AMRO
ASEAN +3 MACROECONOMIC RESEARCH OFFICE

Chapter 3.

Long-term Growth of ASEAN+3: Prospects and Policies

Online Annexes

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Annex 1. Growth Accounting Framework

Section II assumes standard Cobb-Douglas production technology with constant returns to scale (Solow 1957). Potential output can be decomposed into total factor productivity, capital, labor, and human capital:[1]

$$Y_t = A_t * K_t^{1-\alpha} * (L_t * H_t)^{\alpha}$$

Where:

- Y_t is potential output,
- A_t is total factor productivity (TFP),
- K_t is capital stock,
- L_t is labor input,
- H_t is human capital,
- α is the labor share of income.

The initial capital stock is obtained from Penn World Tables (PWT) and adjusted for the base year of 2015. The capital stock series is then estimated using the perpetual inventory method with the depreciation rate from PWT and gross fixed capital formation data from national authorities.

Labor input is computed by multiplying employed persons with average annual hours worked, assuming that both the labor force participation rate and hours are constant. The labor force participation rate is estimated from the labor force data from the International Labor Organization, the United Nations population data, and the unemployment rate from national authorities. The baseline scenario uses the United Nations World Population Prospect 2024's medium variant population scenario to project the growth of the working-age population, while the low fertility scenario uses the low variant.

TFP is calculated using real GDP, capital stock, labor input, and human capital, with the labor share of income based on PWT data or estimated via regression for economies without data.

The projection for TFP and human capital from 2024 to 2050 is based on trend growth since 2000 and convergence effects, adjusted to exclude crisis years. The convergence effect, measuring how fast economies catch up to the frontier economies proxied among the Organization for Economic Co-operation and Development members, is estimated through beta-convergence regression. The projection for capital stock is based on the trend growth of gross fixed capital formation since 2010, constant depreciation rate as in 2019, and convergence effects. The "frontier" used for the projections for human capital is 4.41, which is computed as 16 years of schooling with the assumed rate of return to education from Psacharopoulos (1994). The human capital index is capped at 20 years of education.

In the baseline scenario in Section II, the convergence effect is estimated for each component through regressions. In the geoeconomic fragmentation scenario (also in Section II), the convergence effect of TFP is removed. In the upside scenarios discussed in Section IV, each component's projected convergence rate is assumed to match the historical rate of leading ASEAN+3 economies (Hong Kong, Japan, Korea, and Singapore).

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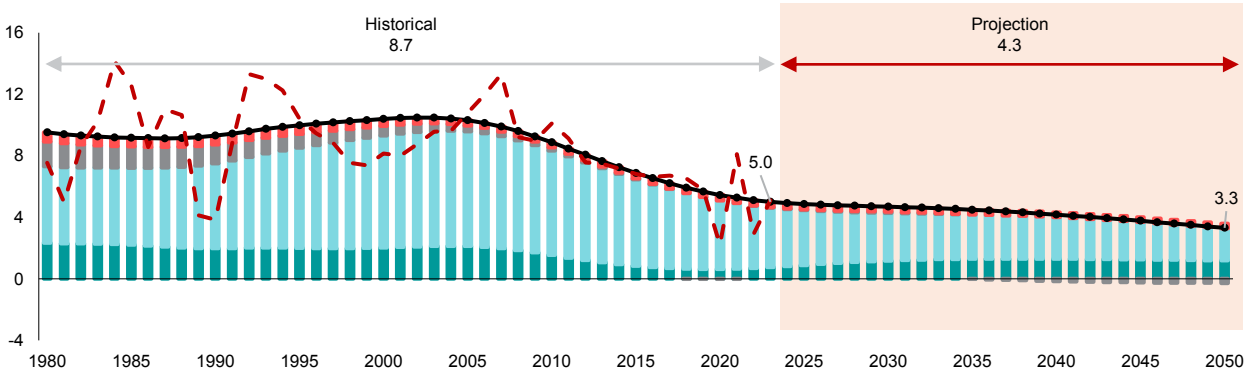
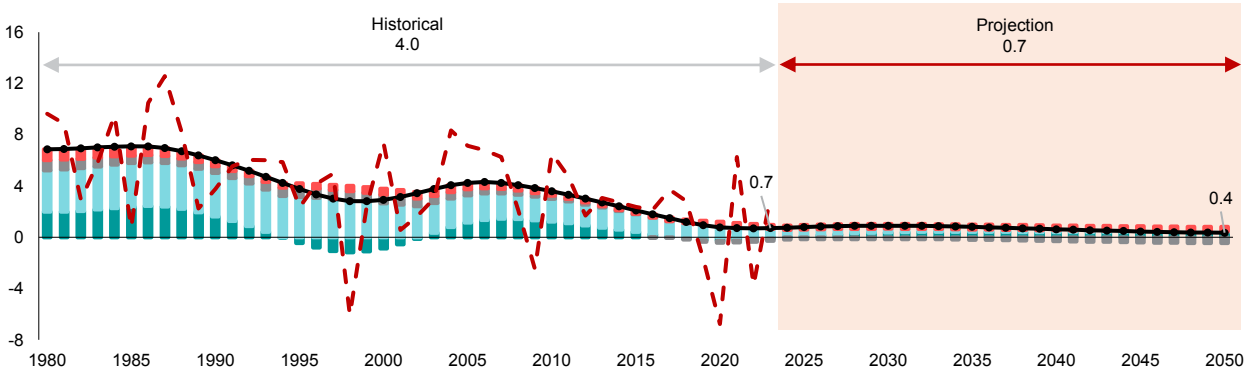
[1] The natural resource input R_t, measured as the oil and gas production (in volume terms) with the resource share of income of 0.1, is included for Brunei.

Annex 2. ASEAN+3 Growth Potential Trends and Projections, by Economy

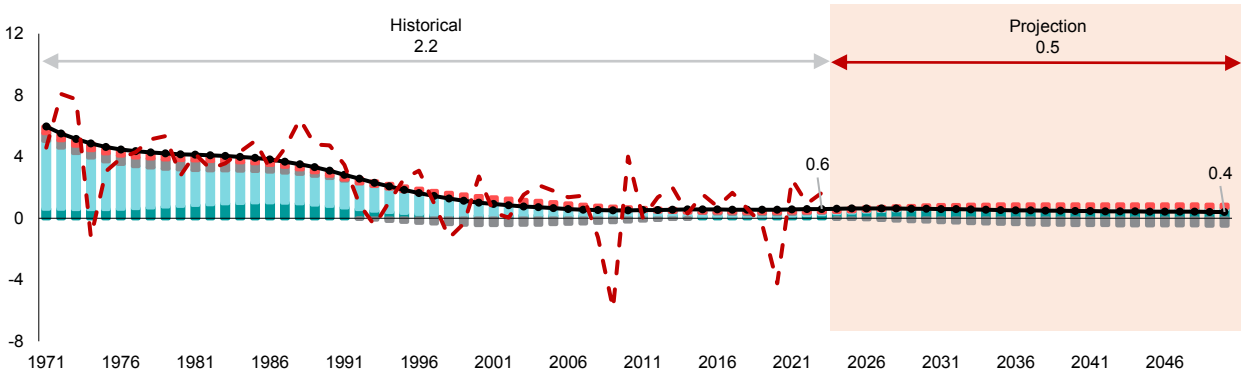
China



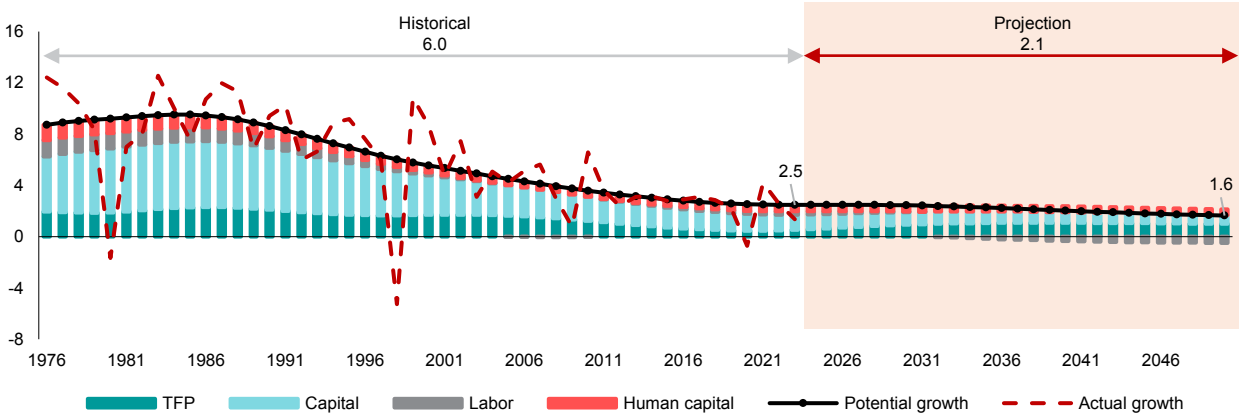
Hong Kong



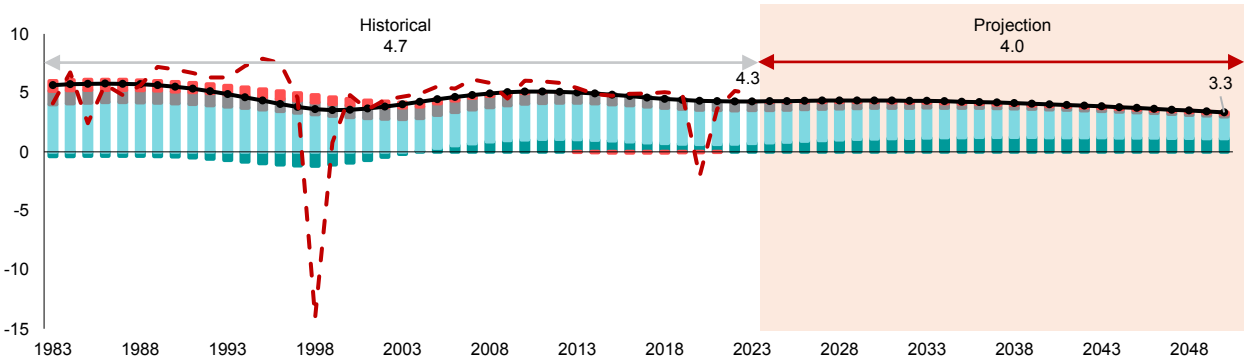
Japan



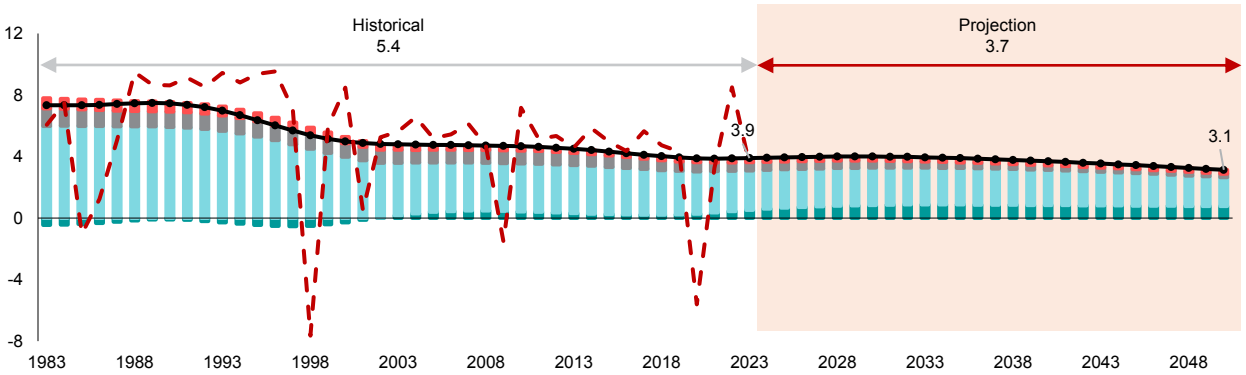
Korea



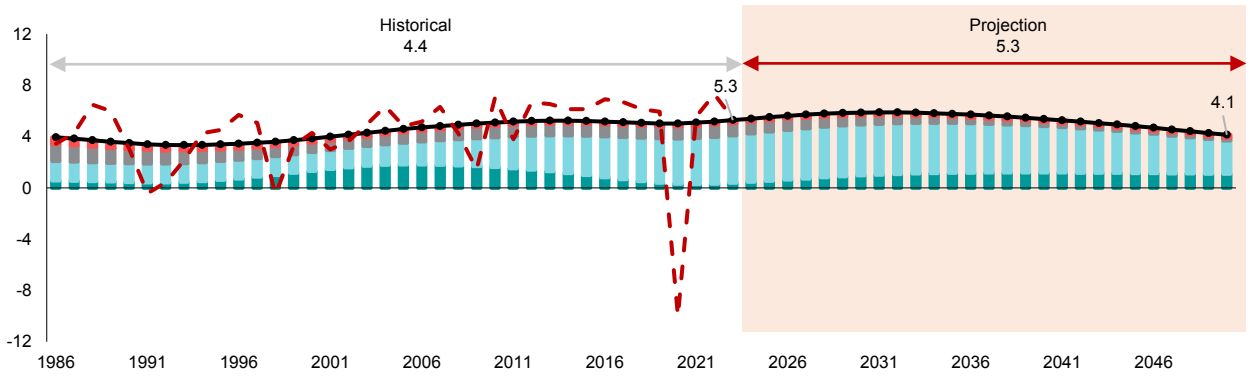
Indonesia



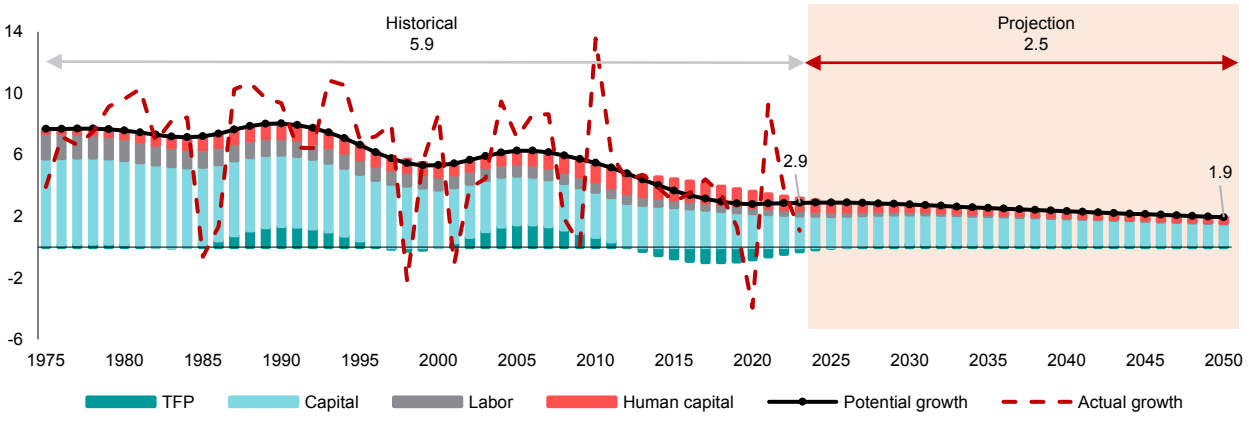
Malaysia



The Philippines



Singapore



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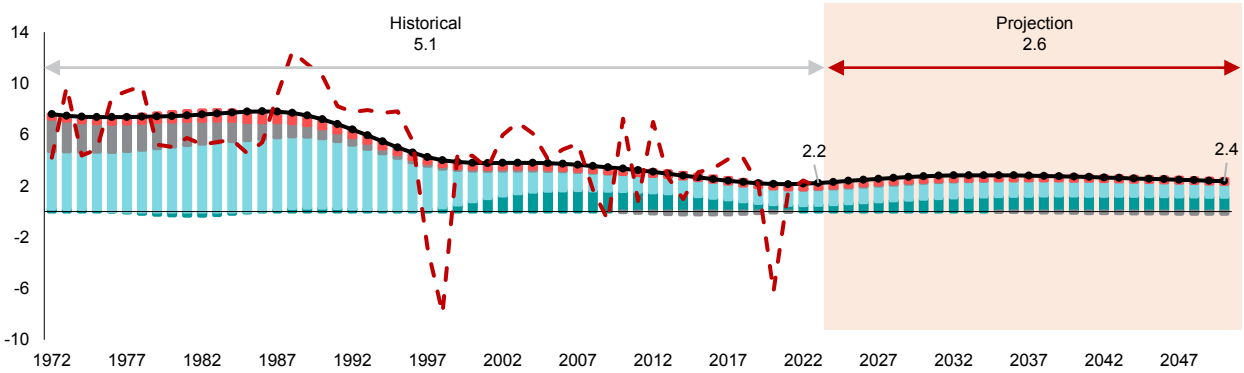
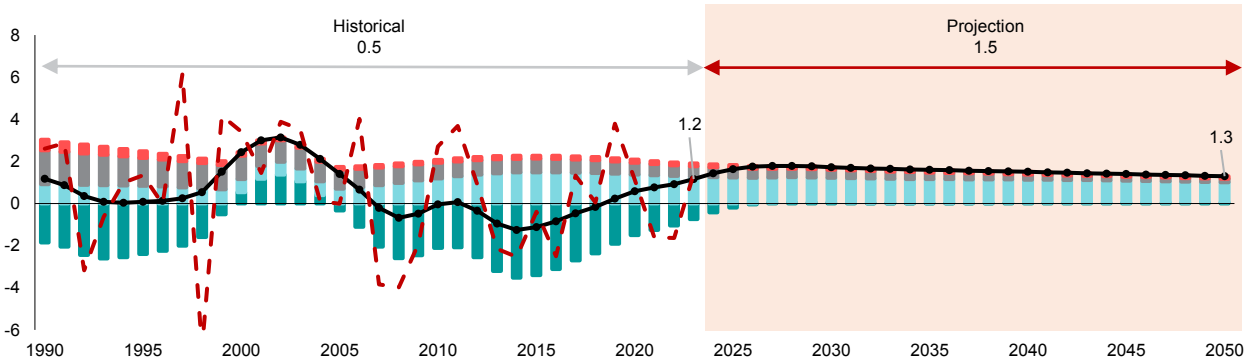


Brunei



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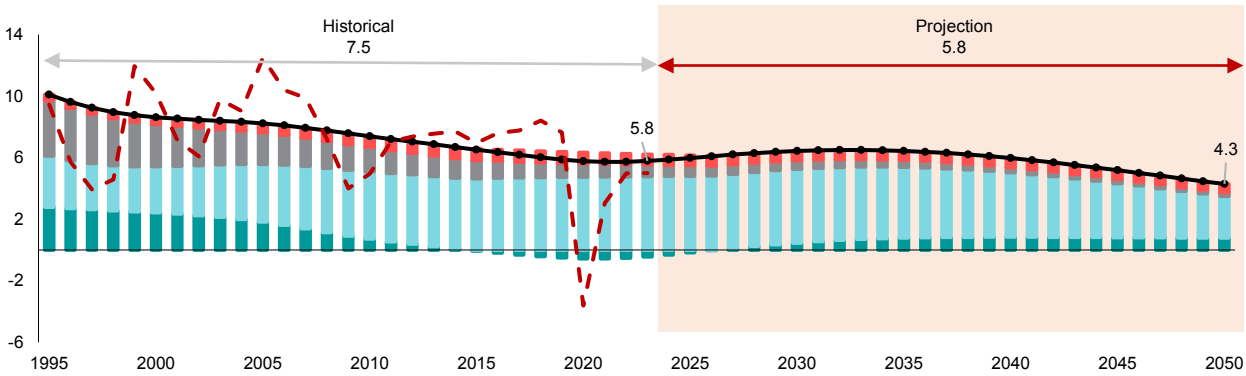
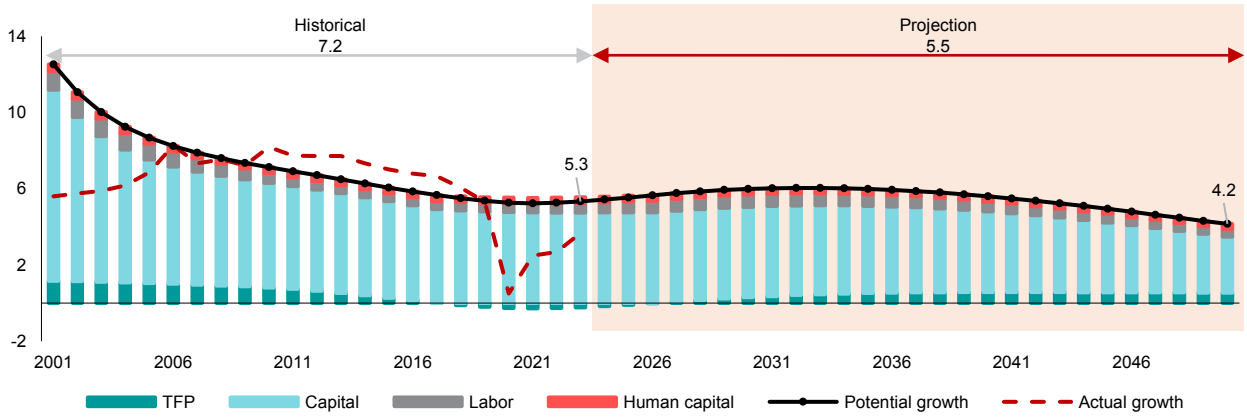


Lao PDR



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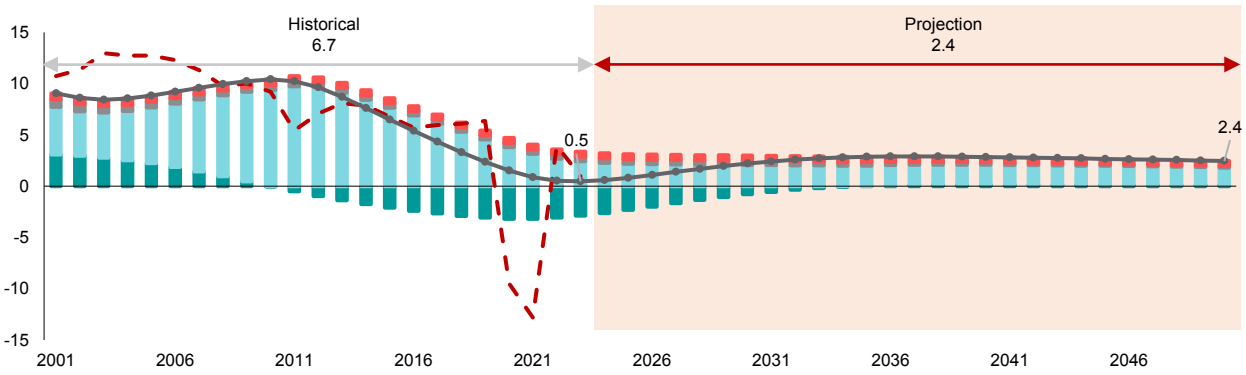
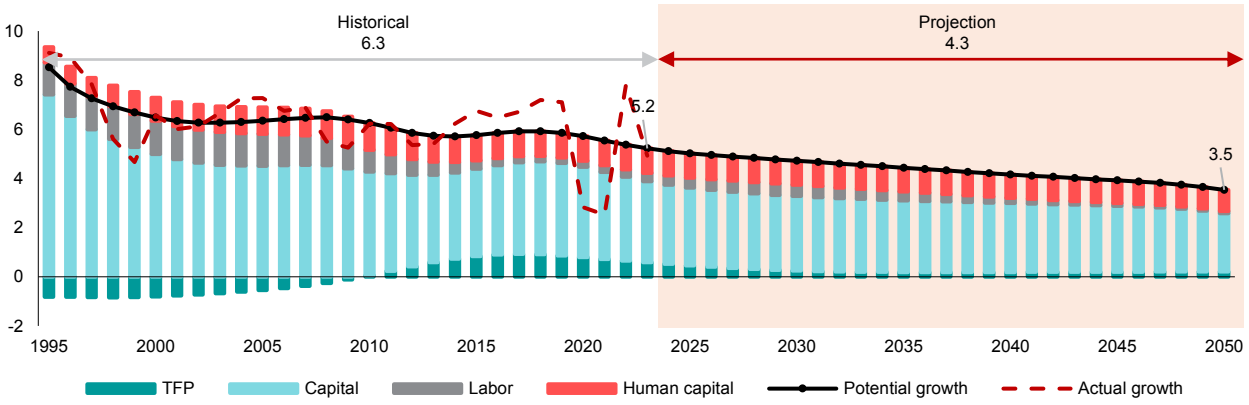


Vietnam



Source: International Labour Organization; International Monetary Fund; National authorities via Haver Analytics; Penn World Table; UN World Population Prospects; World Bank; AMRO staff calculations.
Note: TFP = total factor productivity, Data for Cambodia is up to 2022 and AMRO staff forecast is used for 2023. Data labels show the potential growth for 2023 and 2050. The historical and projection for potential growth show the average over the entire period. The TFP component for Brunei includes the estimation of oil and gas production growth.

Annex 3. Decomposition of Labor Productivity Gains

Section III utilizes the shift-share decomposition method to explore the underlying dynamics of the recent slowdown in ASEAN+3's productivity growth. This method recognizes the importance of sectoral development patterns for economic growth and is widely adapted in studies related to structural change.[2] It expresses the aggregated labor productivity (P) at time T as:

$$P_T = \frac{Y_T}{L_T} = \frac{\Sigma_{s=1}^{n} Y_{s,T}}{L_T} = \sum_{s=1}^{n} \frac{L_{s,T} Y_{s,T}}{L_T L_{s,T}} = \sum_{s=1}^{n} S_{s,T} P_{s,T}$$

where Y denotes value-added, L is the employment, and s is the sector (s=1,2,…n). As such, $S_{s,T}$ and $P_{s,T}$ are the employment share and labor productivity of sector s at time T. Aggregate labor productivity is the weighted sum of sectoral labor productivity, using sectoral employment shares as weights.

Using the above equation, the change in productivity from time 0 to T could be decomposed into three components.

$$P_T - P_0 = \sum_{s=1}^{n} S_{s,T} P_{s,T} - \sum_{s=1}^{n} S_{s,0} P_{s,0}$$

$$= \sum_{s=1}^{n} S_{s,T} P_{s,T} - \sum_{s=1}^{n} S_{s,0} P_{s,T} + \sum_{s=1}^{n} S_{s,0} P_{s,T} - \sum_{s=1}^{n} S_{s,0} P_{s,0}$$

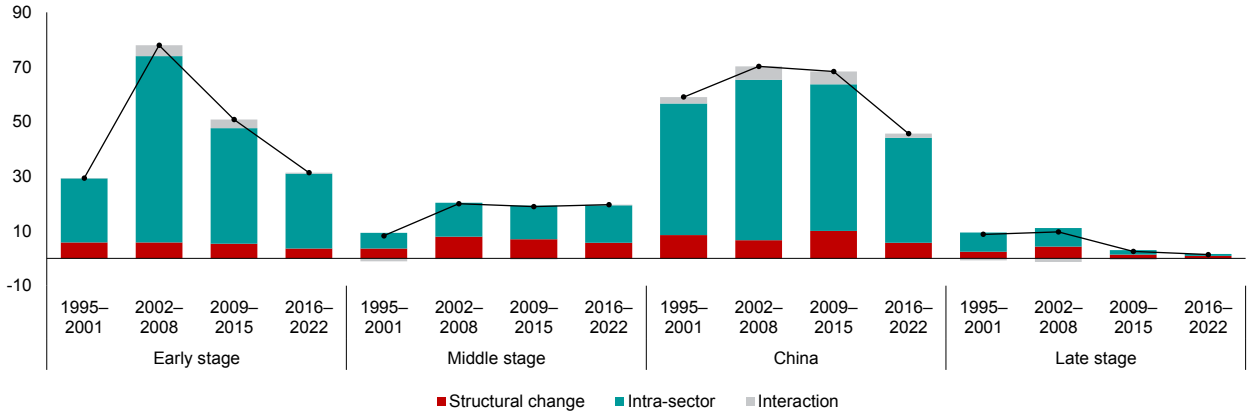
$$= \sum_{s=1}^{n} (S_{s,T} - S_{s,0}) P_{s,T} + \sum_{s=1}^{n} (P_{s,T} - P_{s,0}) S_{s,0}$$

$$= \sum_{s=1}^{n} (S_{s,T} - S_{s,0}) P_{s,0} + \sum_{s=1}^{n} (P_{s,T} - P_{s,0}) S_{s,0} + \sum_{s=1}^{n} (P_{s,T} - P_{s,0})(S_{s,T} - S_{s,0})$$

The first term $(\Sigma_{s=1}^{n}(S_{s,T} - S_{s,0}) P_{s,0})$ represents the effect of structural change through sectoral labor reallocation. The second term $(\Sigma_{s=1}^{n}(P_{s,T} - P_{s,0}) S_{s,0})$ captures the productivity improvement within the sector, or the intra-sectoral effect. The third interaction term $(\Sigma_{s=1}^{n}(P_{s,T} - P_{s,0})(S_{s,T} - S_{s,0}))$ illustrates the dynamic component of structural change, which becomes positive when labor shifts to sectors where productivity is higher and growing.

The figures below provide additional information on the decomposition of labor productivity gains in ASEAN+3, (1) by stage of structural change; and (2) by individual ASEAN+3 economies.

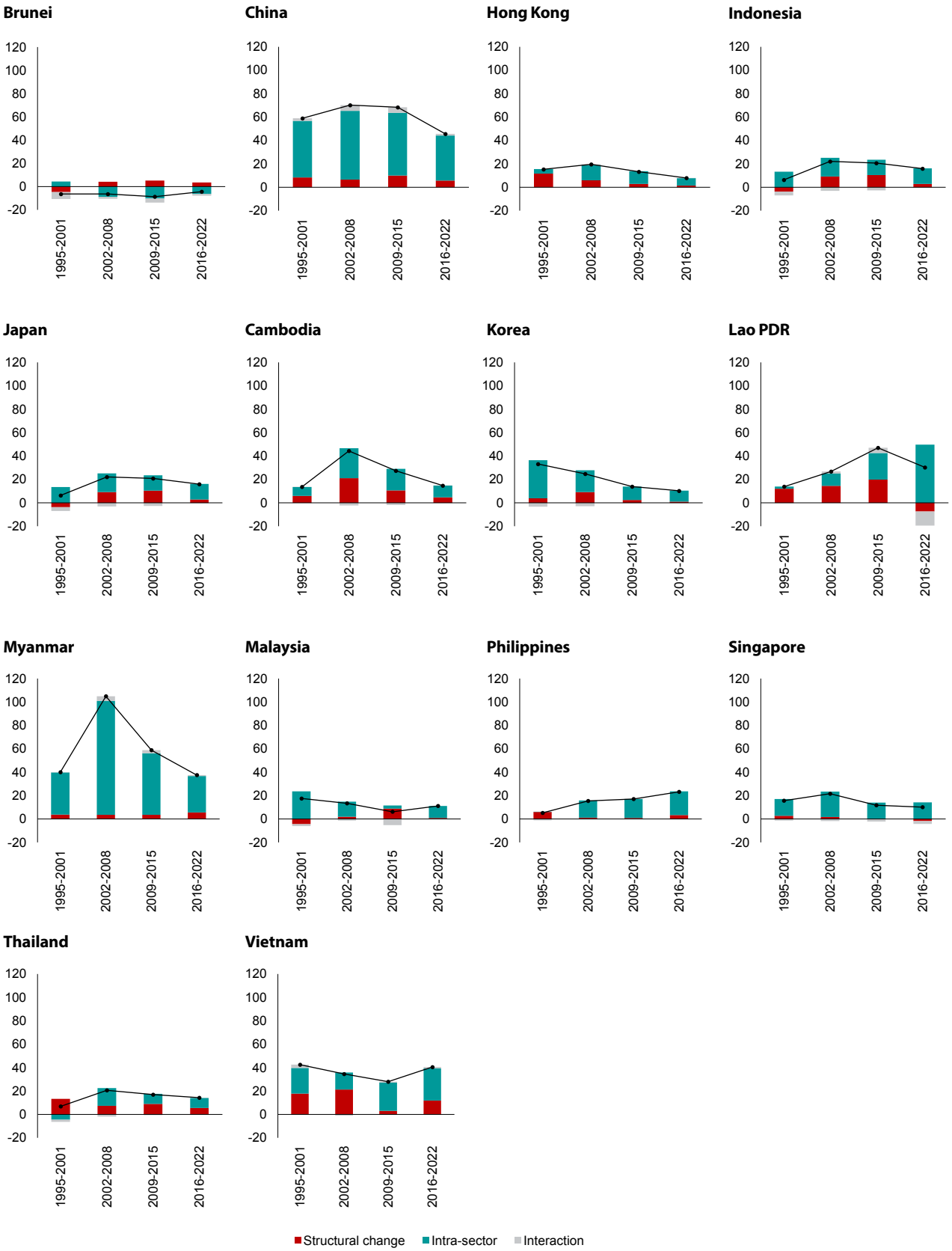
Figure A3.1. ASEAN+3: Decomposition of Labor Productivity Gains, by Stage of Structural Change
(Percent, growth over seven years)



Source: International Labour Organization; United Nations Industrial Development Organization; United Nations Statistics Division; AMRO staff calculations.
Note: The figure decomposes the productivity growth over seven years. Labor productivity is the aggregated sectoral value added per employment and is a five-year moving average weighted by the value-added at constant price and employment size. Online annex 4 features details on the structural change stage.

2/ Past studies using a similar approach include Timmer and Vries (2009); Pagés and others (2010); McMillan and Rodrik (2011); Klyuev (2015); and Diao and others (2017).

Figure A3.2. ASEAN+3: Decomposition of Labor Productivity Gains, by Economy
(Percent, growth over seven years)



Source: International Labour Organization; United Nations Industrial Development Organization; United Nations Statistics Division; AMRO staff calculations.
Note: The figure decomposes the productivity growth over seven years. Labor productivity is the aggregated sectoral value added per employment, a five-year moving average weighted by the value-added at constant price and employment size.

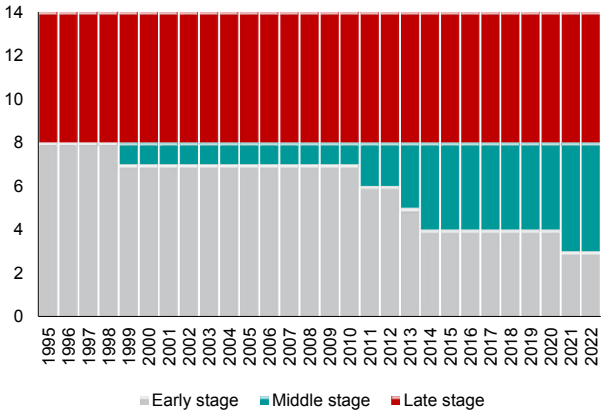
Annex 4. Classification of Economies by Stage of Structural Change

Baymul and Sen (2020) classified economies into three groups based on the sectoral employment share. The economy is (1) structurally underdeveloped (i.e., the early stage) when its agriculture employment share is the largest, (2) structurally developing (i.e., the middle stage) when the share of services employment is largest, followed by agriculture, and (3) structurally developed (i.e., the late stage) when in employment the manufacturing share is larger than agriculture.

AMRO staff expanded this framework to value-added shares to determine the stage of structural change from *both* employment and value-added aspects. The story of structural change could differ by the aspect that one chooses to analyze: based on Baymul and Sen (2020)'s approach, ASEAN+3's structural change occurred rapidly after the 2010s (Figure A4.1). Yet, one can argue that it has consistently happened since the early 2000s, if the same criteria is applied to the value-added shares (Figure A4.2). Thus, Section III accounts for progress in both employment reallocation and value-added in comprehensively determining the stage of structural change across ASEAN+3 economies (Table A4.1).

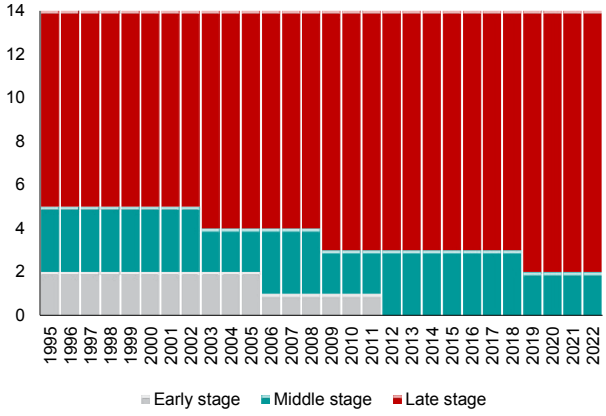
The figures below provide additional information on the stages of structural change in the ASEAN+3 region, in terms of (1) where it is relative to other parts of the world; (2) the evolution of structural change in each economy; (3) as well as the sectoral employment and value-added shares for individual ASEAN+3 economies.

Figure A4.1. ASEAN+3: Structural Change Stages by Employment Share
(Number of economies)



Source: International Labour Organization; AMRO staff calculations.
Note: Employment share is a five-year moving average.

Figure A4.2. ASEAN+3: Structural Change Stages by Value-added Share
(Number of economies)



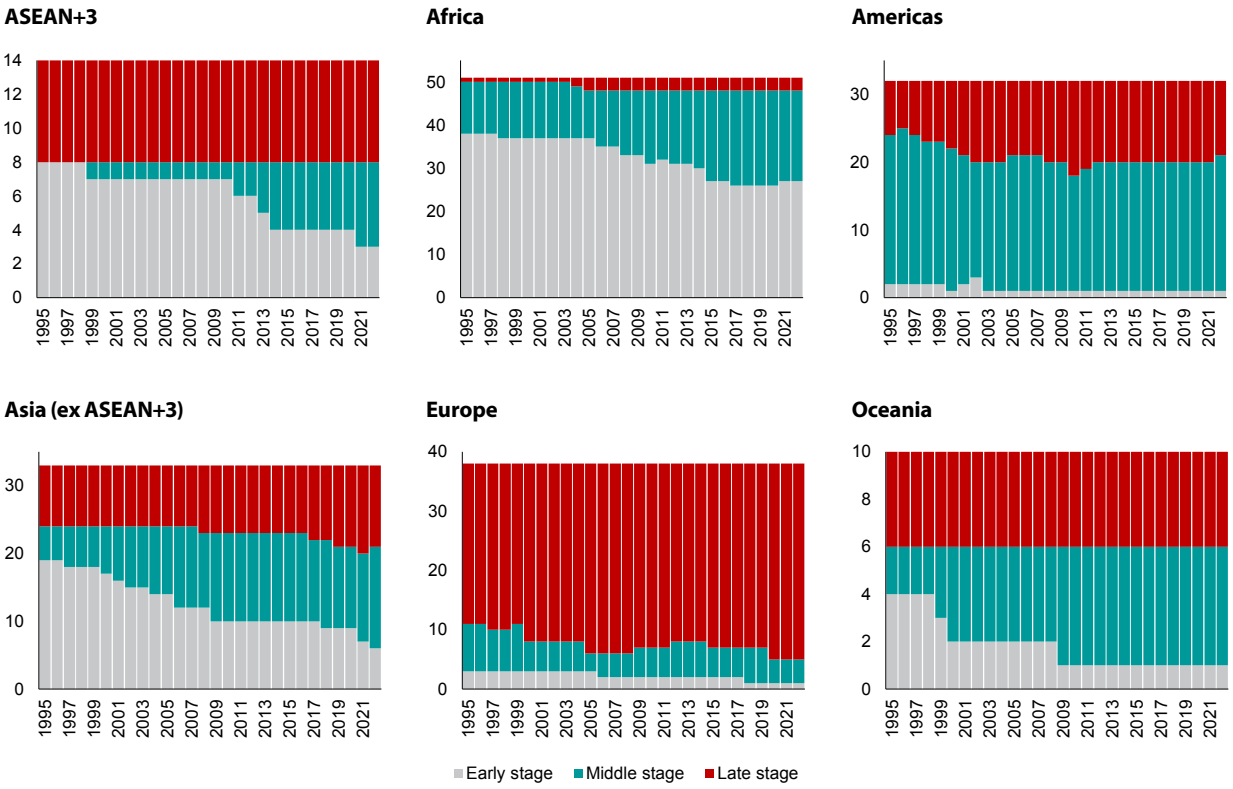
Source: United Nations Industrial Development Organization; United Nations Statistics Division; AMRO staff calculations.
Note: Value-added share is a five-year moving average and is a real value based on 2015 value.

Table A4.1. Structural Change Stage Definitions

Structural Change Stage	Criteria
Early Stage	• A > (S or M) for *either* employment or value-added
Middle Stage	• S > A > M for both employment and value-added *or* • S > A > M for employment and S > M > A for value-added *or* • S > M > A for employment and S > A > M for value-added
Late Stage	• S > M > A for *both* employment and value-added

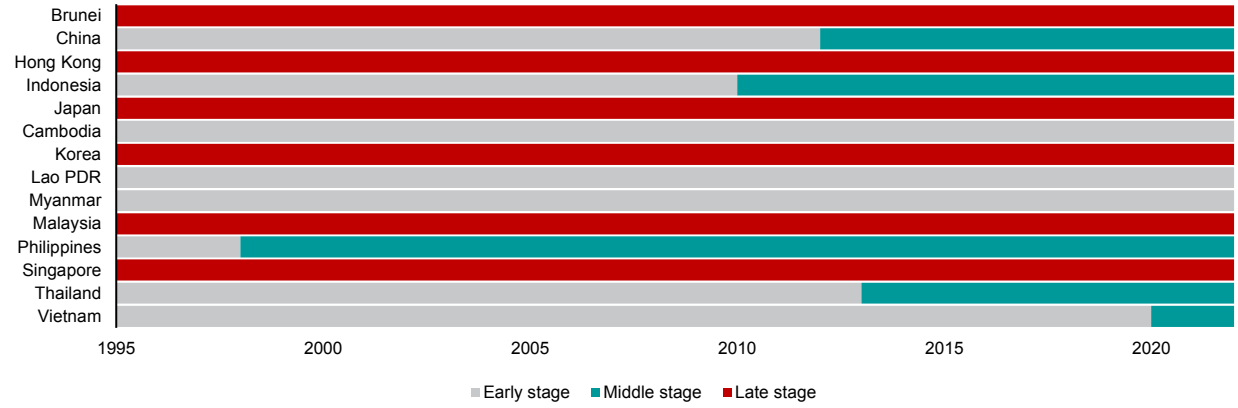
Source: AMRO staff.
Note: A, M, and S denote shares of agriculture, manufacturing, and services sectors.

Figure A4.3. World: Evolution of Structural Change, by Region
(Number of economies)



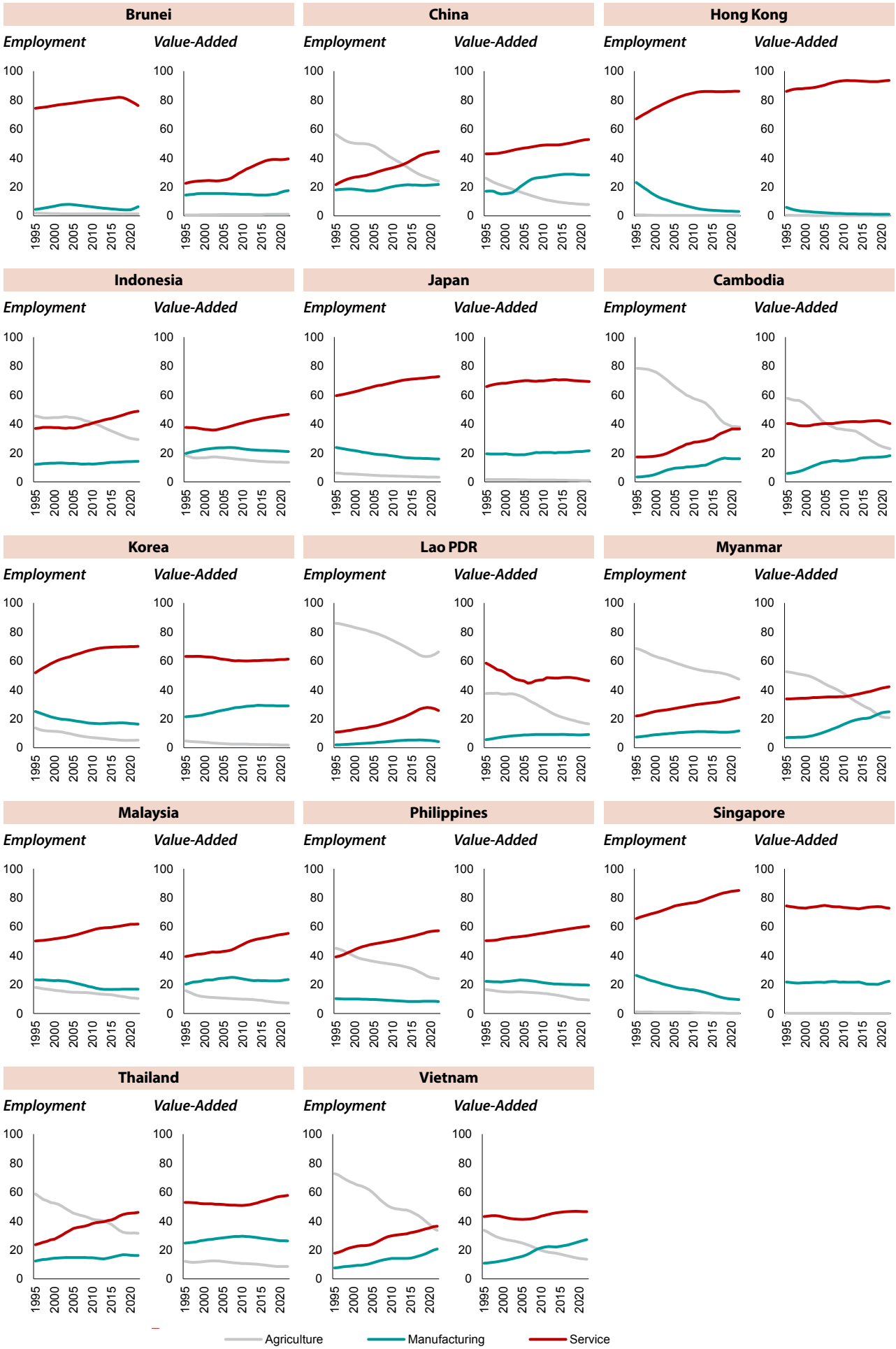
Source: International Labour Organization; United Nations Industrial Development Organization; United Nations Statistics Division; AMRO staff calculations.
Note: Employment and value-added shares are five-year moving averages. Value-added is based on 2015 values. Regional grouping follows the United Nation's grouping. The number of economies is 14 in ASEAN+3; 51 in Africa; 32 in the Americas; 33 in Asia excluding ASEAN+3; 38 in Europe; and 10 in Oceania.

Figure A4.4. ASEAN+3: Evolution of Structural Change over Time, by Economy



Source: International Labour Organization; United Nations Industrial Development Organization; United Nations Statistics Division; AMRO staff calculations.
Note: Employment and value-added shares are five-year moving averages. Value-added is based on 2015 values.

Figure A4.5. ASEAN+3: Sectoral Employment and Value-Added Shares, by Economy



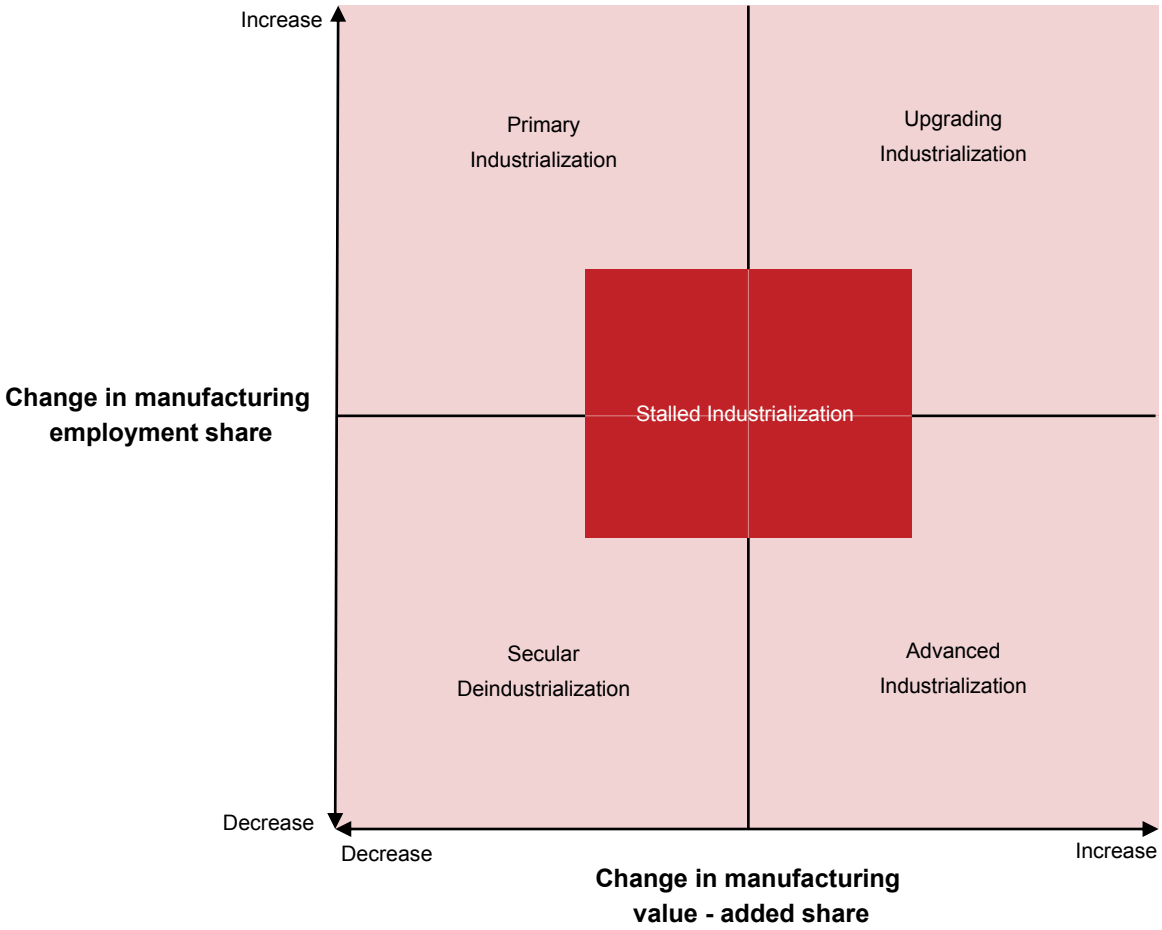
Source: United Nations Industrial Development Organization; United Nations Statistics Division; International Labour Organization; AMRO staff calculations.
Note: Employment and value-added shares are five-year moving averages. Value-added is based on 2015 value.

Annex 5. Classification of Economies by Phase of Industrialization

Kim and Sumner (2019) and Alisjahbana and others (2022) used a simple framework to demonstrate the diverse industrialization patterns across economies. Their approach assessed the changes in manufacturing employment and value-added shares and categorized the industrialization patterns into five types: (1) "primary industrialization," when economies industrialize mostly from the employment shift; (2) "upgrading industrialization" when economies see an increasing share of manufacturing in both employment and output; (3) "advanced industrialization," when economies' manufacturing activity becomes less labor-intensive; (4) "secular deindustrialization," when economies shift away from manufacturing activities; and (5) "stalled industrialization" when economies see industrialization stagnate (Figure A5.1). Typically, the normal path for an economy is to move sequentially, from (1) to (4), and to avoid falling into (5).

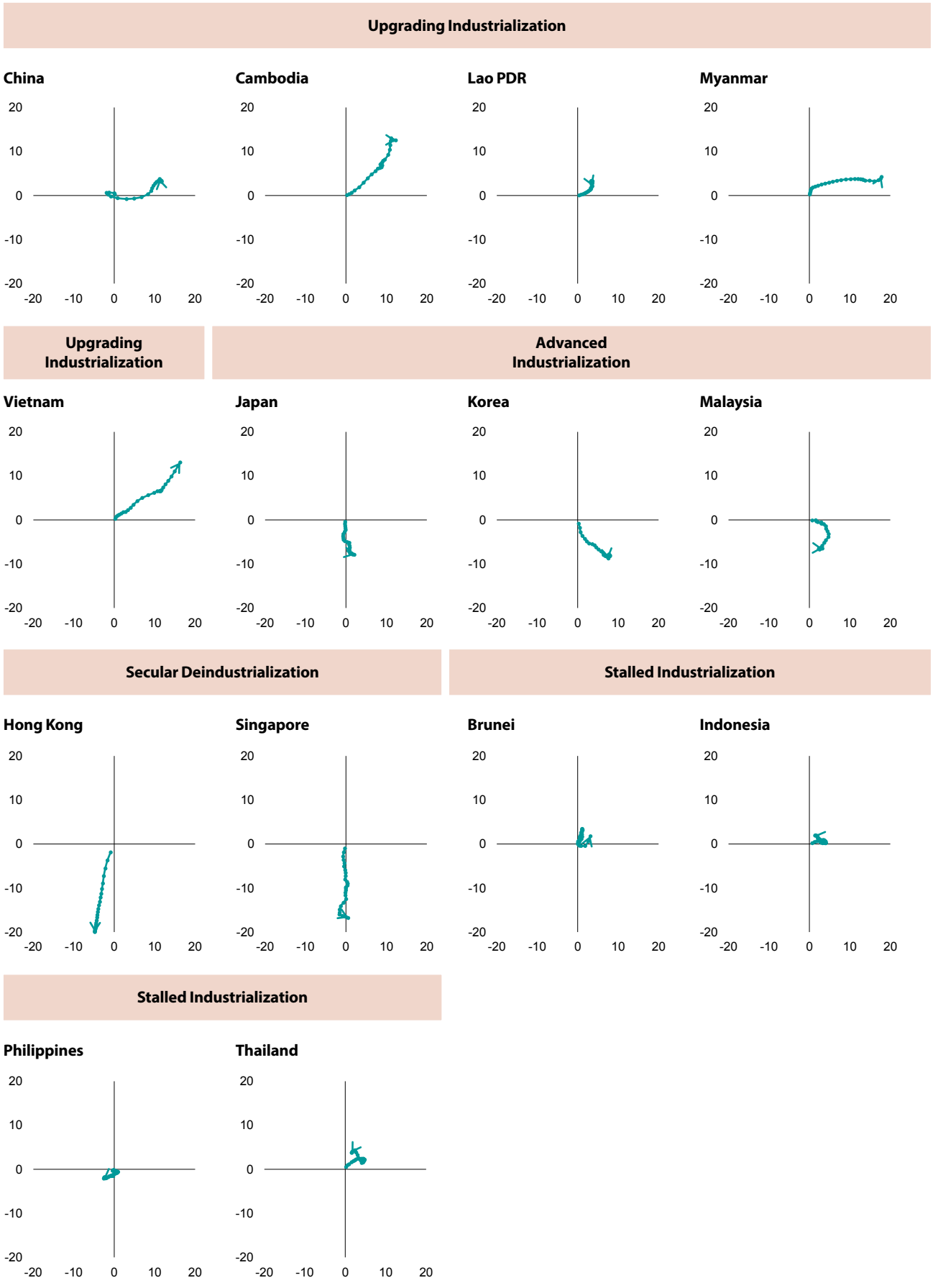
Figure A5.2 provides additional information about the phase of industrialization of individual ASEAN+3 economies.

Figure A5.1. Five Phases of Industrialization



Source: Kim and Sumner (2019); Alisjahbana and others (2022).

Figure A5.2. ASEAN+3: Phases of Industrialization Pattern, by Economy, 1995–2022
(Percent)



Source: Kim and Sumner (2019); Alisjahbana and others (2022); International Labour Organization; United Nations Industrial Development Organization; United Nations Statistics Division; AMRO staff calculations.
Note: Value-added and employment shares are five-year moving averages. Value-added is based on 2015 values. X-axis shows the change in manufacturing value-added share since 1995. Y-axis shows the change in manufacturing employment share since 1995.

Annex 6. Labor Productivity Distance to the Global Frontier

There are multiple ways to define the global productivity frontier (Andrews and others 2015, 2016). The common approach takes the top 5 percent or 10 percent of the productive sample for each sector and year. However, in this case, the number of frontier economies for each year could vary depending on the sample size, which potentially affects the implications when observing historical development. Another method is to use a fixed number, such as the top 10 or 20 most productive samples. This may alleviate any effects of the changing sample size. Nevertheless, it is important to note that the set of frontier economies changes over time in both approaches.

Section III defines the non-ASEAN+3 OECD members as comprising the frontier. Since the sample size of the economies in the data set used in this section is fixed throughout the year, the section could apply either of the above approaches. However, the most productive economies among the 178 samples tend to possess unique features, such as having a small population, or being rich in natural resources. Thus, the section selected the following OECD members as the proxy set, but excluded Korea and Japan, the subjects of analysis (Table A6.1). This way, the set of frontier economies used in for the analysis in Section III remains the same.

The distance to the global frontier compares the productivity level of each ASEAN+3 economy with that of the frontier, for agriculture, manufacturing, and services. The section first calculates each economy's sectoral labor productivity level, measured as the value added per employment. Second, the productivity level of the global frontier for each sector is computed as the weighted average of non-ASEAN+3 OECD economies, using sectoral value-added and employment size as weights. The distance to the global frontier (*DTF*) of economy *i* for sector *s* at time *T* is derived by comparing its sectoral productivity level (*P*) to that of the global frontier (*f*).

$$DTF_{i,s,,t} = \frac{P_{i,s,t}}{P_{f,s,t}} \quad (1)$$

For each sector, the productivity of an economy lags the global frontier if it is below 1 ($DTF_{i,s,,t}<1$); is at par with the frontier when 1($DTF_{i,s,,t}=1$); and is beyond the frontier when greater than 1 ($DTF_{i,s,,t}>1$).

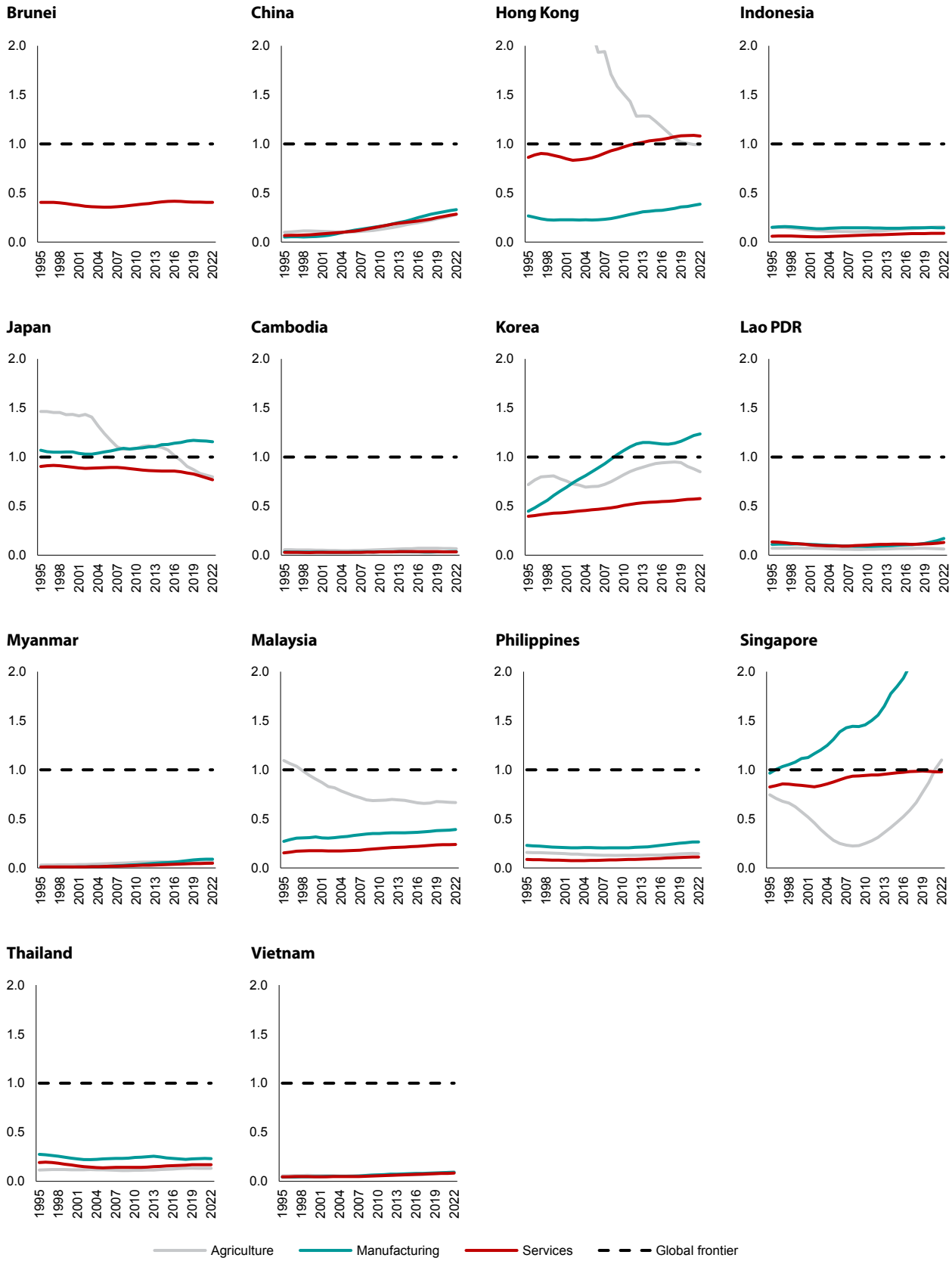
Figure A6.1 shows the historical development of labor productivity for ASEAN+3 economies in relation to the frontier.

Table A6.1. Non-ASEAN+3 OECD Members

Non-ASEAN+3 OECD Members			
• Australia • Austria • Belgium • Canada • Chile • Colombia • Costa Rica • Czechia • Denmark	• Estonia • Finland • France • Germany • Greece • Hungary • Iceland • Ireland • Israel	• Italy • Latvia • Lithuania • Luxembourg • Mexico • Netherlands • New Zealand • Norway • Poland	• Portugal • Slovak Republic • Slovenia • Spain • Sweden • Switzerland • Türkiye • United Kingdom • United States

Source: OECD; AMRO staff compilations.
Note: OECD membership is as of November 2024.

Figure A6.1. ASEAN+3: Labor Productivity Distance to the Frontier, by Economy
(Index)



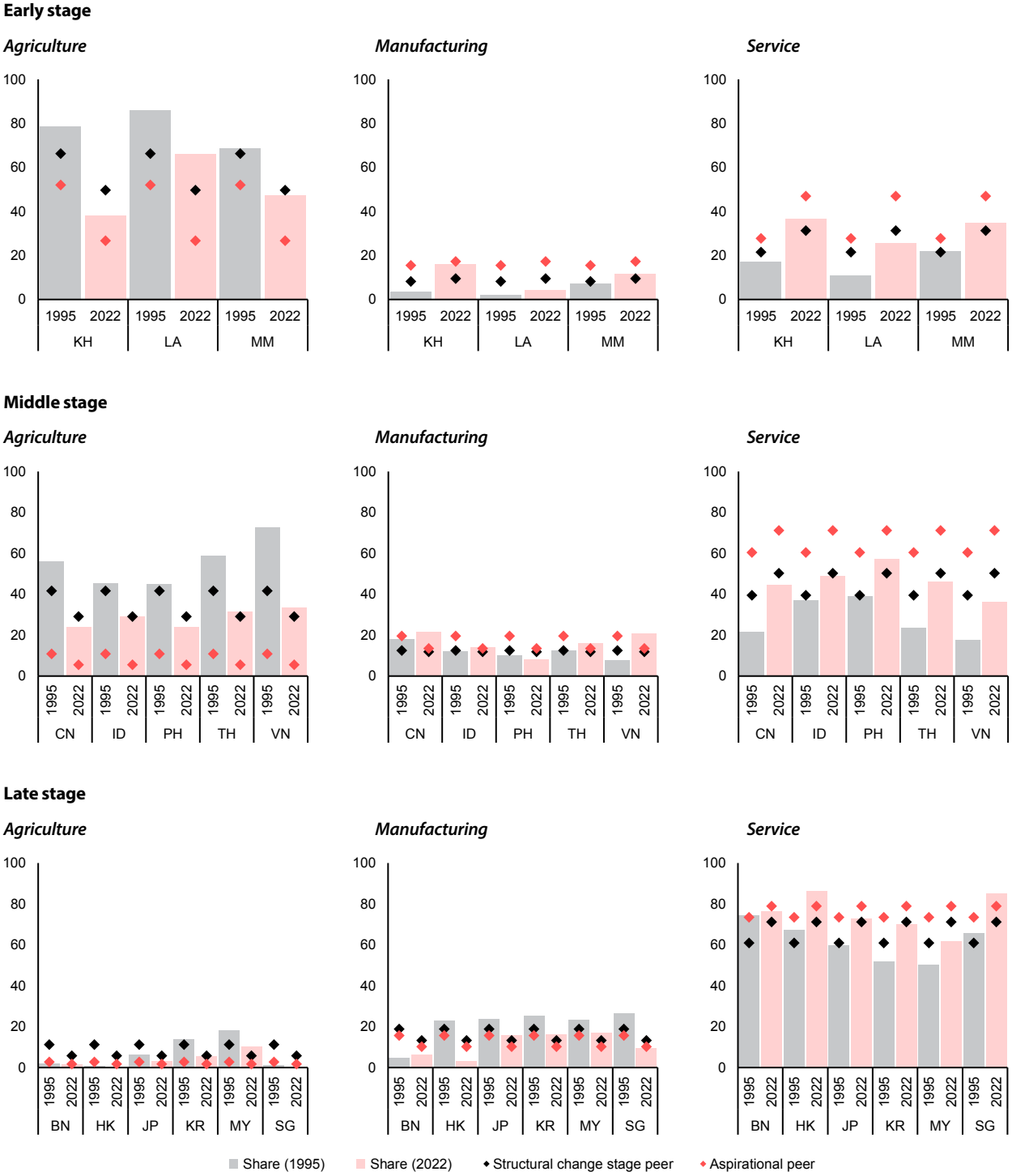
Source: International Labour Organization; United Nations Industrial Development Organization; United Nations Statistics Division; AMRO staff calculations.
Note: Labor productivity is measured as the sectoral value added per employment and is a five-year moving average weighted by the value-added at constant price and employment size. Global frontier refers to the weighted average of non-ASEAN+3 OECD members. Brunei's agriculture and manufacturing sectors, and Hong Kong's agriculture sector from 1995 to 2005 are not shown in the chart as their distance to the frontier is above 2.

Annex 7. Progress of Structural Change Relative to Peers

Two groups of economies are identified to assess the progress of structural change in ASEAN+3: those in the *same* stage of structural change ("stage peers") and those in the *next* stage of structural change ("aspirational peers"). For comparison, stage peers exclude ASEAN+3 economies while the aspirational peers include ASEAN+3 economies. For the "aspirational peer" of late-stage economies, the United States is selected as a proxy.

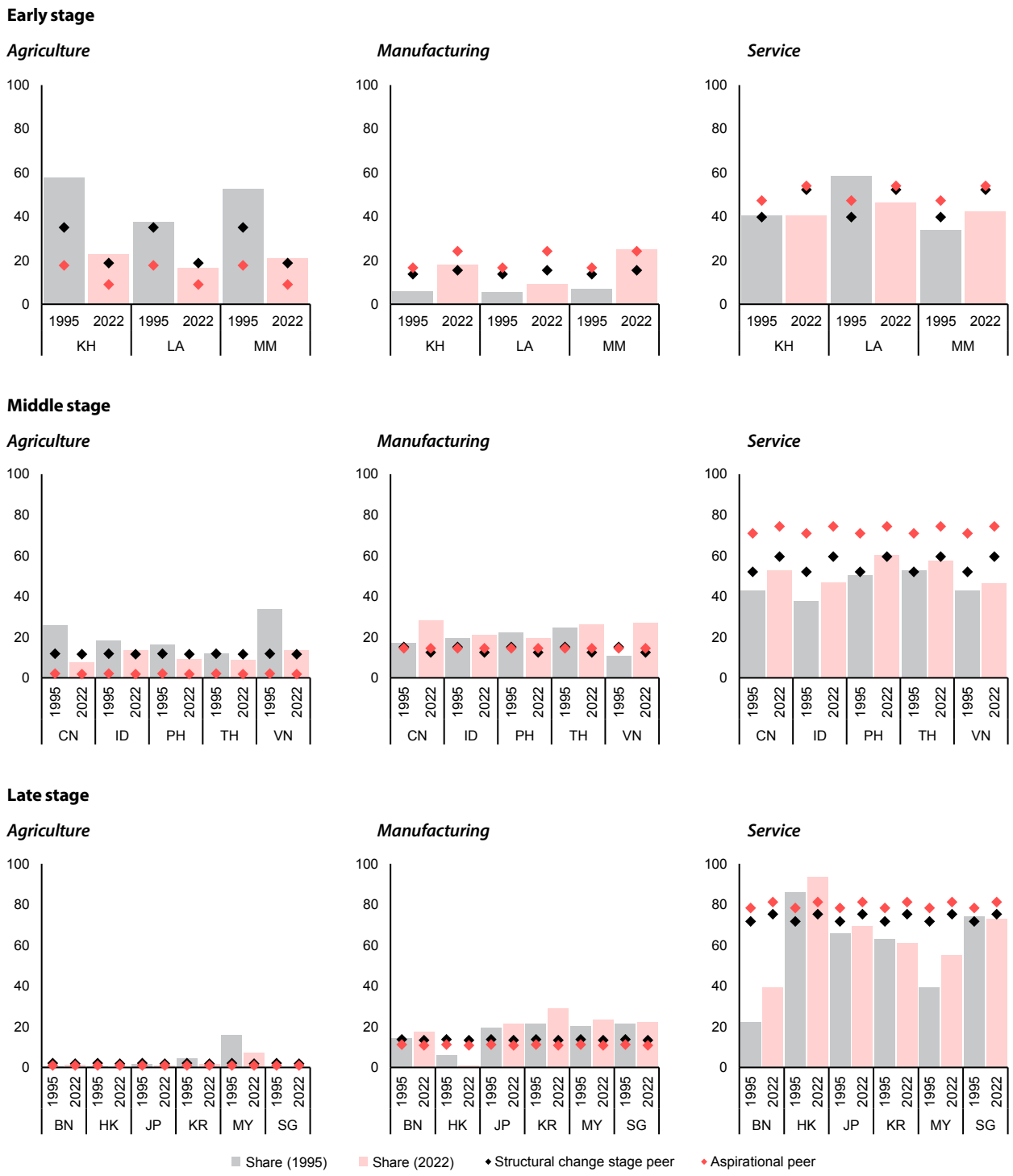
Figures A7.1 and A7.2 show ASEAN+3 economy comparisons with peers from 1995 to 2022.

Figure A7.1. ASEAN+3: Sectoral Employment Shares Relative to Peers
(Percent of total employment, five-year moving average)



Source: International Labour Organization; AMRO staff calculations.
Note: BN = Brunei; CN = China; HK = Hong Kong; ID = Indonesia; JP = Japan; KH = Cambodia; KR = Korea; LA = Lao PDR; MM = Myanmar; MY = Malaysia; PH = the Philippines; SG = Singapore; TH = Thailand; VN = Vietnam. China is included in the middle-stage group for brevity. Employment share is a five-year moving average weighted by the employment size. Structural change peer is the weighted average of the other economies in the same structural change stage. Aspirational peer is the weighted average of the economies in the proceeding structural change stage. For the late stage, the United States is the aspirational peer.

Figure A7.2. ASEAN+3: Sectoral Value-added Shares Relative to Peers
(Percent of total value-added, five-year moving average)



Source: United Nations Industrial Development Organization; United Nations Statistics Division; AMRO staff calculations.
Note: BN = Brunei; CN = China; HK = Hong Kong; ID = Indonesia; JP = Japan; KH = Cambodia; KR = Korea; LA = Lao PDR; MM = Myanmar; MY = Malaysia; PH = the Philippines; SG = Singapore; TH = Thailand; VN = Vietnam. China is included in the middle-stage group for brevity. Value-added share is a five-year moving average weighted by the GDP size. Structural change peer is the weighted average of the other economies in the same structural change stage. Aspirational peer is the weighted average of the economies in the proceeding structural change stage. For the late stage, the United States is the aspirational peer.

References

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