Box A: Carbon Pricing in Asia[1]

Introduction

Climate change caused by rising concentrations of greenhouse gases poses a significant challenge to modern societies and economies, creating a need for joint action to limit carbon emissions. Carbon pricing is a potentially effective policy tool to help facilitate the needed changes in fossil fuel energy use.

Carbon pricing has not been as widely adopted in Asia as in some other parts of the world, due in part to implementation challenges and concerns over its potential impact. This Box analyses how higher carbon prices in Asia would affect specific industries, through both direct and indirect channels. While the estimated economic impact could be non-trivial, simulations using a global macro model show that other policies can be adopted to mitigate some of the negative near-term effects.

Current State of Carbon Pricing in Asia

Countries in Asia have adopted various approaches to carbon pricing. The most common is via an emissions trading system (ETS), which China, Japan, Korea, and Indonesia have adopted. China operates both a national ETS, covering the power sector, and eight regional ETS pilots that focus on other parts of the economy, including transport, industry, and buildings. Korea has a national ETS covering sectors such as waste, aviation, industry, and power. In addition to its two subnational ETS in Tokyo and Saitama, Japan implemented a new voluntary ETS in October 2023, which is expected to transition into a mandatory national ETS in 2026. In ASEAN, Indonesia recently launched its ETS in 2023. While this scheme currently covers only coal-fired power plants, Indonesia aims to expand its scope over time.

In comparison to an ETS, carbon taxes have been less widely used across Asia, but interest in this approach is gaining traction. Japan introduced a carbon tax in 2012, but the rate has remained very low, at around USD 2 per tonne of CO2-equivalent (tCO2e). Singapore was the first in ASEAN to implement a carbon tax in 2019, with plans to increase the current rate of USD 20/tCO2e gradually in the next six years, to reach USD 38–60/tCO2e by 2030. Thailand recently announced the imposition of a carbon tax of about USD 5.5/tCO2e from 2025—only on oil products for now, such as diesel and gasoline—making it the second ASEAN economy to utilise this instrument. Indonesia had also planned to introduce a carbon tax in 2022 but postponed the implementation to 2025 due to the still-weak global environment and volatile energy prices at that time (Teja, 2023).

Other countries in the region—including Malaysia, the Philippines, and Vietnam—are currently assessing or planning the introduction of carbon pricing instruments to align with their commitments to the Paris Agreement. Malaysia will introduce a carbon tax for the iron and steel industries by 2026, while Vietnam plans to launch a pilot ETS on a voluntary basis in 2026. Thailand's draft Climate Change Act, once approved, will also formally establish the rules and mechanisms for a domestic ETS. Among smaller ASEAN economies, Brunei and

---

[1] This Box is a collaborative project between economists in the ASEAN+3 Macroeconomic Research Office (AMRO) and EPG, MAS, and does not necessarily represent the official views of AMRO or MAS.

Lao People's Democratic Republic (Lao PDR) are currently studying the feasibility of carbon prices.

In addition to these explicit carbon pricing schemes, many countries in the region—such as Indonesia, Lao PDR, the Philippines, Singapore, Thailand and Vietnam—are already imposing indirect carbon taxes, for example through excise duties on fuel (Asia Foundation, 2023).

Assessing the Impact of Carbon Pricing on Industries in Asia

In general, higher carbon prices raise the cost of fossil fuel-based energy and thereby production costs in an economy. The higher relative costs of such fossil fuels should incentivise substitution to greener energy alternatives and more energy efficient technologies. At the same time, the increase in production costs has a negative income effect and could weigh on the output of the affected industry sector in the short term, which would cascade through the economy as a whole.

The analytical exercise below shows how a more extensive adoption of carbon pricing across Asia would feed through industry linkages using an input-output (IO) framework. This is an important perspective as sectors face differing costs from the implementation of carbon taxes, depending on the impact on their production structures. Based on how much of this cost burden is passed on to output prices, certain commodities or services will also experience a fall in demand as the market moves towards less carbon-intensive substitutes.

Carbon Tax Assumptions and Country Coverage

To conduct this analysis, country-level carbon tax rates are computed from the Net Zero 2050 scenario provided by the Network of Central Banks and Supervisors for Greening the Financial System (NGFS).[2] This is NGFS' most ambitious scenario, where net CO2 emissions reach zero around 2050 through stringent polices, and global warming is limited to 1.5° Celsius. In this scenario, carbon prices are assumed to increase by between USD 160 and USD 315 per tonne of CO2e in nine Asian economies in the short run,[3] depending on the country. The nine economies (Asia-9) examined can be grouped into the five middle-income economies—China, Indonesia, Malaysia, the Philippines and Thailand (henceforth MI-5)—and the four high-income economies—Hong Kong, Korea, Japan and Singapore (henceforth HI-4).

Input Output Analysis: Methodology

Leontief input-output analysis is employed to calculate a first-order estimate of the sectoral and economy-wide effects of the carbon taxes. This linear approach[4] provides useful

2 In particular, NGFS defines this as a scenario where "ambitious climate policies are introduced immediately," including new technologies to accelerate decarbonization. See NGFS (2024) for further details on the scenarios.

3 A carbon tax of USD 162/tCO2e is assumed for Korea, Malaysia, Philippines, Singapore, and Thailand. For China and Hong Kong, the price is assumed at USD 208/tCO2e, while for Japan, the price is set at USD 315/tCO2e. To be consistent with the Net Zero 2050 scenario, these are assumed to be in place by end-2026.

4 The approach implicitly assumes that supply is fully elastic, demand is downward sloping, and that there is no factor substitution in production, thereby providing an upper-bound estimate of the impact of the proposed carbon tax.

sector-by-sector insights and a comprehensive picture of the downstream effects of a large tax shift.

In the first step, estimating the price impact from implementing the Net Zero 2050 scenario requires an assumption on the *post-carbon tax* change in factor costs ($\Delta\mathbf{f}'$), for each industry. The increase in factor costs arising from the tax hike can be approximated by multiplying the new carbon prices with industry-specific CO2e emissions levels for each economy. Sector-level carbon tax rates are computed to provide an initial estimate of the increase in the cost of production.

In the next step of the procedure, the presumed carbon tax is incorporated in a vector of the changes in factor costs ($\Delta\mathbf{f}'$) for each industry.[5] Using the Leontief input-output table of coefficients, $\mathbf{A}$, the change in prices ($\Delta\mathbf{p}'$) of output of each industry is computed as:

$$\Delta\mathbf{p}' = \Delta\mathbf{f}' \cdot [\mathbf{I} - \mathbf{A}]^{-1} \quad (1)$$

where $\mathbf{I}$ is the diagonal identity matrix. Demand elasticity assumptions were imposed to calculate the vector of the effects of the imputed price changes on final demand ($\Delta\mathbf{x}$). Then the vector of industry-by-industry changes in total output ($\Delta\mathbf{q}$) (and therefore in total revenues) can be calculated as:

$$\Delta\mathbf{q}' = [\mathbf{I} - \mathbf{A}]^{-1} \cdot \Delta\mathbf{x} \quad (2)$$

The analysis was implemented across 35 industries for Asia-9 economies, which includes 14 industries in manufacturing, 19 in services and the remaining covering agriculture and mining. This follows the structure of the Asian Development Bank's (2023) Multiregional Input-Output Tables, from which the latest available data for 2022 were used for this exercise.

Input-Output Analysis: Results

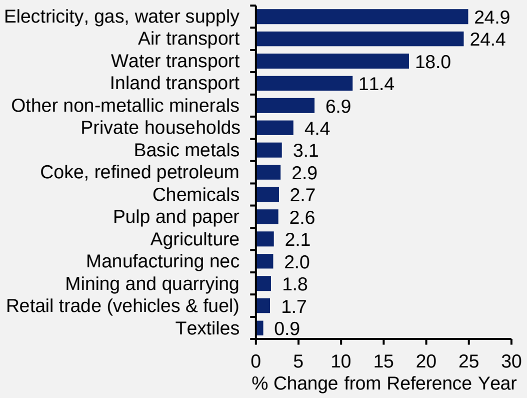
Accounting for about 80% of Asia-9's CO2 emissions, the utility sector will face the highest average effective carbon tax rates under the Net Zero scenario **(Chart A1)**. This is followed by the transport sector, particularly aviation and shipping. The initial, substantial increase in producer prices will be primarily concentrated in a few sectors, mostly within the five most carbon-intensive industries. Nevertheless, the overall increase in prices is primarily driven by the carbon tax hike's *indirect* impact, rather than the *direct* rise in factor costs **(Chart A2)**. The tight industry linkages in Asia-9 will play a key role in transmitting the impact of carbon prices to the rest of the economy via higher *intermediate* input costs.[6] Clearly, transition costs can spread beyond individual industries, with economy-wide implications.

---

[5] The factor cost, which comprises all primary costs (including wages) is a ratio of total value added (including imports) to total output, per industry. Note that the value added row vector in IO accounting includes taxes, and so a new tax policy—in this case, a carbon price hike—will induce an increase in factor costs.

[6] Whereas the derived sector-level carbon tax rates can be viewed as the *direct* price effect of the tax, there is also the *indirect* effect: those arising from higher *intermediate input* prices passed on by supplier industries that similarly face a carbon tax.

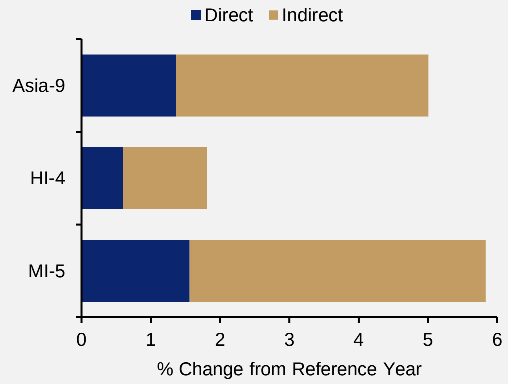
Chart A1 Sectors with highest average carbon taxes in the Net Zero scenario



Source: Global Trade Analysis Project, ADB

Note: Chemicals include chemical products. Private households are those with employed persons. "nec" refers to "not elsewhere classified".

Chart A2 Impact on overall producer prices in the Net Zero scenario



Source: AMRO staff calculations

For most normal goods, price increases will translate into lower demand for a sector's goods or services, and consequently, revenues. Lower profits can weigh on the affected sector's demand for goods from other upstream sectors, depending on inter-industry production linkages. To gauge which Asia-9 sectors could face the largest revenue declines, two different demand scenarios are examined: (1) a *moderate* decline in demand (MS) and (2) a *severe* fall in demand (SS). The two differ in terms of price elasticity assumptions to help illustrate a range of potential industry output losses as a result of a carbon tax, considering the different degrees of price elasticity of demand for different goods and services. The first scenario assumes demand is inelastic except for a subset of industries that produce goods or services whose demand is more discretionary in nature, which are assumed to have unitary elastic demand. The second scenario extends this assumption of unitary elastic demand to all sectors.[7]

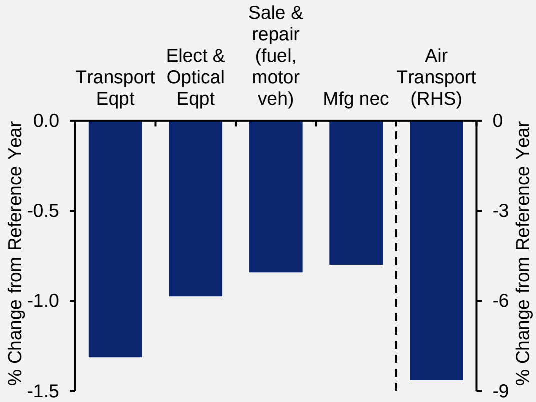
Under a *moderate* demand shock scenario, the large revenue losses from both direct and indirect effects will cut across Asia-9 manufacturing—especially the transport equipment, furniture, and electronics industries—as well as services, especially aviation **(Charts A3 and A4)**. In MI-5, services related to tourism and travel, as well as to transport equipment could face significant revenue declines, especially as the transportation sector remains as one of the largest emitters in the region. Under the *severe* scenario where final demand for all sectors is equally responsive to the carbon price increase, the most carbon-intensive industries would experience the largest revenue losses: utilities, transport services, and the manufacturing of fuels, minerals, metals, and chemicals. Revenue losses across Asia-9 could be up to 1.5 times higher in the case where indirect effects through the supply chain are fully considered **(Chart A5)**.

It is crucial to note that the resulting IO estimates can only be interpreted as the first-order, short-run effects of any tax policy, i.e., it does not consider substitution in response to

[7] As in Kay and Jolley (2023), the *moderate* decline in demand scenario assumes $\Delta p' = \Delta x$ (unitary elastic demand) for a subset of 11 sectors. For the other sectors, demand is assumed to be inelastic, and a change in pricing will not impact final demand or revenues. The *severe* scenario assumes $\Delta p' = \Delta x$ for all 35 sectors; that is, the change in price caused by the carbon tax will lead to a decline in final demand—of the same magnitude—for all sectors of the economy.

higher prices by firms. The Leontief model does not take into account any factor substitution or changes in production linkages in response to the increase in carbon prices. Therefore, the estimated price changes and revenue losses represent upper bounds as in Perese (2010). Economic agents will adjust their behaviour and preferences over time to adopt cheaper, less carbon-intensive alternatives. To the extent that this switch helps offset (some of) the additional burden from higher carbon taxes, the overall cost will be less than the estimates presented here. This would depend on (1) the transition period of the policy; and (2) the wider availability and reliability of "clean" alternatives for households and firms to switch into, which could be achieved with the help of technology.

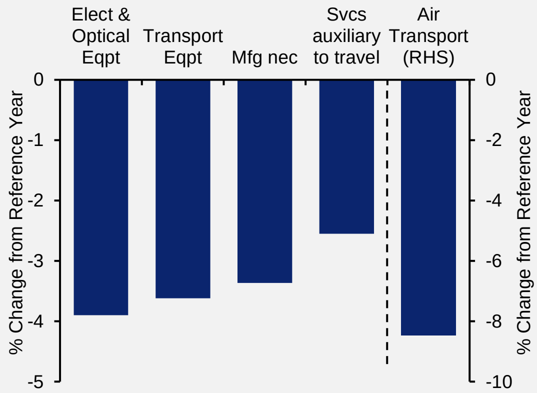
Chart A3 HI-4: Sectors with highest revenue impact



Source: AMRO staff calculations

Note: "nec" refers to "not elsewhere classified".

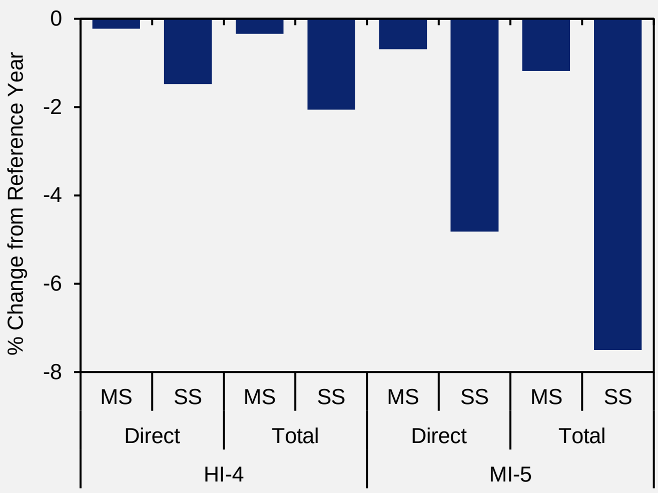
Chart A4 MI-5: Sectors with highest revenue impact



Source: AMRO staff calculations

Note: "nec" refers to "not elsewhere classified".

Chart A5 Estimated corporate revenue impact in Asia-9



Source: AMRO staff calculations

Note: The difference between the "direct loss" and the "total loss" corresponds to the "indirect loss", which represents all corresponding reduction in supply chain activity across the entire economy. MS = moderate scenario; SS = severe scenario.

Policies to Mitigate the Impact of Carbon Pricing

Notwithstanding the upper-bound negative impact presented above, there are complementary policies that governments in the region can adopt to mitigate the effects of adopting a transition policy centred on carbon pricing.

To assess these policy options, an integrated global model, Oxford Economics' Global Economic Model (GEM) is used. The GEM is a global, general equilibrium model with Keynesian features in the short run and neo-classical properties in the long run. It contains carbon tax levers that generate fiscal revenues, alongside fiscal and other policy instruments that can be adjusted. Being a global model, it also captures trade and financial linkages between economies.[8] However, it is important to note that the longer-term substitution effects and production process changes that would arise due to higher carbon prices are not endogenously captured in the GEM. Three key observations emerged from the model simulations.

First, policies to use the additional revenues collected from the carbon tax, also known as "revenue recycling", can substantially offset the drag on output from higher carbon taxes. For instance, governments could increase transfers to households, boosting private disposable incomes and household spending, or increase government investment, which also has positive externalities of inducing increases in private investment, especially in many emerging Asian economies. Model simulations show that if the additional revenue from carbon taxes is fully recycled, it can offset around 55–65% of the impact that carbon taxes alone could potentially have on aggregate output. The offset could be larger if the fiscal spending is specifically targeted at initiatives such as public infrastructure that would support green investment or household transfers to encourage the purchase of more energy-efficient appliances.

Second, if Asia-9 economies also pursue a drive to boost renewable capacity as carbon taxes induce higher demand for renewable sources of energy, overall energy prices should fall and support output in the economy. There is some evidence that public spending in green investments can raise private investment through positive externalities and market creation effects. Deleidi *et al.* (2019) investigated the effect of public direct investment on private investment in renewable electricity technologies for 17 countries over 2004–14 and found that public investments not only had a positive but also consistently the largest effect on private investment flows relative to feed-in tariffs, taxes, and renewable portfolio standards. Model simulations show that a 50% increase in electricity output from renewable sources will support output modestly, offsetting about 15% of the drag from carbon taxes alone. An efficient way to boost the supply of renewable energy is by importing it, particularly for resource-constrained economies (such as Hong Kong and Singapore) with limited renewable energy options domestically.

Third, the additional fiscal spending that is enabled through recycling carbon tax revenues also creates positive spillovers to other economies via trade linkages. In a simulation where *all* Asia-9 economies implement a combination of higher public investment and household transfers as described above, the additional final domestic demand supports the exports of trading partners, including outside of Asia. This stimulates second-round

---

8 The simulations were undertaken in the version of the GEM with a ten-year forecast horizon. For more details on the GEM, please refer to Oxford Economics (2021) and Oxford Economics (2022).

spillback effects to economies implementing carbon taxes with recycling. The simulation shows that such spillovers could help offset the drag from carbon taxes by as much as 20%.

Conclusion

This Box highlights the potential impact on output of carbon pricing in Asia-9, particularly for industries and economies that are currently more reliant on carbon-intensive energy sources. Even as the incidence of carbon pricing may initially fall disproportionately on a few key sectors, the impact will cascade through production interlinkages, further affecting sectors not directly impacted by the initial energy price shock. As such, the use of climate transition policies—undoubtedly urgently required—would need to be sensitive to both the direct and indirect sectoral and distributional effects, while still preserving the important price signal embodied in carbon prices that would help economies move towards net zero. This will be especially crucial for economies with a large number of small- and medium-sized enterprises in the supply of intermediate goods or services, which would have less capacity to react to sizeable price shocks.

More importantly, the negative impact of carbon pricing on an economy's output can be mitigated to a significant extent by the design of accompanying government policies and measures. Recycling carbon tax revenue as household transfers and government investment are useful levers in this domain. There are also considerable positive spillovers across the region if more economies adopt similar policies, including those that support investment in renewable energy capacity. Ultimately, a clear and predictable timeline of policy implementation and regional cooperation would help to manage both the impact and risks of the climate transition that must be undertaken.

References

Asia Foundation (2023), "The State of Carbon Pricing in Southeast Asia" (URL: https://asiafoundation.org/publication/the-state-of-carbon-pricing-in-southeast-asia/).

Deleidi, M, Mazzucato, M and Semieniuk, G (2019), "Neither Crowding In nor Out: Public direct investment mobilising private investment into renewable electricity projects", *UCL Institute for Innovation and Public Purpose Working Paper* No. 2019-10.

Kay, D and Jolley, G J (2023), "Using input–output models to estimate sectoral effects of carbon tax policy: Applications of the NGFS scenarios", *American Journal of Economics and Sociology*, Vol. 82(3), pp. 187–222.

Network of Central Banks and Supervisors for Greening the Financial System (2024), "Climate Scenarios" (URL: https://www.ngfs.net/ngfs-scenarios-portal/explore/).

Oxford Economics (2021), *Climate Change in the GEM.*

Oxford Economics (2022), *Oxford Economics Global Economics Model.*

Perese, K (2010), "Input-Output Model Analysis: Pricing Carbon Dioxide Emissions", *Congressional Budget Office Working Paper* No. 2010-04 (URL: https://www.cbo.gov/sites/default/files/111th-congress-2009-2010/workingpaper/2010-04-io_model_paper_0.pdf).

Teja, N (2023), "Indonesia Working on Plan for Delayed Carbon Tax Legislation.", *Bloomberg Tax*, October 9. (URL: https://news.bloombergtax.com/daily-tax-report-international/indonesia-plans-carbon-tax-legislation-eyes-year-end-roll-out)

Data

Asian Development Bank, 2023, "Multiregional Input-Output Tables", Data set (URL: https://www.adb.org/what-we-do/data/regional-input-output-tables).

Network of Central Banks and Supervisors for Greening the Financial System (2023), "NGFS Scenarios for Central Banks and Supervisors", Data set.