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Managing nature risks: From understanding to action

Business relies heavily on nature to supply much-needed goods and services. Recognizing those dependencies is the first step toward managing the risks and opportunities they create.

by Will Evison, Lit Ping Low, and Daniel O'Brien

Will Evison
is an economist on PwC's global sustainability, climate, and nature strategy team. Based in London, he is a director with PwC UK.

Lit Ping Low
leads PwC's Asia-Pacific climate change practice. She is a partner with PwC Hong Kong.

Daniel O'Brien
is a sustainability and ESG leader and represents PwC as a member of the Taskforce on Nature-related Financial Disclosures. Based in Vancouver, he is a partner with PwC Canada.

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To one degree or another, every company depends on nature. Nature provides business with valuable resources, such as wood and water. Nature's services include protection, as when a wetland mitigates floods, and purification, as when trees remove pollutants from the air. And nature supports production by various means, such as providing fertile soils for planting crops and insects for pollinating their flowers. In fact, when we examined the links between economic activities and natural ecosystems, we found that 55% of global GDP—equivalent to about US$58 trillion—is moderately or highly dependent on nature.[1]

At a time of great concern about climate change, you might already be thinking of what comes next. Dependencies on nature, like any other dependencies, expose companies to risk: forests can burn, just as factories can. Moreover, as consumers and investors grow more worried about harm to the natural world, companies will face increased scrutiny of whether they are managing their impacts and dependencies on nature so as to lessen any related risks that threaten their business.

Businesses' exposure to nature risk can be surprisingly extensive. In five industries, we found that all the economic value from companies' own operations—accounting for some 12% of global GDP—exhibits high dependence on nature, which means the value could be wiped out by disruptions to natural ecosystems. In 11 other industries, at least 35% of the economic value from company operations and supply chains exhibits high or moderate dependence on nature, which means ecosystem disruptions could materially reduce financial

US$58 trillion

of global GDP—55%—is highly or moderately dependent on nature.

More than half

of the market capitalization listed on 19 of the world's largest stock exchanges is exposed to material nature risks.

5

industries' direct operations are 100% highly dependent on inputs and services provided by nature.

Source: ENCORE database, EXIOBASE, S&P Capital iQ, PwC analysis

returns. Even industries with lower levels of dependence in their own operations still have some risk exposure because of high and moderate dependencies in their value chains.

Widespread nature dependencies translate into risk exposure for investors too. Our analysis of 19 large stock exchanges shows that more than half the market value of listed companies is subject to nature-related risk, due to the listed companies' moderate and high dependence on nature.

Scientific evidence of nature's decline points to an increasing likelihood that nature risks will materialize for companies. Given these dynamics, we believe business leaders would do well to take certain actions. One is to measure their company's baseline of nature dependencies and impacts and to quantify any associated risks and opportunities. Another action is to improve mechanisms for collecting and managing nature-related data, which will help with making business decisions and meeting disclosure requirements; this is likely to involve greater engagement along the value chain. And a third action is to set goals for neutralizing nature risks and impacts and working toward a nature-positive business model, which is one that enhances natural capital and conserves ecosystem services. Together, these moves can help leaders manage their company's interactions with nature in ways that benefit their many stakeholders and the world we all share.

Businesses depend on nature to create value

Most businesses depend on materials and services from natural ecosystems (including working ecosystems such as farms and managed forests). But the

dependencies can sometimes be hard to spot. Finding them involves taking stock of the goods used along a company's value chain and tracing those goods back to their biological sources, as well as mapping out the ecosystem functions that aid business activity.

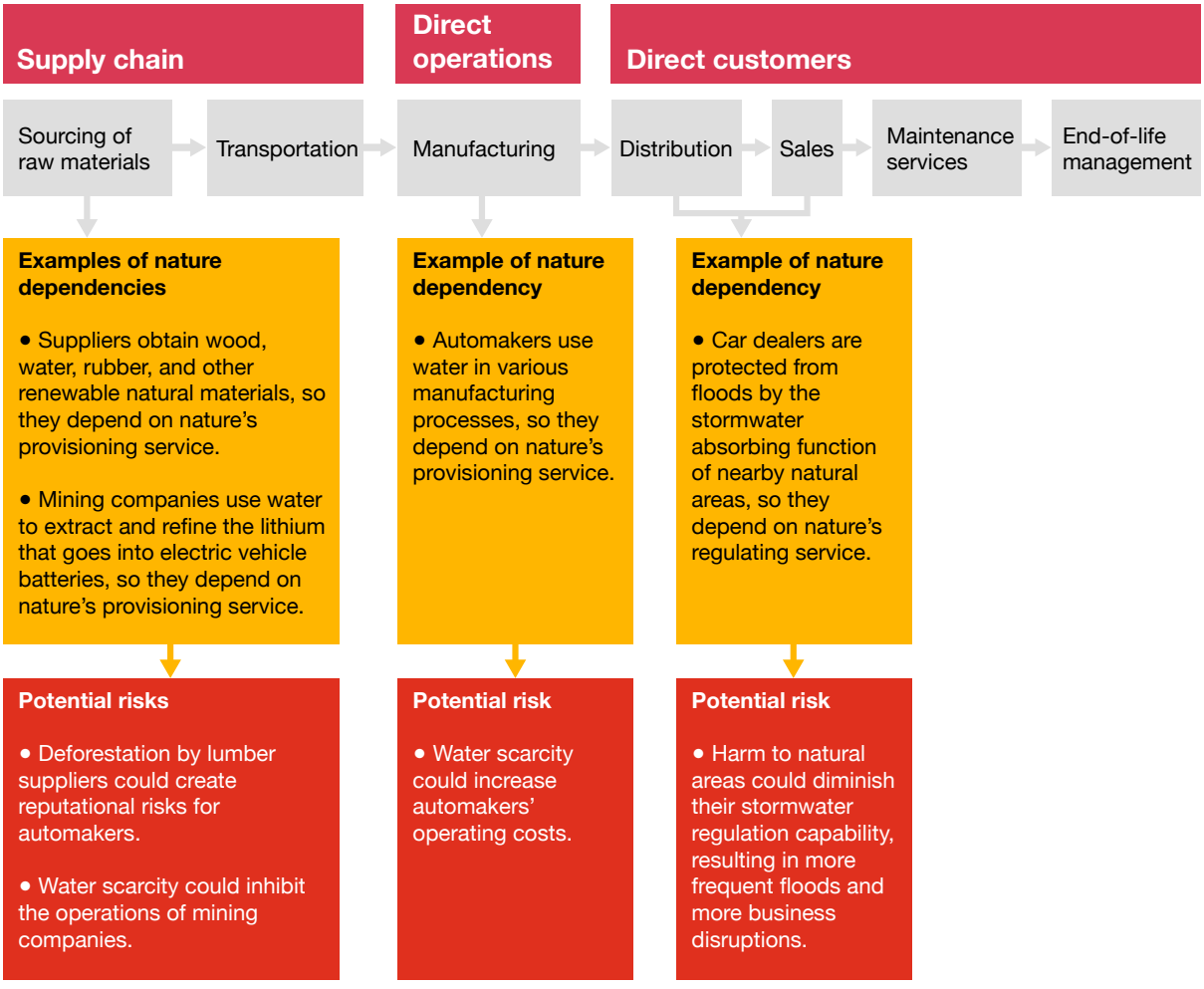
Examples from two industries, automotive and construction, illustrate some of the many ways that companies depend on nature (see chart, page 5). Automakers fit cars and trucks with tires, hoses, and other parts made from natural rubber. To make electric vehicles, they procure batteries containing lithium, a mineral that may require substantial water to extract and process. In the construction industry, lumber suppliers rely on forests to produce wood—and forests cannot thrive without healthy soil. Likewise, clients of construction firms, such as real estate developers, may rely on intact natural landscapes to increase property values and raise demand for new housing.

In these examples, the wood, water, and rubber that companies use represent environmental goods, and they result from ecosystem functions known as provisioning services. No less important are "regulating services," such as water flow regulation, which irrigates forests. The natural landscapes that feature in real estate projects count as "cultural services," and soil formation, which enables forests to grow, is a type of "supporting service." The upshot, of course, is that companies depend on these environmental goods and ecosystem services, and many more, to do business.

But what happens to businesses when ecosystems deteriorate? The short answer is that they face the risk of costly disruptions. And that risk is building up. A 2019 report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), a UN-appointed body, said that 14 of 18 categories of ecosystem services have been in decline since 1970, and 1 million species are at risk of extinction because of human activity. Recent research by the WWF shows that wildlife populations, which serve as indicators of ecosystem health, have decreased nearly 70% over the past 50 years. As it is, many businesses may be bringing physical nature risks upon themselves by degrading the ecosystems they rely on.

Another form of nature-related risk, known as transition risk, occurs when

The automotive industry value chain depends on nature at multiple points, which creates potential risks



Note: This is an illustrative and inexhaustive list of nature dependencies and associated potential risks.

Source: PwC analysis

regulators, standard-setters, investors, and other stakeholders push businesses to account for their impacts on nature and to adopt nature-friendly practices. Representatives of nearly 200 governments agreed in December 2022 to adopt the Kunming-Montreal Global Biodiversity Framework (GBF), which calls on nations to establish disclosure requirements for companies, to set targets for protecting nature, to remove incentives that harm nature, and to increase funding

for conservation, among other steps.

Disclosure requirements and reporting standards are already taking shape. For example, reporting on nature is specified in the European Union's Corporate Sustainability Reporting Directive (CSRD), which will eventually apply to an estimated 50,000 companies. In parallel, the market-led Taskforce on Nature-related Financial Disclosures (TNFD) has created a framework for nature reporting, with support from industry and numerous governments. These developments should bring consistency to the way that companies measure and report on nature-related issues.

The accelerating pace of ecosystem decline and societal response makes nature loss as urgent a problem as climate change. To manage the risks that nature loss can cause, businesses must first determine where such risks might arise—starting with an assessment of their own nature dependencies.

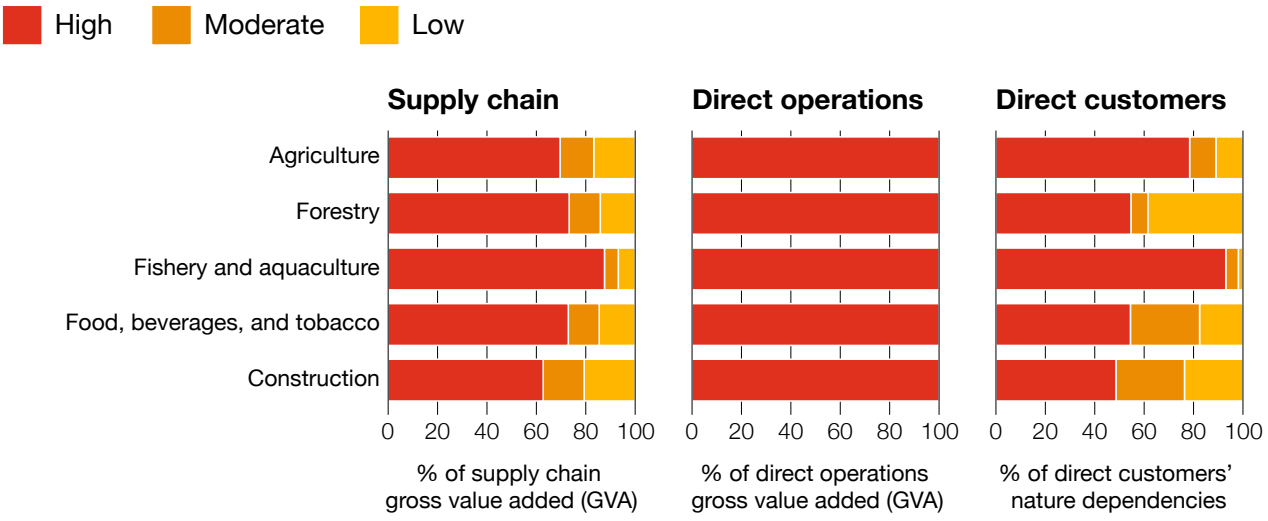
Nature dependencies span industries and capital markets

In looking at their company's nature dependencies, executives might be guided by a general understanding of where dependencies exist for their industry. Each of the 20 industries we studied is exposed to risk because of high or moderate dependencies on nature somewhere in its value chain. Investors, too, will want to scan widely for potential risks: on ten of 19 major stock exchanges, more than half the value of the listed companies exhibits high or moderate nature dependence.

All industries have exposures to nature risk in their value chains

We estimated industries' dependence on nature using information from the ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) database, which records nature dependence at the sector level, and the EXIOBASE database, which records supply, use, input, and output of products at the country level (for more information, see the Methodology section, page 15). This analysis showed that most industries have high or moderate nature dependencies in their direct operations. High and moderate dependencies also occur in industries' supply chains or customer bases, even in industries with minimal

In five industries, all of the economic value from direct operations exhibits high nature dependence



Note: Here, nature dependence measures the degree to which the economic value generated by business activity is exposed to the risk of ecosystem disruption. High dependence means that economic value comes from business activities that could fail financially as a result of particular ecosystem disruptions. Moderate dependence means that economic value comes from business activities that are likely to experience a material reduction in financial returns because of particular ecosystem disruptions. Low dependence means that economic value comes from business activities that are likely to experience limited material financial effects of ecosystem disruptions.

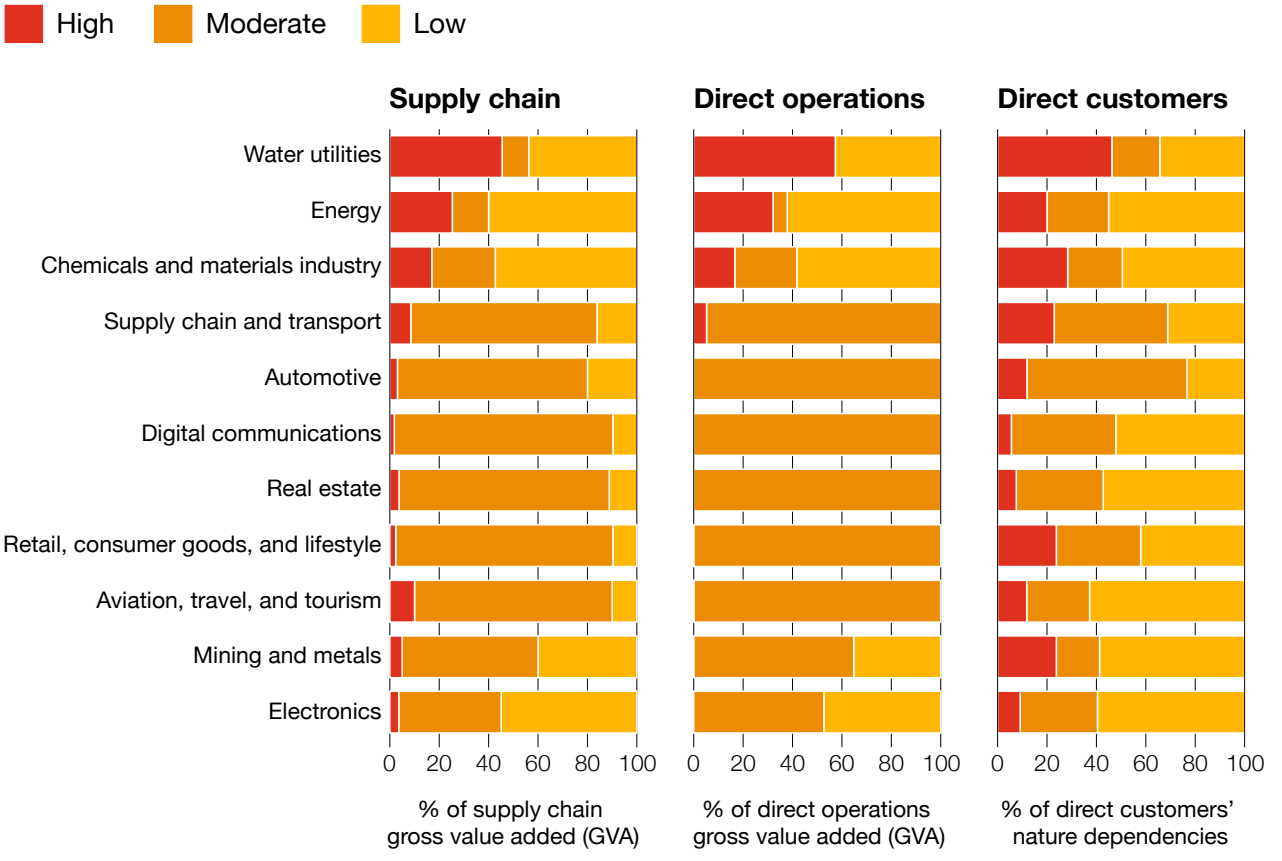
Source: EXIOBASE, ENCORE database, PwC analysis

dependencies in their own operations. To simplify matters, we grouped the 20 industries into three categories according to their levels of dependence.

Highly nature-dependent industries. In five industries, including agriculture and forestry, 100% of the economic value generated by direct operations exhibits high dependence on nature (see chart above). In addition, at least 50% of the economic value produced by the industries' supply chains is highly nature-dependent. Construction is the largest industry in this category, with direct operations that account for US$6.5 trillion of economic value. Together, the five industries in this group produce more than US$13 trillion of economic value—12% of global GDP.

Moderately nature-dependent industries. Another 11 industries—including automotive, retail, and consumer goods; real estate; and mining—have moderate or high dependence on nature for at least 35% of the economic value

Eleven industries have moderate or high nature dependence for at least 35% of the economic value from their direct operations and supply chains



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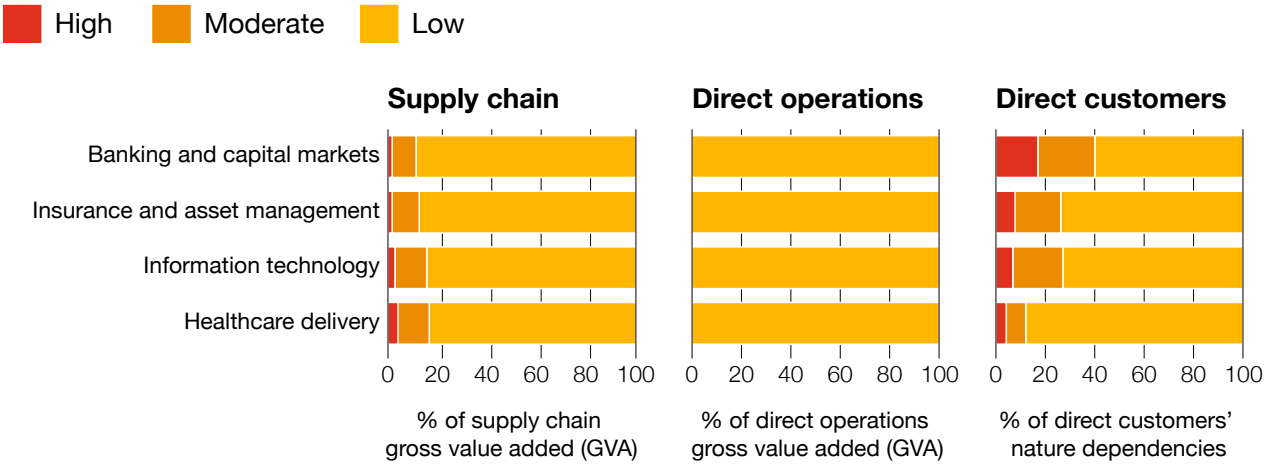
Source: EXIOBASE, ENCORE database, PwC analysis

generated by their supply chains and their direct operations (see chart above). For example, chemicals companies may depend on natural and seminatural habitats, vegetation, and soil quality to provide flood and storm defense and to treat effluents, enabling business continuity at their plants.

Slightly nature-dependent industries. For the four industries in this group, less than 35% of the economic value generated by their supply chains

Four industries have relatively low levels of nature dependence in their direct operations and supply chains, but higher levels of nature dependence downstream



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Source: EXIOBASE, ENCORE database, PwC analysis

and direct operations is highly or moderately dependent on nature (see chart above). An example is the healthcare delivery industry, which has dependence upstream in its supply chain, due to nature's role in the production of medicines. Although nature dependence is generally less significant in these industries, there will be some exceptions. Executives can help identify and manage risks by talking with customers about their own risk exposures or by taking action to conserve or restore the ecosystems on which their suppliers depend.

Investors face nature risk exposure as well

Because companies depend on nature, shareholders do too. We estimated shareholders' nature dependencies for each of 19 major stock exchanges by calculating the dependence of the market value of listed companies (based on the ENCORE database's sector-level dependence ratings). The overall nature dependence of

these listings is close to that of the global economy, with just over half the company value—nearly US$45 trillion—exposed to financial risk through high or moderate nature dependence. Variations appear from one stock exchange to another, due to the mix of companies on each one (see chart, page 11). Some noteworthy examples follow:

New York Stock Exchange (NYSE). The value of NYSE listings has a below-average level of high or moderate dependence (40%), as much of the company value on this stock exchange belongs to low-dependence industries such as banking and information technology. Nevertheless, the NYSE's sheer scale gives it an outsized share—more than 20%—of all the market value that is highly or moderately nature-dependent across the 19 exchanges.

London Stock Exchange (LSE). Nearly half (47%) of the company value traded on the LSE is highly or moderately dependent on nature, which is in line with the global average. Much of that value comes from companies in the food, beverages, and tobacco industry (10% of the value of listings) and the mining and metals industry (10%).

Euronext. Listings in Euronext, the world's fourth-largest stock exchange by market capitalization of listed companies, have an above-average level (60%) of high or moderate dependence on nature. Much of that dependence occurs in large industries with high nature dependence, including retail and consumer goods, and food, beverages, and tobacco.

Taiwan Stock Exchange (TWSE). Listings on Taiwan's stock exchange are the most dependent on nature of the 19 stock exchanges that we studied; more than 70% of the market value of these listings show high or moderate dependence. This is largely because energy companies, representing a moderately nature-dependent industry, account for 40% of the market capitalization of TWSE-listed companies.

Three things to do now

It may not be long before nature-related issues affect your company's bottom line. For that reason, we recommend that executives place nature on a par with climate change in their risk assessments. Forward-thinking leaders will look

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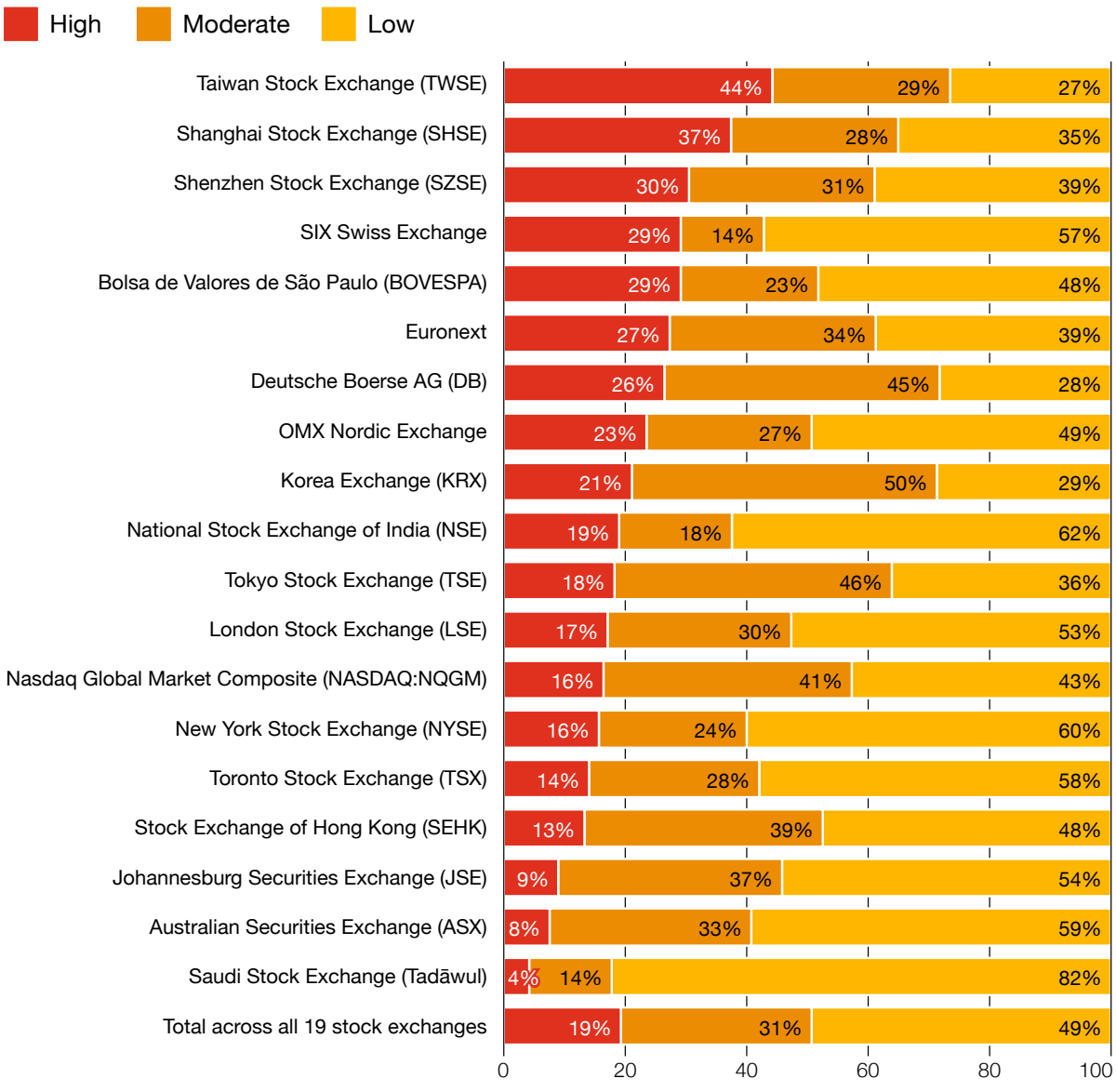
More than half of the market value of companies listed on 19 major stock exchanges is exposed to financial risk through high or moderate dependence on nature



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Source: EXIOBASE, ENCORE database, S&P Capital iQ, PwC analysis

To manage nature dependencies and impacts well, you will need highly reliable data sources, systems, and controls.

for possibilities to create nature-positive business models that don't just mitigate risks but also strengthen financial returns and benefit society. They might also find opportunities to deal with climate priorities and nature priorities at once. For example, many nature-based solutions to climate change, such as reforestation, help capture emissions while also enhancing biodiversity, directing capital to developing economies, and supporting indigenous peoples and local communities.

Regardless of whether they prioritize risk mitigation, value creation, or both, all executives stand to gain from taking three actions to manage their company's nature dependence:

Measure your nature baseline. As in other realms, a good step toward effective management of nature is assessing baseline performance, or the extent of a company's nature dependence and impacts. Various resources can help you set a nature baseline at multiple levels of detail. For instance, the Integrated Biodiversity Assessment Tool (IBAT), the ENCORE database, and the Aqueduct water-risk tools can help identify potential impacts and dependencies at the regional level; and new technologies such as low-cost environmental DNA (eDNA) sampling can enable accurate site-level monitoring of changes in biodiversity. Then, executives can translate material dependencies and impacts into risks and opportunities. Risks can be inferred by playing out scenarios in which an ecosystem failure disrupts business operations. One apparel company we know applied a combination of qualitative and quantitative measures to gauge nature

dependencies and impacts throughout its value chain. That information helped the company find opportunities to reduce nature impacts, along with operating costs, by increasing its use of recycled materials.

Improve decision-making and transparency with better data. To manage nature dependencies and impacts well, you will need highly reliable data sources, systems, and controls. These resources will also help with meeting disclosure requirements and explaining to investors and other stakeholders why you're choosing to pay attention to nature issues. That said, the same resources could take some time to put in place, so leaders should plan accordingly. CDP, an organization that benchmarks corporate sustainability reports, estimates that companies need 12 to 18 months to prepare for partial nature-related disclosures, and two to three years to get ready for full disclosure. The process might involve accounting for site-specific requirements, given that nature-related risks and opportunities can be highly localized.

Set ambitions to manage risk and capture opportunity. Once you know your company's baseline levels of nature dependence and impact, you can set goals for mitigating risk and creating value by better managing interactions with nature. The Science Based Targets Network (SBTN) provides one framework for companies to formalize their nature ambitions using scientific measures of various outcomes. In more general terms, levels of ambition range from "do less harm" to "cause no net biodiversity loss within own operations" to "achieve a net positive impact on biodiversity along the value chain." An example of how companies progress from assessing dependencies to setting ambitions can be found in Kering, a luxury goods group. When Kering conducted a land-use valuation exercise, it found that conventional agricultural practices in its supply chain were degrading ecosystem services on which the company depended. In June 2020, Kering published its biodiversity strategy, committed to have a net positive impact on biodiversity by 2025 and launched a fund to pay for implementing regenerative agriculture (a practice that seeks to make working farms into healthy ecosystems) on 1 million hectares by the same year.

Nature's rapid decline means that executives can no longer ignore either the risks stemming from ecosystem failures and biodiversity losses or the emerging

regulatory requirements and stakeholder demands which relate to nature. The starting point for building resilience is understanding your company's dependencies on nature. From there, you can determine what threats your company may face, as well as the value it can create, for itself and for society, by working toward a nature-positive future.

Note

1. This percentage of GDP with moderate or high dependence on nature is higher than the equivalent percentage given in Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy, a report published by the World Economic Forum in collaboration with PwC in 2020. The change results partly from updates to some dependence ratings and partly from increases in certain sectors' shares of global gross value added (GVA). For more information, please see the Methodology section on page 15.

Methodology

Nature dependence of direct operations

An earlier analysis of the nature dependence of industries' direct operations was carried out by PwC as part of the World Economic Forum's New Nature Economy Report Series and published in the *Nature Risk Rising* report in 2020. To allow comparisons between the analysis in the 2020 report and the analysis in this article, we have repeated much of the methodology used to measure dependencies within industries' direct operations and supply chains. The new analysis showcases that the total economic value that is highly or moderately dependent on nature has increased by US$14 trillion. The differences between the previous analysis and this analysis are as follows.

Use of the ENCORE database to assign industry dependence levels

The data used to assign dependence ratings to industries, sectors, and production processes has been updated. Since the publication of the 2020 report, the Natural Capital Finance Alliance released the ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) database in partnership with UNEP-WCMC (UN Environment Programme World Conservation Monitoring Centre). This database reflects current academic consensus on how dependent different sectors are on ecosystem services.

As a result, some industries have higher dependence ratings in this analysis than in the 2020 analysis—reflecting an increased acknowledgment of how these industries rely on nature to generate and protect value. For example, ratings for some sectors of the digital communications industry have increased from low to moderate dependence.

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Growth of global GDP

Since the previous analysis was conducted, total GDP has increased by about US$20 trillion, from US$86.2 trillion in 2018 (the figure used in the 2020 report) to US$105.6 trillion in 2022 (the figure used in the analysis for this article). This increase accounts for about US$10.1 trillion of the additional GDP that is highly or moderately dependent on nature.

Industry breakdown of gross value added

Overall, the analysis for this article suggests that the global economy is more dependent on nature than indicated by the 2020 analysis. Other than updates to some dependence ratings as a result of using the ENCORE database, the increase in dependence can be explained by certain moderately and highly dependent industries making up a greater share of global gross value added (GVA). For example, the agriculture and construction industries' shares have increased relative to the 2020 analysis.

For this publication, we analyzed the nature dependence of 163 industry sectors and their supply chains across a variety of ecosystem services, using the Natural Capital Finance Alliance and UNEP-WCMC's ENCORE database.

Each ENCORE sector was assigned an overall dependence rating based on the multiple ecosystem service dependencies it contained, which were each ranked from 1 (very low) to 5 (very high). The overall dependence score weighted the following criteria:

- The number of different individual dependencies identified
- The mean strength of those dependencies
- The maximum strength of any individual dependency.

For our analysis, consolidated dependence scores above 3.0 were considered "high," scores between 2.0 and 3.0 were considered "moderate," and scores below 2.0 were considered "low."

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By aligning these sector-level dependency ratings to GVA data, split by sector and country, we estimated the amount of direct GVA generated with a high, moderate, and low nature dependence.

To determine nature dependence by industry, sectors were aggregated into industries, based on the World Economic Forum Strategic Intelligence industries. The industry GVA was calculated as the sum of GVA in all relevant sectors. The share of industry GVA in high, moderate, or low dependency categories was then calculated using the dependence scores of the sectors within that industry.

Nature dependence of supply chains

We used a multiregional input–output model, based on EXIOBASE data, to examine trade flows among sectors and investigate nature dependencies in sector supply chains. The GVA generated in the supply chain of each individual sector (the purchasing sector) was calculated using a multiregional input–output model with inputs based on the entire country-level intermediate demand from the sector in question. The sum of supply chain GVA was calculated as the sum of GVA created in all the sectors that made up the purchasing sector's supply chain—in proportion to demand from the purchasing sector as a share of demand from all other sectors at each tier of the supply chain. The share of supply chain GVA in high, moderate, and low dependency categories was calculated using the dependence scores of the sectors within the supply chain, weighted by the GVA created in each.

Sector-level supply chain GVA estimates were aggregated at industry level in the same way as for direct nature dependencies. Where figures are expressed at regional or global scales, the industry-level GVA figures were aggregated and converted to estimates of GDP by adjusting for transfers (selected taxes), which are excluded from sector-level GVA figures.

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Nature dependence of direct customers

We used a similar multiregional input–output model, based on EXIOBASE data, to examine downstream nature dependencies for each sector's direct customers. The model was used to determine the distribution of a sector's sold products among downstream direct customers. The proportions of an industry's total revenue that exhibit high, moderate, and low nature dependence were calculated by first assigning nature dependence levels to the industry's revenues from each sector (using ENCORE ratings of sectors' nature dependence) and then summing all the revenues at each level of dependence.

Nature dependence of equities listed on stock exchanges

We analyzed the nature dependence of the market capitalization for all companies listed on 19 of the world's largest stock exchanges. S&P Capital iQ data was used to provide the market capitalization and industry sector of all primary listings on each of the 19 stock exchanges. Market capitalizations were taken for the end of each quarter of 2022 and used to calculate an average value for the 2022 calendar year. The S&P Capital iQ sectors were mapped to the ENCORE database's nature-dependence ratings for sectors. This mapping was used to calculate how much of each listed company's market capitalization has high, moderate, or low nature dependence in its direct operations.

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