Environmentally adjusted multifactor productivity

Rising productivity is a key source of long-run economic growth that can increase material living standards. To capture the role of environmental services, the OECD productivity framework was extended to calculate the environmentally adjusted multifactor productivity (EAMFP) growth. The EAMFP thus measures a country's ability to generate income from a given set of inputs (including also domestic natural resources). At the same time, it accounts for the production of undesirable environmental by-products (pollution).

The EAMFP complements the traditional measure of productivity – multifactor productivity (MFP) – widely used by economic and finance policy makers. It fosters greater consideration of environmental concerns in economic policy decisions. Compared to the MFP, the indicators below allow better identification of the sources of economic growth and better assessment of long-term growth prospects. In fact, if productivity measurement is not adjusted for environmental services, productivity growth can sometimes be overestimated. This is the case in countries where economic growth relies on depletion of natural capital or on heavily polluting technologies. On the other hand, productivity growth can be underestimated in countries that invest in more efficient use of domestic natural resources or abate pollution (e.g. invest in cleaner technologies).

The EAMFP measurement framework remains a work-in-progress. In the current edition, natural capital is limited to subsoil assets (fossil fuels and minerals). Pollution is limited to air emissions (greenhouse gases and air pollutants).

Main trends and recent developments

Productivity gains have played a key role in sustaining economic growth

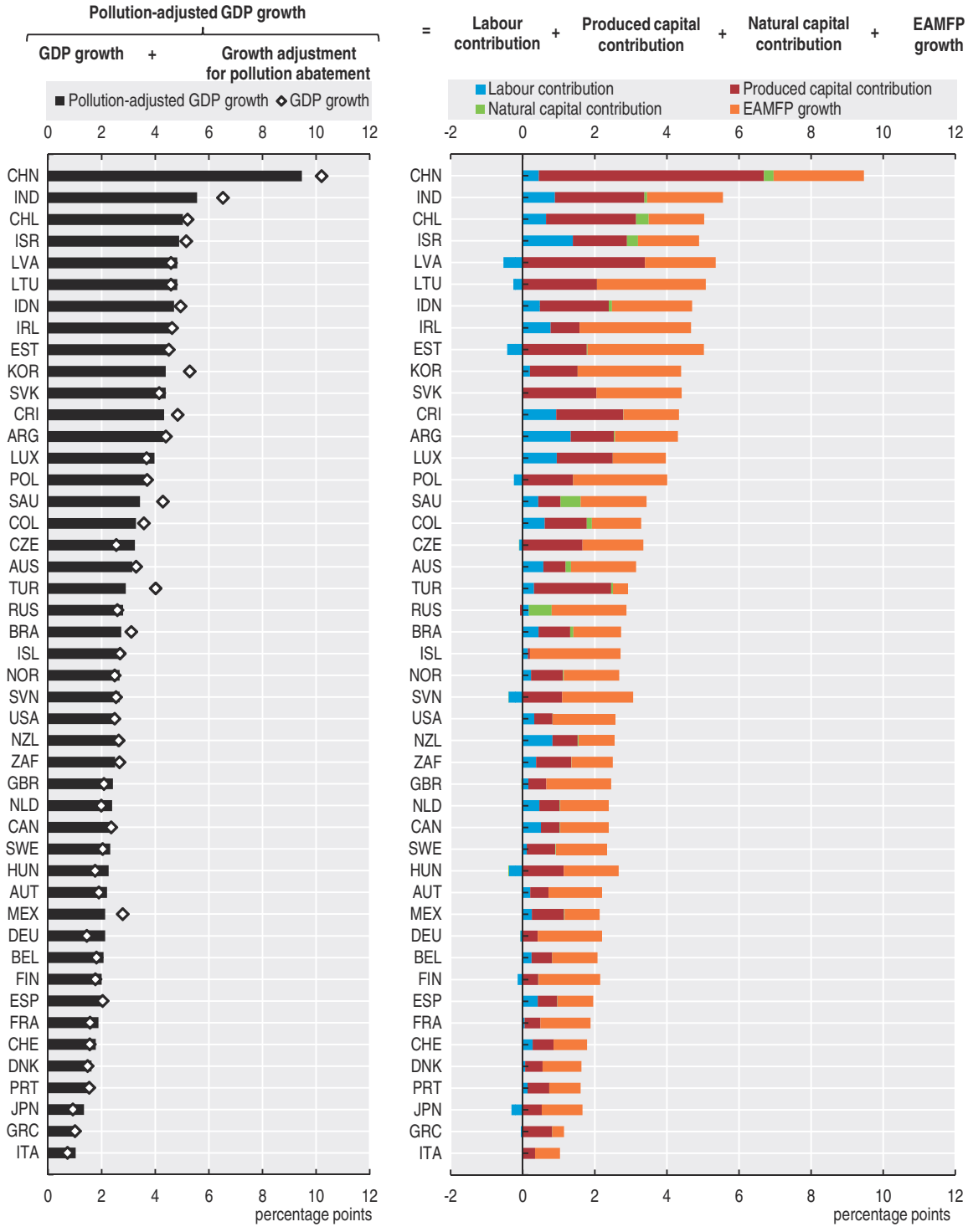
All OECD and G20 countries have increased their productivity (EAMFP) over the last two decades (Figure 5.1, Figure 5.2a). Countries such as Estonia, Ireland and Lithuania have achieved more than three percentage points of growth thanks to fast-rising productivity. In countries such as Greece and Turkey, slow productivity improvements (less than 0.5 percentage points) have compromised growth.

In relative terms, countries such as Iceland, Finland, Japan or Germany have achieved the bulk of growth (around 80%) essentially via productivity gains (Figure 5.2d). In countries like India and the People's Republic of China (hereafter China), less than 40% of growth performance can be attributed to rising productivity.

Differing reliance on factor inputs is the key reason for different overall growth performance of many OECD and BRIICS economies (Brazil, Russian Federation [hereafter Russia], India, Indonesia, China, South Africa). OECD countries have generated growth

Figure 5.1. **Growth accounting: The sources of growth vary across countries**

Long-term averages (circa 1991-2013)



Note: The coverage of environmental services remains partial, currently limited to subsoil assets on the input side and air emissions as undesirable output. In panel B, negative values mean that the contribution of input to output growth has been decreasing.

Source: OECD (2016), "Environmentally adjusted multifactor productivity", *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933484605

almost exclusively through productivity gains. Conversely, BRIICS economies have drawn more on increased use of labour, produced capital and natural capital to generate additional growth (Cárdenas Rodríguez, Haščič and Souchier, 2016).

Natural capital can contribute significantly to output growth

The growth contribution of (domestic) natural capital – currently represented by subsoil assets – is small in most countries relative to produced capital and labour (Figure 5.1, Figure 5.2b). In fact, natural capital will contribute little to output growth in countries where extraction rates remain fairly constant over time. This is even the case if resource extraction represents a considerable share of GDP in countries such as Canada. However, in some resource-rich countries, increasing extraction rates and higher value of extracted domestic natural resources have contributed to a significant share of output growth over the past two decades. This is the case for Russia, Saudi Arabia, Chile, Israel and Australia (Figure 5.2e).

Indeed, about 23% of Russia's output growth is due to extraction of its subsoil assets. This raises concerns over dependence on natural resource extraction and the need to identify new sources of growth in the long run. Meanwhile, in the United Kingdom, more use of other inputs (such as labour and produced capital) and productivity improvements have compensated for declining natural resource extraction.

Some countries have achieved economic growth at the expense of environmental quality

The growth adjustment for pollution abatement – currently represented by greenhouse gases and air pollutants – is positive in countries where pollution emissions have decreased over the last two decades, and negative in countries where emissions have increased. It reflects to what extent economic growth has been achieved at the expense of environmental quality. In 29 countries, as pollution emissions have decreased over the last two decades, GDP growth rates must be adjusted upwards to correctly reflect their growth performance. Conversely, in 17 countries where emissions have increased, the adjustment is negative. This is the case of India, Saudi Arabia and China, and some OECD countries such as Turkey, Korea and Mexico (Figure 5.1, Figure 5.2c).

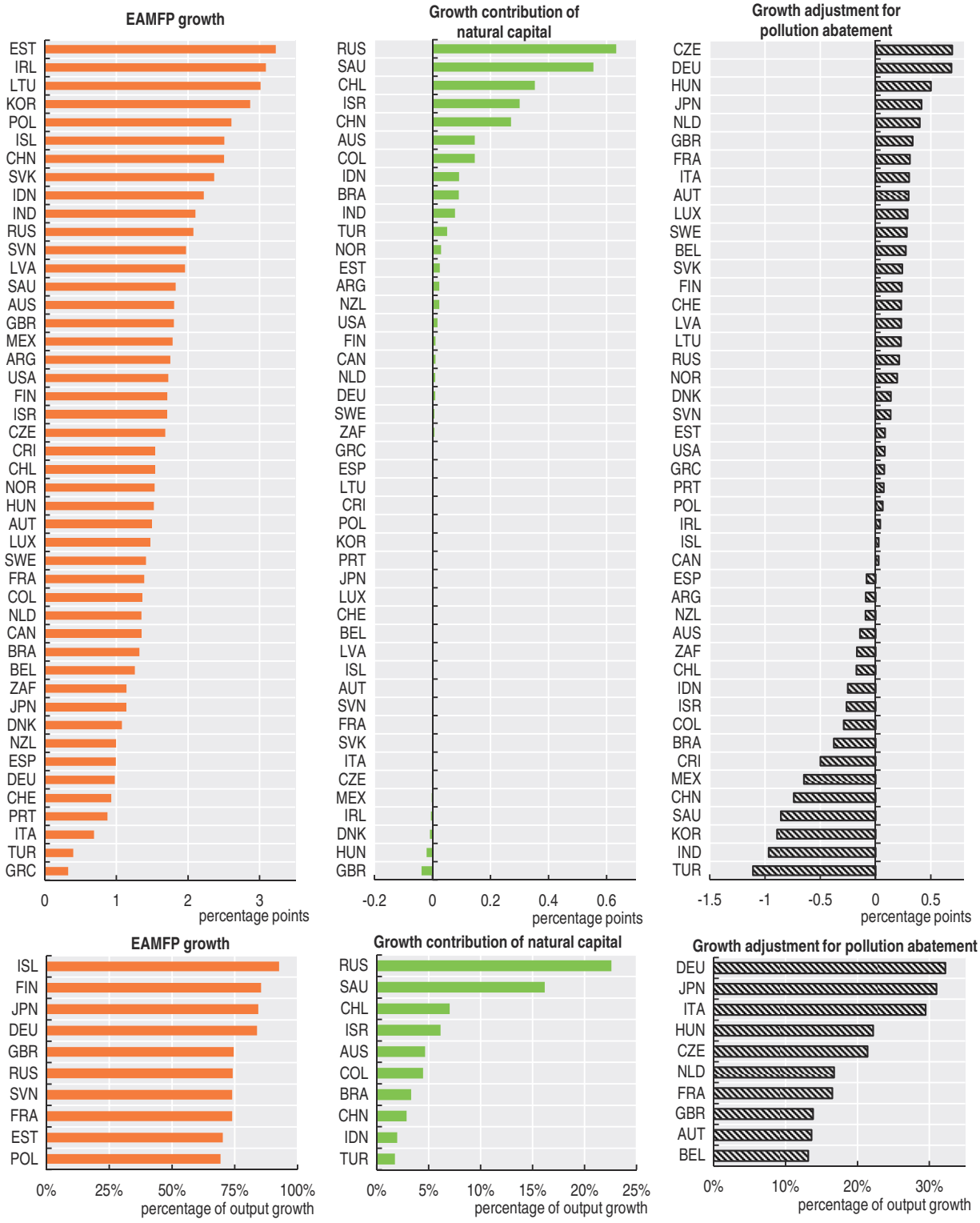
Measurability and interpretation

The indicators presented in this chapter relate to the following:

- **Environmentally adjusted multifactor productivity growth** expressed as a long-term average growth rate in percentage points, and as a share of output growth. The growth in EAMFP measures a country's ability to generate income from a given set of inputs, including domestic natural resources. At the same time, it accounts for the production of undesirable environmental outputs.
- The **growth contribution of natural capital** expressed as a long-term average growth rate in percentage points, and as a share of output growth. It measures how much current income growth depends on domestic natural resource use.
- The **growth adjustment for pollution abatement** expressed as a long-term average growth rate in percentage points, and as a share of output growth. It measures to what extent economic growth has been achieved at the expense of environmental quality. See also *Glossary*.

Figure 5.2. **Productivity and the role of environmental services for growth**

Long-term average (circa 1991-2013)



Note: The coverage of environmental services remains partial, currently limited to air emissions and subsoil assets.
Source: OECD (2016), "Environmentally adjusted multifactor productivity", *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933484611

These indicators should be interpreted with caution. In the current edition, the coverage of environmental services remains partial. It is limited to eight types of air emissions (CO_2, CH_4, N_2O, NMVOC, SO_X, NO_X, CO, PM_{10}) and 14 types of subsoil assets (hard coal, soft coal, gas, oil, bauxite, copper, gold, iron ore, lead, nickel, phosphate, silver, tin and zinc). Many other natural resources (e.g. soil, biodiversity) and many environmental services (e.g. pollination, water purification, avalanche and landslide prevention, landscape amenities, etc.) are not taken into account. Pending better data availability, future work will seek to include more natural resources and environmental services.

In addition, these indicators provide an aggregated picture of the economy. As any other country-level measure, they might hide important sectoral or firm-level differences (see e.g. Albrizio, Koźluk and Zipperer, 2017). These indicators are sensitive to the business cycle. For example, they are volatile in times of economic recession. Analysing long-term trends, as presented here, helps to mitigate these concerns.

The underlying growth accounting framework only allows measurement of changes in productivity ("growth"). It does not permit measurement of productivity levels, or contribution to the level of GDP. This should be kept in mind when comparing across countries. Finally, in growth accounting, inputs and outputs are evaluated from the producers' perspective. The EAMFP framework does not account for environmental damages or the social costs of pollution. Therefore, it is not a measure of social welfare.

Sources

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Further reading

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