this is positive and highly desirable: it pushes forward the production 'frontier' by reducing production costs (and can result in entirely new products and services becoming available). The impact is felt in commodity markets, improving the fortunes of economies with the resources now in higher demand (a positive shock). But it can upend the plans of those with metals or fuels which are now vulnerable to substitution (a negative shock). Science and technology are undoubtedly sources of Knightian uncertainty.

Innovation in renewable energy generation and storage as well as EV manufacturing is running at an ever-faster pace. This is propelled by the rising price of critical minerals such as cobalt and lithium, together with public action promoting green technologies (via subsidies, carbon pricing etc.), learning-by-doing among manufacturers, and a revolutionary shift in the science of energy materials through the adoption of artificial intelligence, machine learning and robotic automation in research laboratories.[13] This promises faster rates of materials discovery than traditional combinatorial materials chemistry.[14] Venture capital is pouring into the new science of metamaterials, which are materials engineered to have properties not found in natural materials. Blending silicon with metamaterials engineered with special electromagnetic properties promises greater efficiency in solar power cells, for example. The price of silicon itself quadrupled over 2020–21, which is a further incentive to this research.

Such progress is vital for achieving net zero's goals. It does, however, pose hard-to-gauge market risks for mining companies and for their host countries and the revenues they can expect. Scientists will eventually make the breakthroughs that reduce the intensity of use of critical materials—but the timing of these discoveries, and then the timescale to commercialization and widespread adoption, constitute major unknowns.

Graphite provides an illustration of the innovation induced by a tightening market. Graphite carbon used in the anode of a lithium-ion battery makes up half of a typical battery's materials (by weight). It is currently either mined (the top three producers are China, Mozambique, and Brazil) or synthesized from petroleum or coal (using considerable amounts of energy). The average EV

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[12] Addison (2012) and Addison and Murshed (2005) discuss investment responses in fragile states, especially after the end of conflict.

[13] Just one example is the UK's Security of Supply of Mineral Resources (SoS MinErals) which is a multi-million pound research programme. This one programme alone involves 50 industrial partners and over 20 universities and research organizations https://www2.bgs.ac.uk/sosminerals/home.html.

[14] Ozin and Loh (2022: viii).

uses 80kg of graphite.[15] Just one company, Tesla, is on course to use some 94 per cent of the entire annual global supply of natural (mined) graphite, according to analysis by mining.com.[16] There has been little new investment in graphite mining outside of China (where Chinese EV manufacturers have tied up most supplies) because banks are reluctant to fund despite expectations of strong market growth (one exception is Mozambique's mine owned by Syrah Resources, a Tesla supplier, which is now set to raise output).[17] Western vehicle manufactures urgently need alternatives.

One innovation comes from the Nordic region. Northvolt, a Swedish batteries manufacturer which supplies Volvo, together with Stora Enso, a Finnish wood-products company, have researched into lignin, a natural polymer found in plant cell-walls (lignin imparts stiffness to the plant and comprises 20–30 per cent of a tree: see Box 1).[18]

Graphite also illustrates the pressures coming from geopolitics. Chinese mines account for 65 per cent of natural graphite mining, and China has over half the world's graphite processing capacity.[19] Aside from concerns over China, as the world's biggest EV market, restricting supplies to foreign manufacturers, the 2022 US Inflation Reduction Act (IRA) does not permit tax credits for EVs manufactured using minerals extracted, processed or recycled by a 'foreign entity of concern' (a designation aimed squarely at China).[20] For cobalt and lithium, China also accounts for 60 and 80 per cent respectively of global refining capacity. Consequently, western EV manufacturers are scrambling to contract supplies of critical minerals, including graphite, from outside China. This is an added incentive to R&D into reducing the intensity of critical minerals such as lithium, cobalt, nickel, and graphite used in manufacturing. Neodymium and the other 16 rare earths of the periodic table present especially difficult issues as China accounts for about 85-90 per cent of the global supply of these.[21] There is now a substantial global response to this dilemma with intense efforts to find new sources of supply but also to understand how rare earths are formed with test sites in Brazil, Madagascar, and others.[22]

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[15] https://www.bioeconomy.fi/making-sustainable-car-batteries-from-wood/

[16] https://www.mining.com/all-the-mines-tesla-needs-to-build-20-million-cars-a-year/

[17] https://www.syrahresources.com.au/our-business/balama-graphite-operation

[18] https://www.storaenso.com/en/products/lignin/lignode and https://www.ili-lignin.com/what-is-lignin.html

[19] IEA (2022e: 7).

[20] CRS (2022: 3).

[21] Neodymium when alloyed with iron makes the strongest permanent magnets, critical to wind turbines and electric motors.

[22] Sweden has a huge and as yet undeveloped deposit of rare earths.

Box 1: Lignin—an example of innovation

Lignin from timber is now refined into hard carbon powder to replace graphite carbon in the anode of lithium-ion batteries. Relative to using graphite and synthetic carbon, lignin has a superior molecular structure (yielding more efficient batteries with shorter charging times), its GHG emissions in extraction (and across its life-cycle) can be as low as 3% of those of graphite and synthetic carbon, it is non-toxic, and it is cheap (lignin accounts for around one-third of the organic carbon in the biosphere). Lignin has considerable appeal as it replaces a fossil-fuel based resource with a renewable one delivered through a responsible supply chain (Finland's Stora Enso practices sustainable forestry). Given the considerable forest resources of the Global South, there could be a potential market for sustainably-produced lignin, though it will probably take many years before it eats into the market share of graphite.

Graphite is also another illustration of the increasing pressure to build responsible supply chains, particularly to take account of such human rights as forced labour. For example, the US has placed sanctions on some silica products manufacturers in Xinjiang (China) and this has contributed to a higher silicon price in recent years. For some metals we may see an increasing price premium for supplies that have certified supply chains over those that do not. The London Metals Exchange is exploring ways to facilitate trading in such certified metals.

2.3 The stranding of fossil fuels

Uncertainties in the markets for fossil fuels arise from the timing of the eventual decline in global demand, which will render substantial reserves uncommercial to extract ('stranding') and generally cut taxable economic rents (and thus revenues to the state). Here we focus on the consequences that policymakers need to keep in mind.

On the potential hit to revenues, any estimate is inevitably speculative given the uncertainties.[23] Jensen (2023) estimates that for a sample of 40 economies dependent on the extraction and export of fossil fuels, generating an average of one third of their public revenues (and well over half in many cases), they will lose more than 60 per cent of their oil rents by 2040 if global net zero is achieved by 2050.[24] This uncertainty makes it even more urgent to diversify tax bases.

Yet a great deal can happen over the next quarter century, to raise or lower the eventual fiscal hit from stranding, not least continued innovation in the oil and gas sector to reduce production costs as well as emissions.[25] This may ease some of the headwinds for economic rents and therefore revenues from oil and gas. Additionally, fossil-fuel producers must now keep a close eye on the metals markets: the availability and price of critical minerals affects the profitability of producing wind turbines, EVs etc, thereby acting as a either a brake or an accelerator on the speed of the energy transition—and therefore on how quickly fossil fuels will strand. And a 'tail risk' for fossil-fuel producers, but a definite positive for the planet, is an acceleration in climate action—especially much more finance for low-income countries (LICs) to shift to renewables.

[23] Mercure et al. (2018) discuss the macroeconomic impact of stranding.

[24] This amounts to some US$12–14 trillion in oil rents (on a net present value basis) under the IEA's net zero 2050 scenario compared to IEA's 'business as usual' scenario (reflecting stated policies) (Jensen 2023: 6).

[25] Data science, including artificial intelligence, facilitates the discovery of new fields and increases the life of old ones, while robotics reduce production costs.

Manley et al. (2017) have also analysed the nature of this risk for developing economies with ample fossil-fuel resources and therefore considerable exposure to revenue loss. Their key point is that international oil companies (IOCs) can more easily diversify away from the risks of stranding (on average they hold 13 years of reserves on their balance sheets) than can host countries (which hold a median of 45 years of known reserves in the study's sample). The IOCs can ultimately shrink in size by returning capital to their shareholders and/or by diversifying into renewables—and most have already increased the share of renewables in their asset base. In contrast, countries must diversify by investing in renewable natural capital, human capital, and physical capital (increasingly in productive sectors unrelated to non-renewable resource extraction such as agriculture, manufacturing, and services). In sum, they must successfully transform their economies—and require assistance with finance and expertise to do so. This is, to say the least, a hugely difficult undertaking. Producers that fail could become 'stranded nations.'

Additionally, governments face political and economic pressures to remain on fossil-fuel pathways for their own energy and transport needs: to do this they commonly subsidize fossil fuel use (especially transport fuels) often at a substantial fiscal cost. There is considerable policy inertia, especially given the large sunk costs of many years of existing investment, much of which has been undertaken by state-owned National Oil Companies (NOCs). NOCs are oil and gas champions within national political systems. Moreover, NOCs are partnering with IOCs in projects involving often complex financing arrangements entailing substantial debt obligations. There is a danger that less experienced NOCs in new producers (countries with no previous oil and gas extraction) such as Uganda take on too much of the project's risk, making them more vulnerable than their IOC partners to both market volatility and stranding.[26]

Countries in this situation risk over-investing in oil and gas—perhaps requiring time horizons for positive payoffs that are far longer than the realistic commercial lives of their resources—as well as in related industries (via local content policies, infrastructure, and skills). Yet given the uncertainties around the timing and pace of stranding, many governments will still see merit in exploiting non-renewable resources: not only for the revenues but also for national energy needs—coal and gas for power, and petroleum for transport. In short, another clear tension between the poverty and climate imperatives.

Countries that have both metals and fossil fuels can partially hedge the risk to their revenues from a faster energy transition by encouraging more investment into mining critical minerals as one component of a portfolio strategy that dilutes the risk from any single resource. Additionally, they can invest in foreign mining ventures if they have funds. Saudi Arabia, which has deep pockets, is now using its sovereign wealth fund to invest in global mining ventures, and the resulting dividends will offer some compensation for the possible loss of revenues from the stranding of oil and gas resources. Finally, investment in renewable natural capital offers the prospect of revenues from the exciting new prospects of the new global bioeconomy (as our Lignin example demonstrated) which is a further hedge against stranding, and another dimension of the portfolio strategy.

[26] Volatility in the oil price (not least the COVID-19 price slump) has created uncertainties over the amount of revenue that the Government of Uganda can expect when (much delayed) production begins (Abigaba et al., 2021). Export of Uganda's oil can commence when construction of a pipeline to the Tanzanian coast is complete (the project is a partnership between the Uganda National Oil Company (UNOC), the Tanzania Petroleum Development Corporation (TPDC), TotalEnergies and the China National Offshore Oil Corporation (CNOOC). Kayizzi-Mugerwa (2020) discusses Uganda's oil prospects.

3 The resource curse risk

For economists, the term 'resource curse' and its main economic manifestation, 'Dutch Disease'—first coined by *The Economist* magazine to describe the pernicious economic effects of resource windfalls—is often at the forefront of the way we think about the extractives industries. It is not our intention here to summarize the voluminous literature on these topics.[27] Instead, the focus is on some key related concerns.

Non-renewable natural resources have a finite life, which provides a window of opportunity that can accelerate economic development if the revenues they generate are invested well, and strong linkages are created from the extractives sector to the rest of the economy. This is, however, a risky window, in at least three all-too familiar ways.

First, hydrocarbons and mining have often failed to make any significant inroad into poverty in many countries. For example, in the DRC, Nigeria, and Venezuela mismanagement has made the plight of the poor even worse. Instead of kick-starting structural transformation into higher value-added non-extractive sectors, resource wealth has often undermined local agriculture and industry through the currency becoming overvalued (a key contributor to Dutch Disease). Moreover, it has often encouraged significant corruption as well as the blatant theft of revenues. This is the first (economic) risk.

The second is the political risk: Petro-states as a group have a propensity to authoritarianism (e.g., Equatorial Guinea); to secession and conflict in oil producing areas (e.g., Nigeria's Delta); and to civil war (e.g., Libya and South Sudan). Mineral-rich economies are also prone to unstable polities—Peru is a longstanding example—stemming from high inequality when elites capture the rents. Economic and political risk reinforce each other: economic crisis increases the chances of political and social breakdown, and political instability in its turn destabilizes economic policy and frightens investors away.[28]

The third risk is environmental—including the destruction of local biodiversity such as rainforests when cleared for mining and oil and gas extraction—together with pollution of water and soils when oil and mining operators are negligent. On a larger scale, countries producing fossil fuels cannot escape the droughts, floods and cyclones associated with climate change—to which their own fossil fuels contribute when burnt. Many have large agricultural sectors, providing livelihoods for millions of their rural poor, which are at risk from an increasing frequency and severity of climate shocks.[29] The ocean's natural capital, such as coral reefs, is degrading at an unprecedented rate as global surface temperatures increase, undermining livelihoods in fisheries and tourism.[30] This third risk interconnects with the first two: local environmental destruction harms poverty reduction and growth, and adds to political instability (Nigeria's Niger Delta is again an example). And climate change will, if unchecked, add further peril to economies and societies.

The good news is that countries can do much to reduce these three risks (and they could do a lot more if the international community was more generous with its support). Thus, *economic risk* can

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[27] Instead, the reader is referred to Addison and Roe (2020); Auty (2001); Bebbington and Bury (2013); Collier (2010); Davis and Mihalyi (2021); Hendrix and Noland (2014); Lahn and Stevens (2018); Mohaddes et al. (2019); Mihalyi and Scurfield (2020) and Ross (2012). See also Cust and Mihalyi (2017a, 2017b) on the 'presource curse'.

[28] Addison (2003, 2012). Collier (2009); Dietsche (2018a); Lei and Michaels (2011); Ross (2012).

[29] Im et al. (2017).

[30] https://www.iucn.org/resources/issues-briefs/coral-reefs-and-climate-change

be reduced by strengthening the management of public finances and the conduct of macro-economic policy: the fiscal methods for doing this are well documented.[31] In addition to fiscal policy, the danger that Dutch Disease poses to the non-resource sectors like agriculture and industry can be mitigated by investing more in infrastructure—especially reliable (preferably renewable) power systems—to reduce production costs for farmers and manufacturers. Millions of people in the poorer world still earn their living from agriculture (especially as smallholders), forestry and fisheries or in related livelihoods: especially in SSA—nearly 50 per cent of Africans still work in the sector.[32] Investing a portion of the resource revenue windfall in boosting their productivity via irrigation, power, and inputs boosts their incomes, reduces the risks associated with rain-fed agriculture, improves food security, and spreads the benefits of resource wealth widely. Indonesia did this successfully in the 1970s using the revenue from its oil boom (whereas Nigeria let its 1970s oil boom undermine agricultural livelihoods).[33]

Debt accumulation can be better monitored than it often is, and a portion of the resource revenue used to cut borrowing (instead of accumulating more debt on the back of resource earnings).[34] Tax systems can be improved, not only with regard to resource taxation, but also by strengthening tax administrations more generally, and their abilities to efficiently and fairly collect taxes on expenditures, incomes, and property—thereby widening the tax base and reducing the over-dependence on resource taxes that characterises resource-rich countries.

Political risk can be reduced by containing elite capture of resource rents and their misuse for private gain; by building better institutions such as legislative oversight of the revenues and their allocation together with debt accumulation. Reducing the extreme social inequality that characterizes resource-wealthy nations can also be politically stabilizing, especially when revenues are used to redress the grievances of communities, particularly indigenous peoples, who are frequently at the bottom of the social ladder. None of this is easy, it is politically difficult (even in strong democracies), it requires institutional investments that take time to build, and close cooperation with operating companies. Although, there is no single institutional template for these actions, they can provide significant development dividends if successful.[35]

Environmental risk arising from the extractives sector can be reduced by investing in improved regulatory oversight and adding teeth to its enforcement.[36] Satellite monitoring is now cheaper, with a level of detail that identifies forest loss, pollution and other environmental harm at a reasonable cost (these technologies are already helping to reduce the huge and damaging methane emissions from the oil and gas industry). Colombia and Brazil, which have unique bio-diversities, are identifying deforestation caused by illegal logging and mining in this way. Raising the value of natural capital also incentivizes its preservation (and encourages nature-based investing which is a rapidly growing sector globally).[37] Again, the difficulties should not be underestimated—and poorer countries need the requisite technical assistance and finance to help them adopt these new technical possibilities.

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[31] Addison and Roe (2004); Van der Ploeg and Venables (2018).

[32] FAO (2023: 6-7).

[33] Timmer (1988, 2019).

[34] On debt see: Addison and Lebdioui (2022), Fatás et al (2019), and Van der Ploeg and Venables (2018).

[35] Andrews et al. (2017).

[36] However, see Aubynn (2018) for some of the practical difficulties seen from the viewpoint of a regulator.

[37] Lebdioui (2021, 2024).

4 Climate risk

Climate risk is, however, in a class of its own. The developing world as a whole now accounts for more than half of global carbon emissions, with China contributing 30.9 per cent of the total, India 7.3 per cent, followed by Brazil (1.32 per cent), Indonesia (1.67 per cent), South Africa (1.17 per cent) and Mexico (1.1 per cent).[38] The big emitters can make a significant impact on their own climate risk and that of other nations, with their extractives and energy sectors taking a lead in achieving their national determined contributions (NDC) to cutting emissions (under the Paris Climate Accords). However, most developing countries individually account for under one per cent of annual global emissions and together account for miniscule amounts of cumulative (historical) emissions. As signatories to the Paris agreement they are committed to reducing their emissions, but they can do little individually to reduce the global total—yet they will still feel the full force of the climate crisis. For them this is a prime example of uncertainty rather than risk in Knightian terminology.

To take one example, Madagascar has a 0.15 per cent share of annual global carbon emissions.[39] Simultaneously, the island faces severe climate risk to which it has to adapt.[40] Madagascar is vulnerable not only to rising sea levels, but also to cyclones and droughts: three years of drought resulted in a third of the population going hungry in 2022 (the UN declared this to be the world's first climate-change induced famine).[41] Madagascar can at best adapt to, but not eliminate, the climate risks that it faces and even significant adaptation (let alone major mitigation) is impossible without more international help given that the country's poverty is so extensive.

Ultimately, countries with oil and gas and coal have as much of a national interest in averting catastrophic climate change as countries without such resources. But this interest is not necessarily aligned with their developmental ambitions, and their political cycles, in which politicians compete with short time-horizons. In using fossil fuels to build out their domestic energy and transport systems, countries risk not only contributing to an increasing frequency of climate disasters but also to locking themselves into energy pathways that render their economies increasingly uncompetitive as global value chains turn green. Thus Mexico, for example, is hobbled by an energy policy that gives priority to, and subsidies for, the use of national oil and gas in electricity generation.

In sum, countries can take steps to reduce the risks of their resource wealth turning into a resource curse. However, climate risk is of a very different kind, requiring a level of funding and technical expertise that the smaller and poorer countries struggle to find.

5 Mozambique illustrates the risks

Mozambique illustrates all three risks of the resource curse: economic, political and environmental. This southern African country is becoming a major gas exporter: its first liquified natural gas (LNG) was shipped in November 2022 (some gas will also be used in domestic power

[38] https://ourworldindata.org/co2-emissions, country shares of global carbon emissions are for 2021.

[39] https://ourworldindata.org/co2-emissions

[40] https://unfccc.int/node/61105

[41] David Pilling 'Why Famine in Madagascar is an Alarm Bell for the Planet'. *The Financial Times*, 3 August 2022.

generation).[42] The gas is extracted from deposits in the Rovuma Basin off the north-east coast. Mozambique's location on the Indian ocean gives it ready access to the gas-hungry markets of Asia.[43] The government is expecting a substantial revenue windfall (though its expectations may be inflated, and the timing of when the windfall peaks is some years away).

5.1 Economic risks

Once a country that found it hard to attract foreign direct investment (FDI), Mozambique is now one of SSA's largest recipients: net FDI was US$5.1 billion in 2021, equivalent to 32 per cent of GDP, much of it for mega-projects in the gas sector.[44] With nearly half the population still poor, large gas revenues (and the associated economic stimulus from the investments) offer the tantalising prospect of Mozambique decisively breaking out of underdevelopment.[45] Neighbouring Tanzania is similarly excited about its own gas revenue potential.[46]

Mozambique clearly has a big opportunity. However, the nation risks getting it badly wrong—and in the process becoming another Angola or Nigeria, afflicted by the resource curse.

An early warning was the 'tuna bonds scandal', which dates to 2013, and involves US$2.2 billion of debt relating to the financing of fishery protection vessels. Some US$1.3 billion of the loans were concealed until revealed by media reports in 2016. Much of the debt was publicly guaranteed in breach of budget laws and without parliament's knowledge or approval, and at least US$500 million could not subsequently be located by investigative auditors. This is a tangled tale involving international banks, Gulf-based companies, high level Mozambican officials and politicians, and multiple court cases in Mozambique, South Africa, the UK, and the USA. Corrupt payments of US$150 million and more were made, according to a US Department of Justice (DoJ) investigation.[47] The banks involved (Credit Suisse International and VTB Capital) paid fines of over US$600 million (plus restitution payments to bond investors) after pleading guilty to charges of wire-fraud conspiracy and money laundering. [48] Some bank employees and Mozambican officials and others received prison sentences, but investigations and court cases remain ongoing.[49]

Mozambique's citizens bore a heavy cost for the folly and greed of those who ran the scheme. The concealed debt breached the conditions of an International Monetary Fund (IMF) programme, leading to the suspension of lending, aid donors cut their budget support, and a new IMF programme and debt restructuring involved severe public spending restraint for some years after

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[42] 'Mozambique's First LNG Exports to Europe Seen by Early November'. *Reuters*, 21 October 2022.

[43] See also Roe (2020).

[44] IMF (2022:33).

[45] On poverty see Government of Mozambique (2016).

[46] Romsom and McPhail (2020).

[47] https://www.justice.gov/opa/pr/credit-suisse-resolves-fraudulent-mozambique-loan-case-547-million-coordinated-global

[48] https://www.justice.gov/opa/pr/credit-suisse-resolves-fraudulent-mozambique-loan-case-547-million-coordinated-global and https://www.credit-suisse.com/about-us-news/en/articles/media-releases/finma-mozambique-observation-202110.html

[49] 'Mozambique 'Tuna Bond' Scandal: Ex-President Guebuza's son Jailed for 12 Years', *BBC News*, 7 December 2022. https://www.bbc.com/news/world-africa-63887329.

2016.[50] The cost of living spiked as the currency depreciated.[51] A reduction in fiscal space left the country weaker in responding to the onset of the COVID-19 pandemic in 2020. In September 2023 the UK supreme court ruled that the Mozambique could proceed with its case against the boat supplier and Credit Suisse (now owned by UBS) seeking US$1.5 billion in damages (this claim includes US$1 billion for withdrawal of international financial support and US$260 million for higher debt costs as Mozambique's credit rating sank).[52]

The tuna bonds scandal occurred before even one dollar of gas from the big new fields had been shipped—although huge revenues had been widely anticipated in the press and official documents. Mozambique's debt is an example of the 'presource curse', rooted in the difficulties of managing expectations in the face of large revenue windfalls. [53]

The scandal does nevertheless offer Mozambique a salutary lesson on the risks of debt accumulation without full transparency and legislative oversight and, while painful, the debt crisis may perhaps help the country avoid the well-trodden path, of excessive borrowing, followed by Angola, Equatorial Guinea, and Nigeria as its gas revenues start to grow. By 2022, Mozambique was back to a position of debt sustainability, helped by a resumption of growth and stronger tax revenues.[54]

Mozambique is also creating a sovereign wealth fund (SWF) to save a portion of the expected annual gas revenue.[55] SWFs can be used as 'rainy day' funds to help stabilize public spending in the face of fluctuations in resource revenues (from shocks to commodity prices in particular) but also, sometimes, to transfer wealth from one generation to another (Mozambique's fund intends to pursue both objectives). The first goal, fiscal stabilization, is highly desirable: countries without significant public savings must resort to undesirable expenditure cuts or tax increases (as Nigeria did when the COVID-19 pandemic hit oil revenues in 2020).[56] Social spending is especially vulnerable at such times. A stabilization fund helps ease the fiscal pain. Whether poor countries like Mozambique should also use a SWF to benefit is future generations is questionable given the depth of poverty amongst the current generation as well as the high infant mortality rate.[57]

5.2 Political risks

Social inequality is the point at which the economics of resource wealth collides with the politics. The creation of a small super-wealthy elite, while the majority remain impoverished, is a recipe for

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[50] IMF (2020: 9). For further discussion see also Roe (2020). Mozambique defaulted on its debt in 2016, and by 2019 public debt was well over 100% of GDP with arrears on external debt service reaching US$1.4 billion (including arrears on the Credit Suisse and VTB loans). This was a dramatic reversal after the HIPC (Heavily Indebted Poor Countries) Initiative had cut the debt level in the early 2000s (Addison et al. (2004) discuss the HIPC initiatives).

[51] See CIP/CMI (2021) and Mambo et al. (2018) on the severity of the 2015-16 crisis and its impact on households.

[52] 'Mozambique to Seek $1.5bn in Damages over 'Tuna Bond' Scandal', Financial Times, September 20, 2023.

[53] See Cust and Mihalyi (2017a, 2017b) and Collier (2017). Ghana is also an example: see Bawumia and Halland (2018).

[54] IMF (2022: 13). A World Bank supported technical assistance program (Gestão Económica para Desenvolvimento Inclusivo (GEDI)) designed to strengthen all relevant aspect of the country's public investment management system has been established (Gebregziabher and Sala, 2022).

[55] Bank of Mozambique (2020: 1).

[56] On Nigeria, see Addison et al. (2020).

[57] Addison and Lebdioui (2022) discuss this point further.

conflict—especially when living standards differ widely between regions. The location of the nation's resource wealth in an impoverished region is an especially combustible mix.

Such is the situation in Cabo Delgado, a neglected province of north-east Mozambique, the location of the base serving the offshore gas fields. Households living in Mozambique's northern provinces have the highest vulnerability to poverty and the least chance of escape as economic opportunities are so few.[58] In Cabo Delgado province, the poverty rate is well above the national average (itself close to 50 per cent) and the illiteracy rate is 52 per cent, with over half those of school age never having been to school.[59] A vicious insurrection was launched in 2017 by international jihadists recruiting young men aggrieved at the region's poverty and the paucity of local benefits from the gas investments (and from the region's mining as well). [60]

A military solution is unlikely to succeed unless the grievances of northern Mozambique are redressed. Education would be a good place to start given the illiteracy rate, as would smallholder agriculture, and given the scale of the expected gas revenues there must surely be some fiscal space for the required spending. It will certainly be cheaper than combatting a never-ending insurgency if grievance continues to fester. Moreover, ending the conflict will have macro-economic benefits as a good portion of planned investment into the gas fields and onshore infrastructure has been on hold (after Al-Shabaab attacks that impacted a US$15 billion Total Energies LNG project which was halted in 2021).

In sum, the risks arising out of social inequality are among those that Mozambique has the potential to contain and reduce. So too is greater transparency around the management of the prospective gas revenues as well as foreign debt accumulation.

5.3 Climate risks

Climate risk, as for much of the developing world, is a different story, as noted earlier. Mozambique's NDC sets out the country's plan to cut its emissions.[61] Mozambique can play an especially valuable role given its excellent stock of renewable natural capital (carbon sinks such as forests, and nature-based projects will be a good source of community income as well).[62] However, with its carbon emissions constituting only 0.22 per cent of the global (annual) total, Mozambique's can make only a limited contribution to attaining the Paris goals.[63] Nevertheless, Mozambique is very much *impacted* by climate change and will need to adapt. In 2019 the north was rocked by back-to-back cyclones. First, on 15 March 2019 tropical cyclone Idai landed on the coast of Mozambique, just north of the city of Beira, before heading inland and across Zimbabwe and Malawi, leaving at least 1,000 people dead, and countless homes destroyed. Idai was the southern hemisphere's worst-ever weather-related disaster, affecting 3 million people across the region, with

[58] Salvucci and Tarp (2021: 1904). See also Government of Mozambique (2016).

[59] UNICEF (2022: 4).

[60] https://www.crisisgroup.org/africa/east-and-southern-africa/mozambique

[61] https://unfccc.int/NDCREG

[62] Mozambique is one of the first recipients of funding under the World Bank's Forest Carbon Partnership Facility (FCPF).

[63] https://ourworldindata.org/co2-emissions, Mozambique's emissions will rise as gas production increases and it should endeavour to contain scope one and two emissions in the gas sector through minimizing gas flaring and venting, for example (see McPhail and Romsom 2021a, 2021b).

recovery costs estimated to be at least US$2 billion.[64] Cyclone Kenneth followed soon after on 25 April, making landfall near Mozambique's border with Tanzania.

As the climate crisis intensifies such extreme-weather events will increase in frequency and intensity, and rising sea levels will magnify the strength of all similar storm surges. Poorer countries and poorer people are highly vulnerable: the homes of the poor are fragile and incapable of withstanding storms; hunger and water-borne diseases quickly threaten when floods (and droughts) destroy crops and farmland; and humanitarian assistance is hindered by inadequate transport and communications infrastructure. Given the extent and depth of rural poverty in Mozambique (as in SSA generally), and the nature of smallholder agriculture (which remains predominantly rain-fed with little irrigation), it doesn't take much to tip thousands of households into disaster.

Even if the Paris 1.5C goal is met, a portion of the current revenues (and the revenue savings in their SWFs) of oil and gas producers like Guyana, Mozambique and Timor-Leste must be set aside for adaption to climate change and to respond to the associated natural disasters. These funding requirements will escalate if the rise in global temperatures is not contained, with the economic costs of climate change—especially degraded agriculture and lost natural capital—eventually exceeding the monetary value of the revenues from fossil fuels. Tax bases will contract along with economies. And SWFs will be at risk from runaway climate change that eventually undermines the global economy, taking asset values down with it.[65] Such is the paradox at the heart of economies like Mozambique which extract fossil fuels in a world that continues to burn them.

Ultimately fossil fuels will be stranded, perhaps well before Mozambique has exhausted its gas (and very large coal) reserves. This is the fiscal risk arising from stranding, as discussed earlier. Additionally, if Dutch Disease entrenches itself, then Mozambique will be left with an undiversified economy—with high volatility in foreign exchange earnings—and a limited tax base, which will keep the country's debt ratings low and push its borrowing costs higher.

We have focused here on Mozambique as it encapsulates the risks and uncertainties that LICs with hydrocarbon resources face more generally.[66] Ghana too has over-accumulated debt on the back of its oil revenue (and suspended payments on its external debt in 2022). And there is much to learn from Angola and Nigeria which earlier went down the resource-curse road.

6 Managing natural capital

Creating an overall policy framework for natural capital, both renewable and non-renewable, is essential to reducing risk. In most countries, policy for natural capital is compartmentalized into different ministries (separate ministries of mining, energy and the environment). Typically, renewable natural capital (e.g., forests) are undervalued relative to non-renewables (e.g., hydrocarbons), thereby implicitly incentivizing destruction of the former. Carbon pricing and regulatory tools can help level the field, as can the elimination of fossil-fuel subsidies (politically

[64] https://www.worldbank.org/en/news/statement/2019/04/11/statement-on-high-level-meeting-on-humanitarian-and-recovery-efforts-following-cyclone-idai

[65] Estimates are inevitably speculative, but Dietz et al. (2016: 3) put the expected loss at US$2.5 trillion (of a global stock of non-bank financial assets of US$143.3 trillion in 2013) for the emissions path at the time they made their calculation (the loss could go as high as US$24.2 trillion or 17% of the global stock of financial assets in 2013).

[66] Tanzania also faces the same risks: see Roe (2017).

difficult but essential). The developing world is the location of much of the world's carbon sinks, and their value can only rise as the net-zero transition accelerates.

A lesson from the world of finance helps here. Just as an investment portfolio ideally should contain a mix of assets with returns that have limited correlation, so an economy's natural capital consists of a portfolio of resources. Too much investment in hydrocarbons risks a big economic loss consequent on stranding (and continuing down a domestic energy path that limits participation in global value chains (GVCs) as the latter go increasingly green). Mining offers economic opportunities, especially from the net-zero green transition, but risks destruction of natural capital if pollution and land-use impact are not contained. Underinvesting in forests, reefs, and soils loses the opportunity of perpetual income—from sustainable forestry, tourism and fishing—and destroying renewable natural capital constitutes a loss of national wealth (often irreversible). Our earlier Lignin example illustrates the potential of scientific advance to create new markets for renewable natural capital: in the case of Lignin, sustainably managed forests. Moreover, renewable natural capital is a 'diffuse' resource that spreads its benefits widely by providing a livelihood for communities, and its management is a labour-intensive task which is good for employment generation. Non-renewables by contrast are 'point' resources: they are often enclaves with a low labour intensity. This employment advantage of natural capital should give it a higher weight in the national resource portfolio.

Finally, just as the discount rate chosen by fund managers determines the net present value (NPV) of any investment portfolio they manage, so the discount rate applied to the portfolio of a nation's natural capital determines its NPV, but also favours some natural assets over others. Policy in most countries tends to operate implicitly with too high a discount rate. This reduces the value of the perpetual income yielded by renewable natural capital relative to non-renewables (the value of which can be extracted in coming decades), thereby tending to favour investment in the latter and destruction of the former. Short-termism exacerbated by the typical political cycle favours the present over the future and reflects not only political opportunism but also the basic fact that most people of the developing world are poorer on average and therefore inevitably favour consumption today over consumption tomorrow.

The good news is that international actors can influence how poorer countries manage their portfolio of natural capital. First, through the provision of expertise in the form of technical assistance. Second, through finance: for investment in renewable natural capital and its maintenance; for reducing emissions and pollution from oil, gas and mining; for investment in wind, solar and other renewable energy; and for easing the adjustment costs of phasing out fossil-fuel subsidies. If the Global North really does want the Global South to achieve net zero, and to cease the production, use and export of fossil fuels, then it needs to provide both the technical expertise and generous investment finance necessary for the energy transition in poorer countries and to help them build more diversified economies with a stronger base of renewable natural capital.

7 International responses

Advanced economies have the finance, both public and private, to manage risks as well as the expertise to build greener economies and to reduce their climate risks. The Biden administration's massive green spending package (the IRA) is the prime example, which the EU is now trying to

match with its own Green Deal.[67] Using their hydrocarbon earnings, the Gulf's wealthy economies are also stepping up their investments in renewables, hydrogen, and nuclear and are building more diversified economies to prepare themselves for the eventual stranding of their oil and gas reserves. China sees immense opportunities to green its own energy system and is taking full advantage of greener GVCs, while India could, with an extra push, catch up on China. Latin America's big economies also have the natural capital and capacity to go green, though some are too hesitant.

However, much of the developing world faces greater difficulties in these areas and is on a much slower path to net zero—some countries have barely begun. The LICs and lower-middle-income countries (LMICs) as well as some of the smaller MICs lack both the finance but also the expertise, and considerable external assistance is needed to build their capacities for effective risk (and uncertainty) management.

In economics, there is a well-known principle of 'the polluter pays. But in the case of emissions, extracting the money out of the polluter is proving an exceptionally hard grind. In 2009 at COP15 in Copenhagen the Global North committed to providing US$100 billion annually by 2020 to the Global South for adaption and mitigation. Disbursements have fallen well short of that goal: in 2022 US$83.3 billion was provided, according to the Organisation for Economic Co-operation and Development (OECD).[68] Others such as OXFAM argue that the true figure is much smaller.[69] The annual goal of US$100 billion has in any case been badly eroded by subsequent inflation and, more fundamentally, was the result of negotiation that did not emerge from a comprehensive analysis of what is really required for both mitigation and adaption. Indeed, for adaption alone, the United Nations Environment Programme (UNEP) reckons that annual needs/costs will now be in the range of US$160–340 billion by 2030.[70] Based on an analysis of the investments and actions required for mitigation and adaption, the Independent High-Level Expert Group on Climate Finance estimates that more than US$1 trillion per annum of public and private money is needed by 2030.[71] UN climate officials are now citing figures of at least US$2.4 trillion per annum for developing countries, excluding China.[72]

Agreeing to establish a climate change loss and damage fund for developing countries was a major win for the 'G77+China' negotiating group of developing countries at COP27 at Sharm el-Sheikh in November 2022.[73] COP28 in Dubai in 2023 saw further negotiation on the fund and initial pledges (though less than a billion dollars in total by the end of 2023).[74] The Global North had resisted such a fund for years, and the tussle is far from over: the EU insists that China, Saudi Arabia and the wealthy Gulf states should contribute to the fund—which would imply taking current emissions into account in determining contributions not just historic emissions. The host of COP28, the United Arab Emirates (UAE) pledged US$100 million in 2023, but the Gulf will need to contribute much more for much longer (as the region, having some of the lowest production costs for oil and gas, is likely to be the last producer standing as stranding accelerates). Furthermore, many campaigners are insisting that the oil and gas industry also contribute to the

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[67] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

[68] OECD (2022: 5). Colenbrander et al. (2022) estimate, using variables such as gross national income (GNI) and emissions, that in 2020 the US provided just 5 per cent of its 'fair share' of the climate finance pledge.

[69] Carty and Kowalzig (2022).

[70] UNEP (2022: xiv).

[71] Songwe et al. (2022).

[72] 'UN Climate Chief Urges COP29 Action to Close Financing Gap', *The Financial Times*, 3 February 2024.

[73] The Group of Seventy Seven (G77) countries now numbers 135.

[74] https://unfccc.int/loss-and-damage-fund-joint-interim-secretariat

fund, and the UN secretary general, António Guterres, has called for windfall taxes on fossil-fuel companies. The fund is a step forward, but it is likely to fall far short of the demands of those campaigning for climate 'reparations'.

Though usually presented as a technical issue climate finance is really a subset of geopolitics. And whereas the Paris accord of 2015 had a favourable tailwind, in that the leaders of China and the United States issued a joint statement in 2014 calling climate change one of the greatest threats to humanity and urging action, today China and the US are butting heads over fundamental issues of national security. Throw into this combustible mix, the Russia-Ukraine war and the resulting shock to energy markets—as well as the Russian economy's own dependence on fossil fuels for both energy and revenue—and we have the least favourable international environment for cooperation since the cold war. The landscape of responsibility is also changing: the debate over the loss and damage fund for example, is increasingly becoming one between the historic emitters (the Global North) and the new emitters (the big economies of the Global South) as well as the big oil and gas producers of the Middle East.

Space precludes us from addressing the broader sweep of development finance here. However, it is in essence highly unsatisfactory. The international debt architecture remains unfit for purpose, and in official development assistance (ODA) many of the OECD's Development Assistance Committee (OECD-DAC) donors continue to fall short of the 0.7 percent GNI target (and notably two aid stalwarts, the United Kingdom and now Sweden, have slid badly). Donors are shuffling funds between ODA and climate finance funds, leading to double counting, together with a prioritization of MICs over LICs; the former are the biggest recipients of climate finance (partly because they are better risks as far as private funding is concerned). This deficiency and imbalance calls for more concessional financing (soft loans and grants) for the LICs, a bigger recapitalization of the multilateral development banks (MDBs), reform of their capital adequacy rules (to unlock more lending), and a reboot of the World Bank which has fallen behind other MDBs in its funding and technical assistance in the climate area.[75] Greater effort to de-risk private sector finance to get more into Africa (whose share is well-below the developing country average) is also essential. There is no shortage of ideas and innovation in climate finance: debt for nature swaps; the new rainforest carbon trading alliance (launched by Brazil, the DRC, and Indonesia at COP27); and the Africa Carbon Markets Initiative (ACMI) to cite just three recent initiatives.[76] What is short is the funding, not only for climate action but development and humanitarian aid more broadly.

For the poorer world, the Global North's stance reeks of hypocrisy. Lecturing the South on the need to commit to an unprecedented energy transition while failing to provide adequate financial help, continuing to use vastly more fossil fuels per capita than the South (with subsidies that far exceed the amount of climate finance on offer), and cutting bilateral and multilateral technical assistance to improve the management and decarbonization of the extractives industries of the South (while simultaneously competing for the South's supplies of oil, gas and coal as well as critical minerals). China is also on shaky moral ground. It cut funding to investments in coal-fired power plants in the Global South—following the pledge to do so by the Group of Twenty (G20) countries at COP26—but new construction of coal power capacity in China itself is six times larger than the rest of the world combined.[77]

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[75] On MDB reform see: Boosting MDBs' Investing Capacity (2022).

[76] https://www.seforall.org/ACMI

[77] CREA (2023). In 2022, the Chines authorities issued permits for new coal plants at an average rate of two per week.

8 Conclusions

In this paper, we have deployed the distinction between risk and uncertainty. Institutions make decisions by assigning probabilities to events, sometimes implicitly and sometimes explicitly by using modelling to do so. The insurance industry for example could not function without taking a view on probabilities in order to price risk. Yet, institutions can become over-confident in their abilities. Thus, Value at Risk (VaR) models, used by financial institutions to measure and anticipate the risk of losses, appeared to work well—and profitably—until the 2007-08 global financial crisis exposed their shortcomings, and banks went belly up. 'Knightian uncertainty' appeared with a vengeance.

That crisis, while dramatic at the time, appears quite straightforward in comparison to the complex and interconnected uncertainties with which we now live. The commodities markets shift by the second as participants, peering into the future, alter their views about the trajectory of the Russia-Ukraine war, the situation in the Middle East, the pace of China's recovery from the Covid-19 pandemic, the resurgence (or not) of inflation, the pace of the energy transition, and whether the era of globalization that has ruled for 30 years is really over. Except for the very largest developing countries, policymakers in much of the developing world can do little to influence these megatrends. Yet, they do need to be aware of them, not only to identify and prepare for the threats, but also to take advantage of the economic opportunities.

At the same time, there is a class of risks embodied in the oft-used phrase 'resource curse' that policy *can* tackle, and for which there are well documented policy answers with a good chance of success if implemented well. Too often it is simply assumed that the resource curse is a fact of economic and political life. Yet countries can build the institutional capacities within government and public agencies to identify and manage the impact of resource wealth, through improving their investment decisions, spending allocations, and debt management. If they can also place day-to-day policy making within a well-articulated vision for longer-term development—and sustain this amid the vicissitudes of the political cycle—then they stand a chance of success.

Nothing is certain in this economic life. Yet some risks are manageable. Poorer countries could assess and mitigate risk if they were provided with more external assistance to build much better analytical capacity, as well as more concessional finance, in all its forms, to manage shocks when they do strike. However, this still leaves countries facing the 'uncertainties', not least those of climate change and those relating to the timing and nature of the global transition to net zero.

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