

IEEJ 60th anniversary event: 3 July 2026

Japan's energy scenario up to 2050

Topic 2 | **Economic impact of disruptions to the supply of critical minerals**

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Widely utilised rare earth elements

'Vitamins of industry'

Examples of rare earth applications

Dysprosium

Neodymium magnets

Gadolinium

Optical glass

Neodymium

Neodymium magnets

Terbium

Neodymium magnets,
Phosphors,
Optical glass

Samarium

Samarium-cobalt magnets

Europium

Phosphors,
Optical glass

Lutecium

Holmium

Thulium

Rare earth elements are used in a wide range of fields, including magnets, batteries, capacitors, optical glass and catalysts.

Even industries that do not use them as raw materials utilise related goods, e.g. phosphors → lighting, displays

Promethium

Ytterbium

Scandium

Lanthanum

Ferrite magnet,
Optical lens,
Nickel-metal hydride battery,
Ceramic capacitor

Yttrium

Phosphors,
Optical glass,
Zirconia stabiliser,
Heat-resistant alloys

Cerium

Glass polishing agent,
Ultraviolet-blocking glass

Praseodymium

Ceramic capacitors,
Glass colourants

Erbium

Optical fibre amplifier

Its importance will grow even further as the energy transition

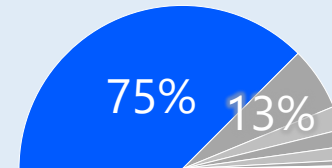
With the transition of the energy supply and demand structure (Scenario Analysis Toward 2050 Using an Optimization Model), the use of rare earths will increase, such as in electrified vehicles that use them in motors and batteries.

New electrified vehicle sales



Both in Japan and globally, the sources of supply are extremely concentrated.

Composition of Japan's rare earth import sources [2025]



In Japan, rare earths are imported not as ore, but in the form of refined metals and alloys.

As the blockade of the Strait of Hormuz has demonstrated, excessive concentration can exacerbate the impact of supply disruptions.

Sir Winston Leonard Spencer Churchill



On no one quality, on no one process, on no one country, on no one company, and no one route, and on no one oil field must we be dependent.

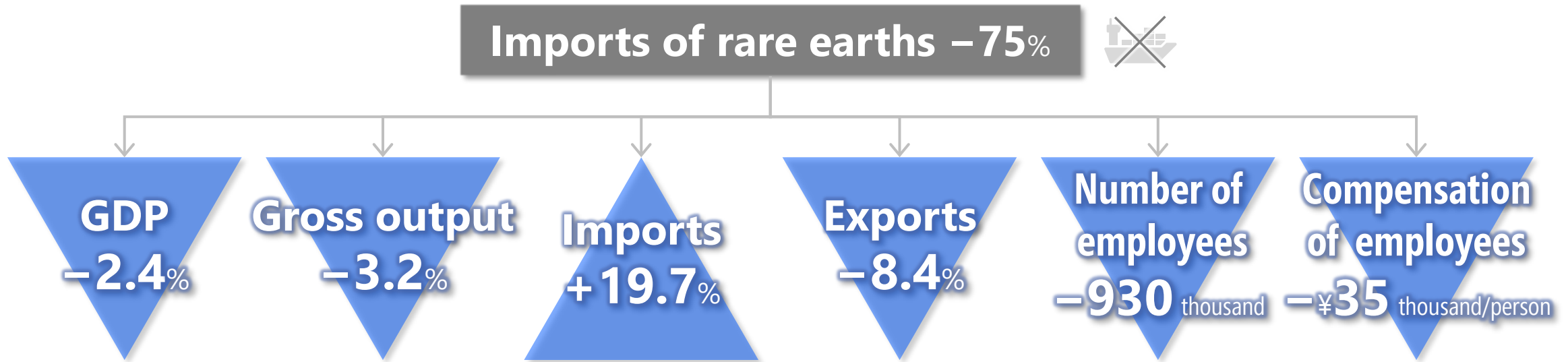
So...

To clarify the extent of the potential risks facing Japan, we quantitatively assessed the direct and indirect impacts that rare earth supply disruptions would have on the Japanese economy.

- We assumed that 75% of imports (exclusively to Japan) would be cut off and that alternative imports would not be available. The same applies to rare-earth magnets.
- A static comparative analysis assessing the impact of rare earth supply disruptions, focusing on their key applications, based on the latest input-output tables [2020] and bold assumptions

Rare earth supply disruptions exert significant downward pressure on the Japanese economy

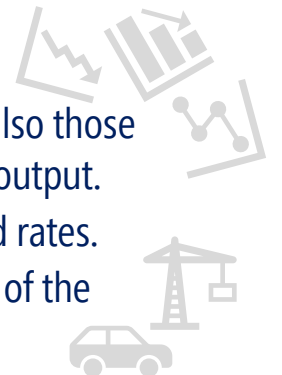
- ✓ In terms of the economy as a whole, the monetary significance of rare earths is by no means substantial.
 - Whilst Japan's gross output exceeds ¥1 200 trillion, imports of rare earth are less than ¥100 billion [2025].
- ✓ Were imports of rare earths to decrease by three-quarters, however, economic activity would be severely constrained.
 - Depending on various assumptions, the impact could spread across all sectors, resulting in a sharp economic slowdown of as much as 2.4% of gross domestic product (GDP). (Approximate figures; the same applies below)
 - If the role of rare earths in the economy and society increases owing to the energy transition, the impact will expand further.
 - Amid major shifts in the international economic and political landscape, this can no longer be dismissed as a tail risk.



Decline in production would be particularly severe in the machinery industries and spread to others

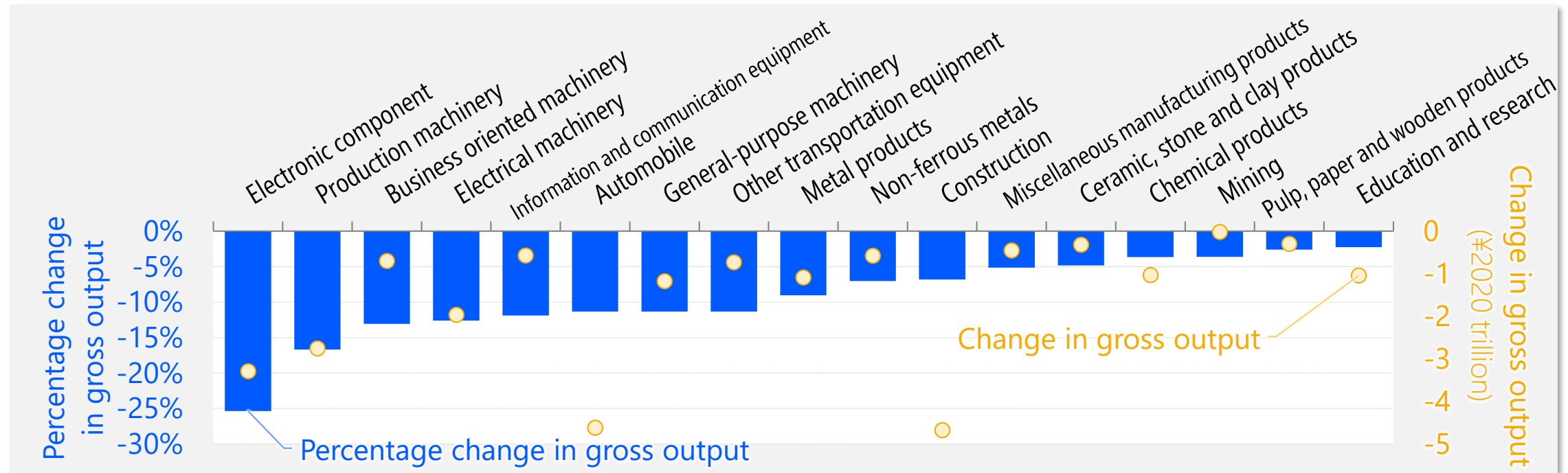
✓ The adverse impact on production is not limited to specific industries alone.

- Supply constraints spread widely through a chain reaction affecting not only industries (goods) that use rare earths directly, but also those that use the goods produced by those industries, and the industries that use those goods in turn... No industry escapes reduced output.
- Production in the machinery industries, which closely linked to rare earths and related goods, would fall sharply in both value and rates.
- The reduced output in the construction sector, which would face shortages of materials and building equipment, would rival that of the automotive sector, underpinned by the scale of gross output.



Changes in gross output due to rare earth supply disruptions

Industries most affected



The slowdown in economic activity would dampen the labour market

- ✓ As economic activity declines across the board, employment would fall sharply in all sectors.

- The number of jobs lost would stand at 930 thousand. 😞

Reference 1 | Historical job losses (thousand)

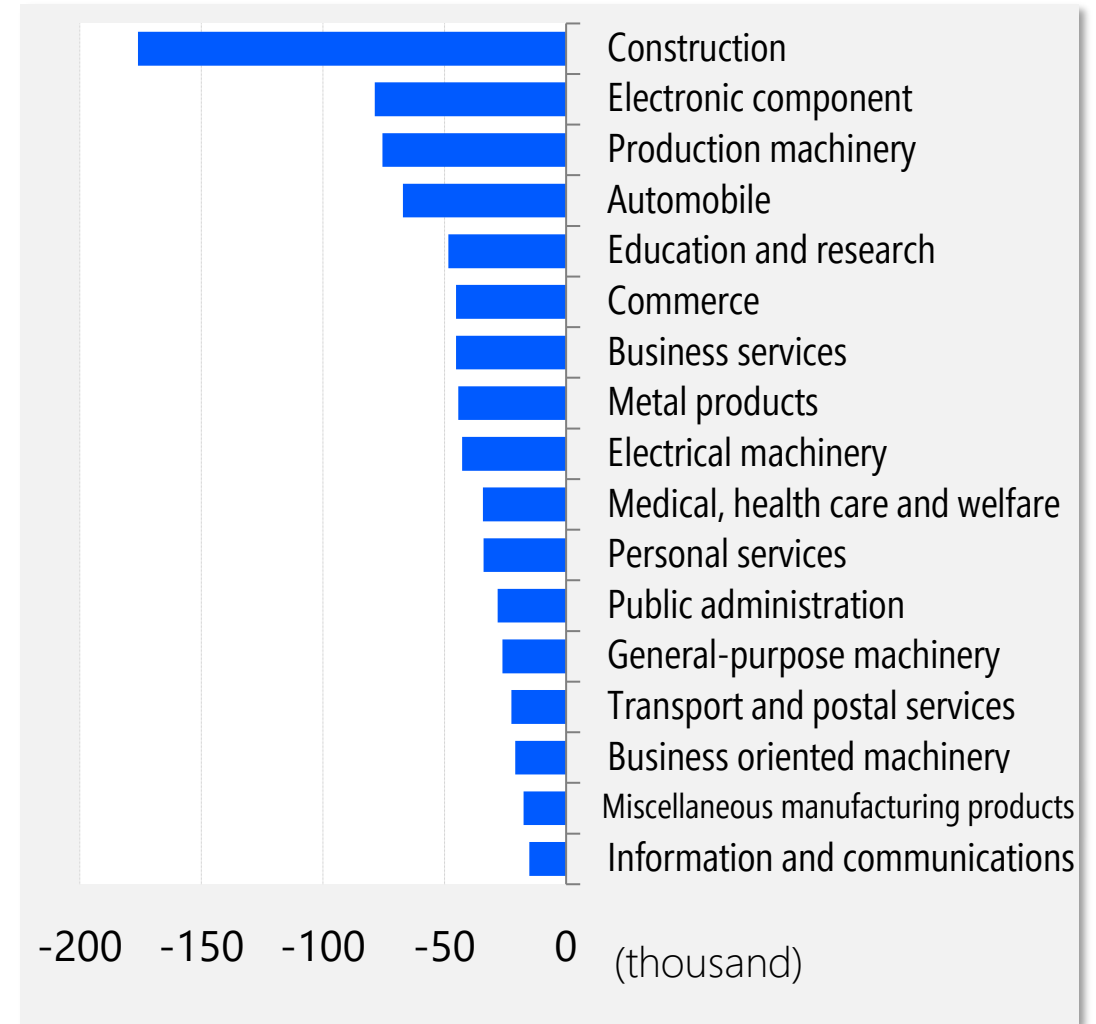
- After the Great East Japan Earthquake [March 2011]: 560 😞
- After the 2008 financial crisis [September 2008–June 2009]: 940 😞
- COVID-19 pandemic [March–June 2020]: 1 180 😞

Reference 2 | Labour and employment situation [FY2025] (thousand)

- Number of employees: 61 900
- Number of job vacancies: 2 300
- Number of fully unemployed: 1 800
- In the labour-intensive construction sector, which employs a large number of people, the decline would be particularly pronounced due to significant restrictions on activity caused by a shortage of building materials.
- The machinery industries, which would see a significant decline in gross output, would follow construction in the ranking.

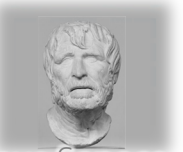
Changes in employment due to rare earth supply disruptions

Industries most affected



Although it tends to be overlooked when considering short-term economic efficiency...

'Hope for the best, but prepare for the worst.'



Lucius Annaeus Seneca

- ✓ Whilst supply disruptions to any goods can have adverse effects, the impact is likely to be particularly severe in the case of rare earths.

None are mined or refined domestically. Even globally, its import partners are highly concentrated. Their role grows in the energy transition.

- ✓ To reduce the risk of supply disruptions



Strengthening the entire supply chain (from ore to finished products)

Diversifying import sources, domestic production and recycling

- ✓ To mitigate the impact of disruptions



Securing reserves and stocks **Just in time case!**

A means to buy time until fundamental measures are implemented



Reducing consumption

Reducing consumption enhances the value of reserves and stocks. The practical application of alternative technologies also presents new opportunities.



Maintaining flexibility in economic activity

Reducing the rigidity of inputs and processes in production is a key factor in significantly mitigating adverse effects.

Addressing
and
roles

- ✓ Alongside the government, the private sector also plays a significant role.



Expanding strategic reserves and stocks, diversifying supply chains and strengthening relations with supplier

Smooth distribution upon release is also crucial.



Active incorporation into business continuity plans (BCPs) within industries closely linked to rare earths and related materials

Collaboration with the relevant and related industries is more effective than initiatives at the individual company level alone



It is also essential that businesses and consumers understand the measures taken to address potential issues. Preparing for risks, like fire services, policing, defence, insurance and climate change measures, requires certain costs and effort upfront.

- ✓ Economic coercion could also lead to supply disruptions in sectors other than rare earths.

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Appendices

Analytical framework and assumptions

- This is a static comparative analysis that assesses the impact of disruptions to the supply of rare earths by focusing on their typical applications.
Although a contraction in production activity could further amplify the downward pressure through changes in demand-side behaviour, this is excluded from the analysis as it falls outside the scope of partial equilibrium analysis.
- The underlying data is Ministry of Internal Affairs and Communications' 'Input-Output Tables for Japan' [2020]. We used a table comprising 138 sectors, aggregated at a level more detailed than the integrated medium-level classification.
Even in the most detailed basic sector classification of the Input-Output Tables (445 rows x 391 columns), rare earths and rare earth-related goods are not treated as independent sectors (goods). The analysis is based on macro data, calibration and bold assumptions, and the results are approximate figures intended to provide a sense of scale.
- The approach to gross output is similar to the Leontief production function, which assumes that output is determined by the input with the most stringent quantity constraint. The elasticity (rigidity) of output goods with respect to input goods was set through calibration, and the rate of output decline is defined as the maximum value of 'rate of input decline x elasticity'.
We did not utilise the existing Ghosh model or the model presented in Sano and Nagamachi's 'An analysis framework for supply shock effects on production and employment' (2022). This was done in order to broadly consider the indispensability of input goods. In other words, in this analysis, a certain degree of indispensability was assumed not only for goods subject to supply disruptions but also for goods into which the effects of such disruptions propagated.
As the mechanism prioritises the assessment of the impact of supply constraints on goods and determines output from inputs, there is a possibility that, for a small number of goods where supply constraints are not severe, excess production may occur that does not correspond to the reduced demand.
- In the event of an import disruption, it was assumed that the volume of rare earth imports would decrease uniformly by 75%.
The import situation is likely to vary for each of the 17 rare earth elements. However, as detailed data on these cannot be obtained from 'Trade Statistics' or, as mentioned earlier, from the Input-Output Tables, this was treated as a convenient assumption.
- To address the reduction in the supply of other goods resulting from rare earth supply disruptions, an increase in imports was assumed.
For goods other than the rare earths where import constraints arise, it was mechanically assumed that imports could be increased up to a maximum of twice the actual level. As this eases input constraints and alters gross output, calculations were repeated until the gross output and imports for all goods converged.
Although drawing down stocks or reserves to address supply shortages is conceivable in the real world, this was excluded from the assessment as it is not suitable for static comparative analysis.
- Other economic impacts, such as GDP, were estimated based on the calculated rate of change in gross output and the elasticity with respect to gross output.
Whilst it would be ideal to use sector-specific values for the elasticity with respect to gross output, estimates covering all sectors were used in view of accuracy and other considerations. Exports were estimated on the assumption that their ratio to gross output remains unchanged. Although it is conceivable that domestic demand would be prioritised over exports in a situation of domestic supply shortages, the extent of such reallocation is difficult to estimate; therefore, for convenience, the structure was assumed to remain unchanged.
- The results of the sensitivity analysis relating to the degree of import disruption, the upper limit on import increases, and the elasticity of output goods with respect to input goods are shown on p. 12.

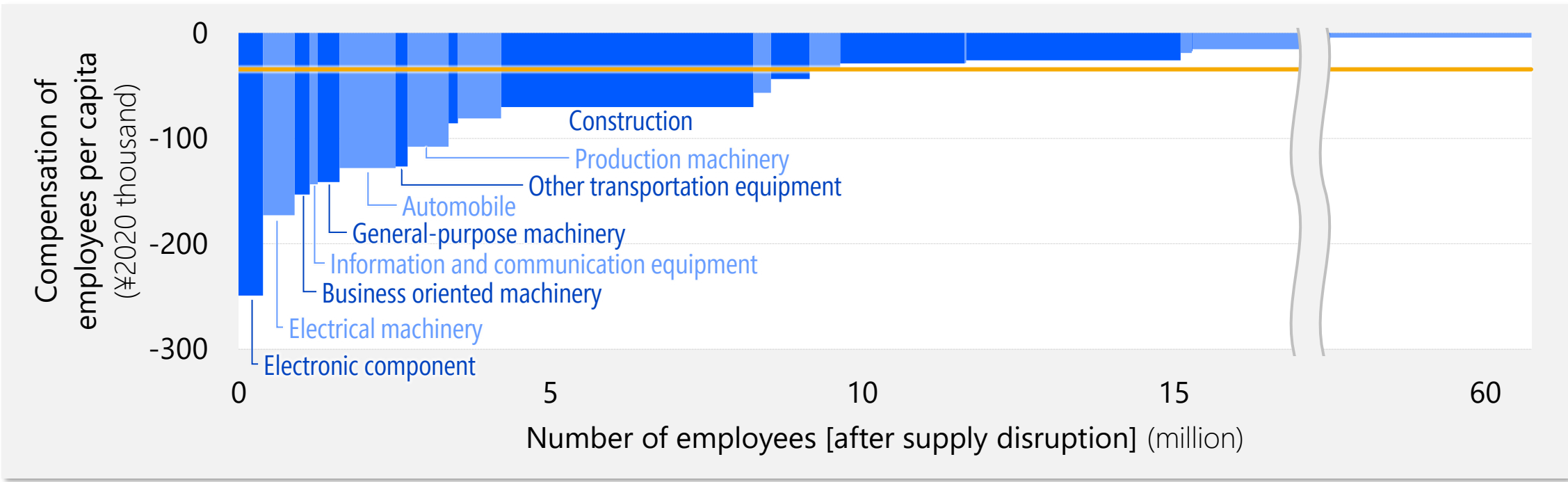
The slowdown in economic activity would worsen the employment situation, and furthermore...



- ✓ With economic activity declining broadly, the number of employees would fall in every sector.
- ✓ Even those fortunately spared unemployment would have to accept averagely –¥35 000 in compensation.
 - The impact would be particularly severe in the machinery industries, with many sectors—led by electronic components—seeing an average reduction of over ¥100 000.
 - One in four of all employees works in an industry where earnings would fall by an average of ¥20 000 or more.
 - The decline in compensation would put downward pressure on pensions, with the impact extending beyond the working-age population.



Changes in compensation of employees due to rare earth supply disruptions

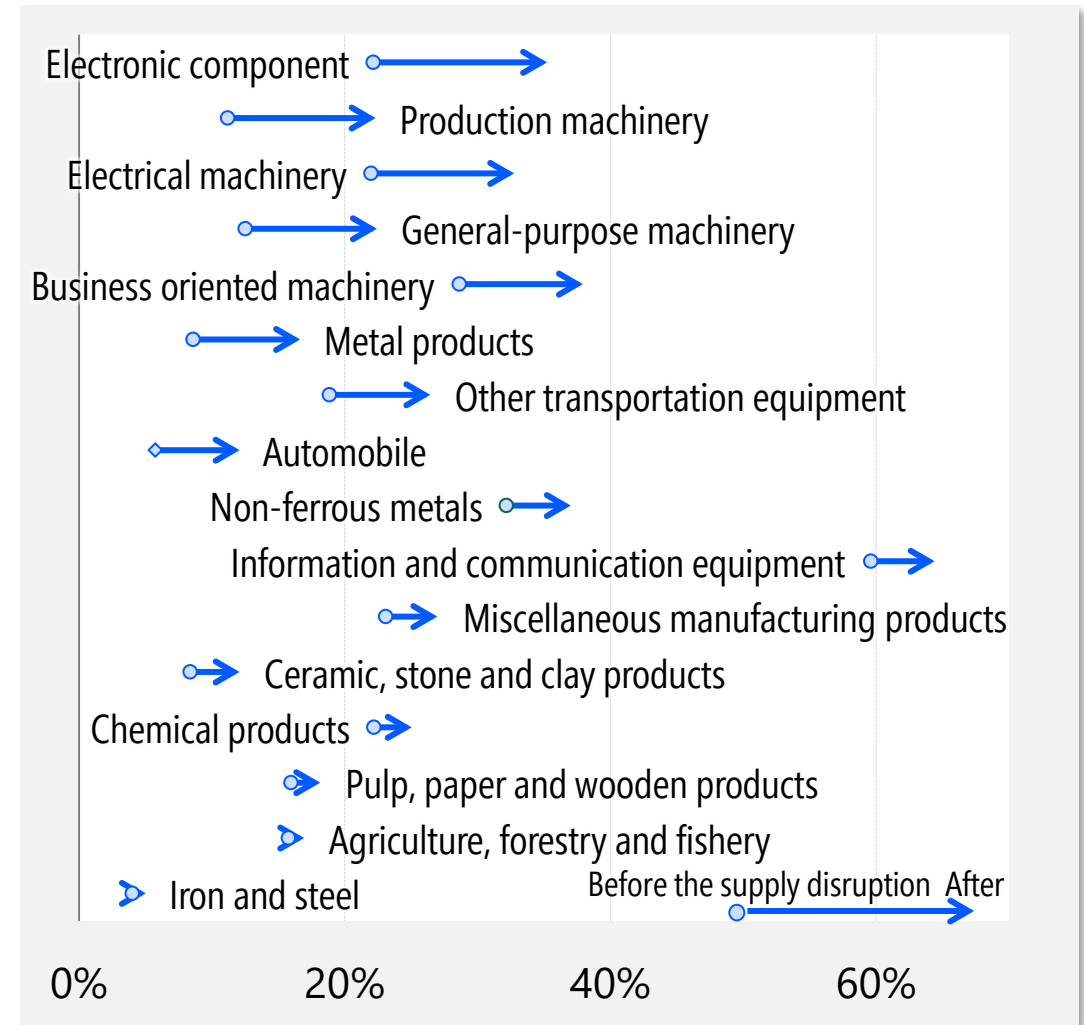


What would increase is dependence on imports

- ✓ To mitigate for supply shortages caused by a decline in gross output, reliance on imports would increase for almost all goods.
 - Imports would increase by 19.7% overall.
 - The share of imports in supply (gross output + imports) would rise by 1.8% points.
It currently stands at just over 10%.
 - This rise in import dependency may create new vulnerabilities.
However, producing everything domestically is not realistic given Japan's supply capacity.
It also lacks economic rationality from the perspective of comparative advantage.
- ✓ Were the rare earth supply disruption to be global, leading to reduced production in various countries, it may not be possible to import enough to make up for the shortfall in Japan.
 - The impact would be far more severe than indicated in this analysis.

Changes in import dependency due to rare earth supply disruptions

Industries most affected

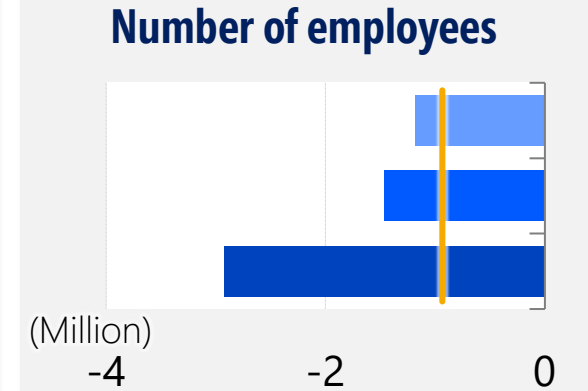
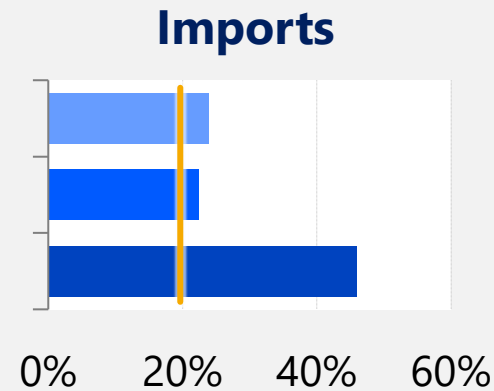
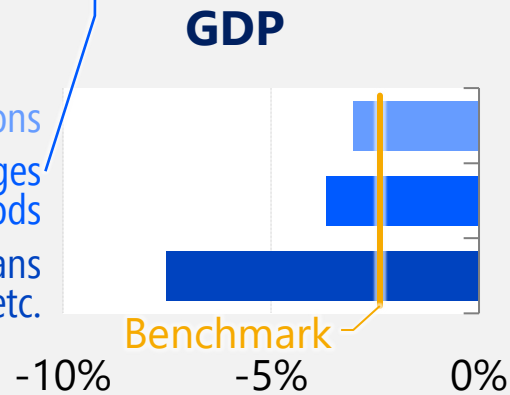


Sensitivity analyses

Rare earth imports: -50% ▶ Half the volume of imports in the Benchmark (import disruption 75% → 88%)

Import increase cap for non-rare earths: -50% ▶ Half of the 100% increase in the Benchmark

More extensive import disruptions
More difficult to address shortages
in the supply of goods
Scarcer in alternative means
of production, etc.



Rigidity of gross output: +50% ▶ The elasticities of output with respect to input are 1.5 times that of the Benchmark.

p.9

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