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March 2021

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REPUBLIC OF KOREA

SELECTED ISSUES

March 3, 2021

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ASSESSMENT OF POTENTIAL OUTPUT AND OUTPUT GAP[1]

Potential growth was already slowing before COVID-19. Initial evidence from the pandemic, along with the experience from other countries and previous recessions in Korea, suggests that the pandemic is likely to have an additional negative impact, though milder than after past downturns due to the smaller initial decline in activity and the resilient performance of investment. Staff estimates that the COVID shock will temporarily bring potential growth below 2 percent before a modest recovery to about 2¼ percent in the medium term under current policies, albeit with a wide range of uncertainty. The estimates yield an output gap of about 2.5-3 percent of GDP in 2020, with sizable economic slack also apparent in other indicators. While a near-term slowdown in potential growth appears unavoidable, staff estimates suggest that implementing reforms to facilitate reallocation of resources across sectors and increase labor utilization could offset much of the shock's medium-term impact.

1. Pre-COVID potential output was projected using two models. These were a production function model and a multivariate filter (MVF) that incorporates labor force participation, capacity utilization, and Consensus Forecasts for GDP growth and inflation as in Alichi (2015). Pre-COVID historical values and forecasts for underlying inputs were used as they existed in January 2020.

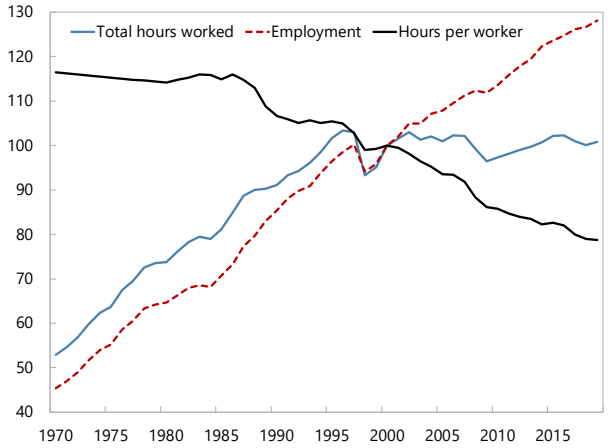
2. These estimates incorporate the ongoing slowdown in labor inputs. The contribution from a growing working-age population outweighed that of the steady reduction in hours per worker to keep aggregate hours worked increasing until the late 1990s, since which time total hours worked have stagnated (Figure 1). Looking to the future, the shrinking population and increase in the share of the elderly would have weighed on growth in the number of workers even in the absence of any shocks. With hours per worker remaining above comparators and recent policy efforts to lower maximum work hours, a continued decline also seems probable. Educational attainment has risen substantially to high levels in recent decades, suggesting that the pace of further increases is likely to level off. The projections in both models capture these factors by estimating labor force participation propensities for detailed age-gender cohorts that account for education and prior history of participation for each cohort.

3. Potential growth was slowing before the COVID-19 shock, with projections of a continued gradual decline driven by lower growth in labor inputs. Both approaches show a deceleration in potential growth from 7 percent in the mid-1990s to pre-COVID estimates for 2019 of 2.4 and 2.7 percent for the MVF and production function, respectively (Figure 2). These results are comparable to a pre-COVID Bank of Korea study which estimated potential growth at 2.5–2.6 percent for 2019–20 (Kwon and others, 2019). Pre-COVID, the models would have projected potential growth at about 2.2–2.4 percent in the 2020's before declining to reach about 2 percent per year in the 2030's, similar to projections in OECD (2018) and Zoli and others (2018). Falling labor inputs directly account for a large share of this slowdown.

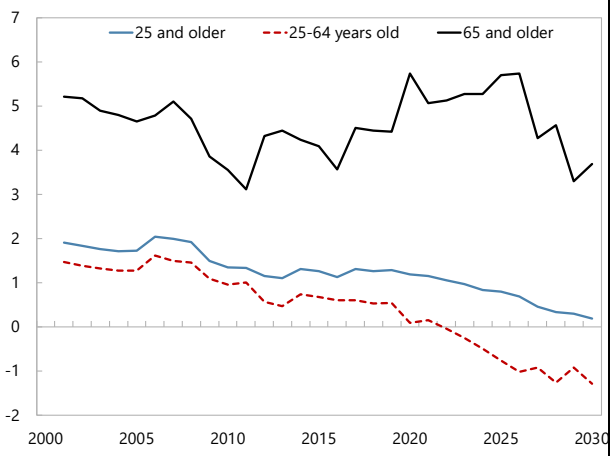
[1] By Andrew Swiston. Based on "*Korea's Growth Prospects: Overcoming Demographics and COVID-19*," forthcoming IMF Working Paper.

Figure 1. Labor Inputs

Measures of labor utilization
(index, 2000=100)



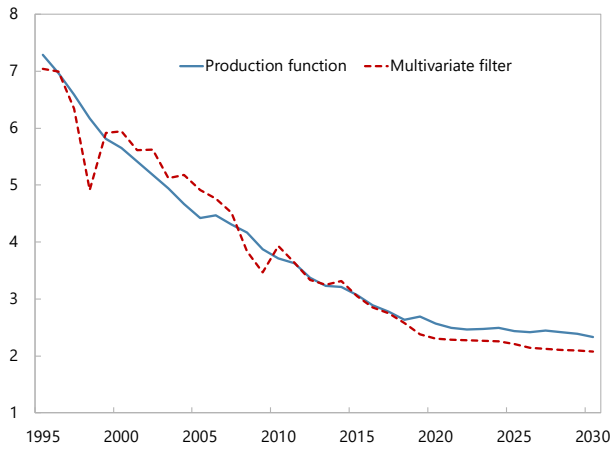
Population growth and projections
(annual percent change)



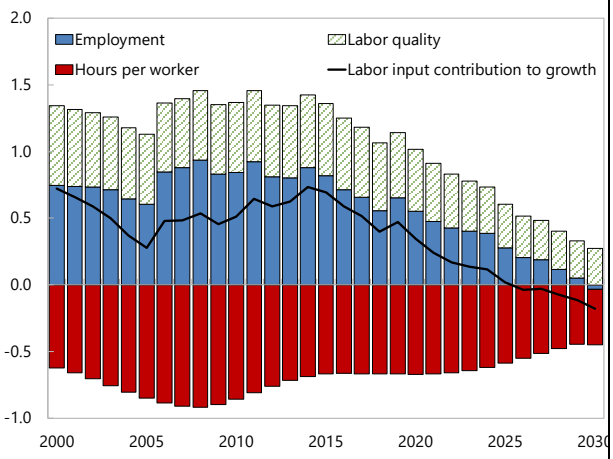
Sources: National sources; OECD; Haver Analytics; and IMF staff calculations.

Figure 2. Potential Output Estimates and Projections Excluding COVID-19 Impact

Potential output estimates and projections
(y/y percent change)



Labor input contributions to potential growth
(percentage points; production function model)



Sources: National sources; Haver Analytics; OECD; Penn World Table; and IMF staff calculations.

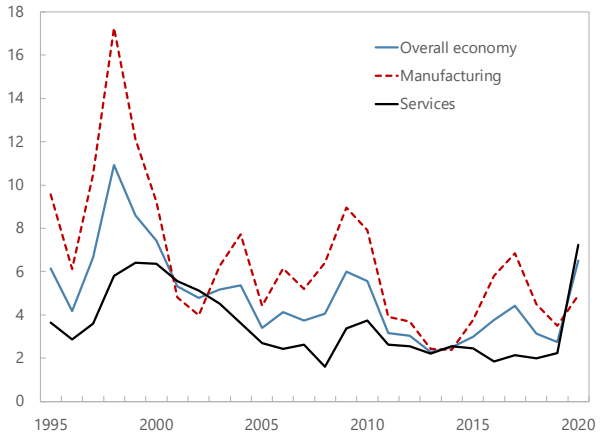
4. The effects of COVID-19 on economic activity have been heterogeneous across industries, raising the possibility of persistent structural impacts. Manufacturing activity experienced a sharper initial fall due to supply chain disruptions and shutdowns in trading partners, but by end-2020 rebounded to exceed its pre-COVID peak. By contrast, services activity experienced a milder initial decline and more sluggish recovery. A reallocation index was calculated using the measure developed by Lilien (1982), applied to *X*, real GDP, in the following equation:

$$Reallocation_t = \left[\sum_{i=1}^{n} w_i \left(\frac{\ln(x_{i,t}) - \ln(x_{i,t-1})}{\ln(X_t) - \ln(X_{t-1})}\right)^2\right]^{1/2}$$

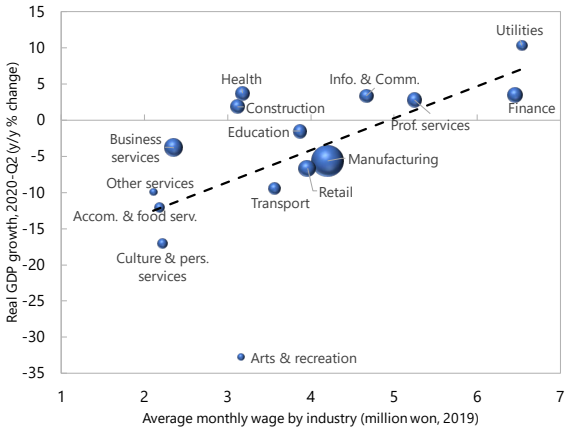
In qualitative terms, this measures the degree to which sectoral growth rates diverge from overall economic growth, capturing the speed at which the structure of the economy is changing. Figure 3 shows how the overall degree of reallocation during COVID-19 is higher than during the Global Financial Crisis (GFC), surpassed only by that during the Asian Financial Crisis (AFC). A distinctive feature of the current shock has been that it has higher reallocation within services. Figure 3 also shows that the effects have been greatest in relatively low-wage industries, in which adaptability to abrupt structural transformation may be lower. Overall, while the size of the recession in 2020 was smaller than previous ones in Korea, it could generate a relatively substantial degree of structural transformation if the above effects persist. This could lead to scarring, in which some workers remain out of the labor force as structural shifts and/or extended periods without employment lead their skills to become obsolete.

Figure 3. Heterogeneous Impact of COVID-19 Shock Across Sectors

Reallocation of activity across sectors
(index, higher values signify faster pace of change)



COVID-19 impact by industry wage level
(bubble size shows industry share in real GDP)

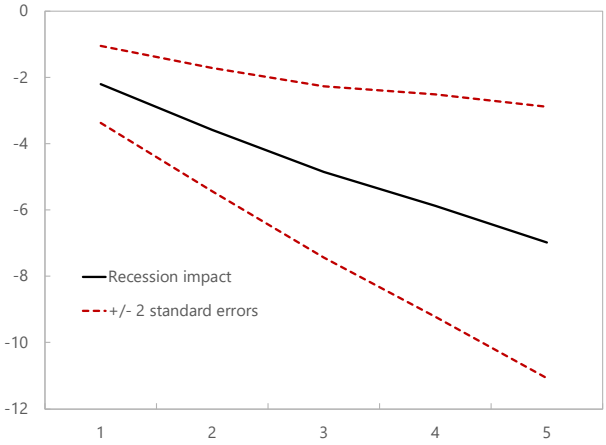


Sources: National sources; Haver Analytics; and IMF staff calculations.

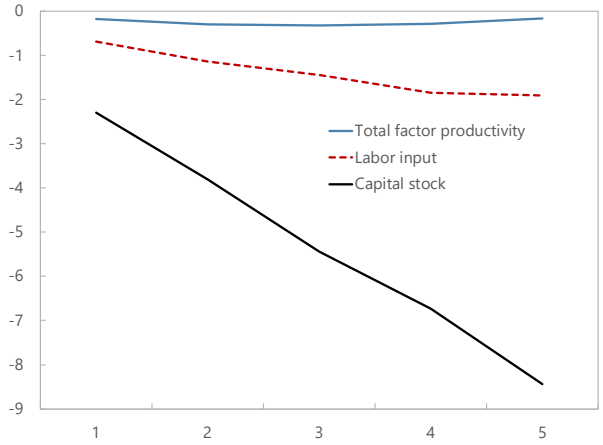
5. Previous recessions in Korea have had a sizable negative impact on potential output (Figure 4). The effects of previous recessions on potential output and each of its components were estimated out to a five-year horizon using the local projections method of Jordà (2005) and Teulings and Zubanov (2014). The approach also accounts for the magnitude of the shock by using an autoregressive model to estimate the growth surprise associated with each recession. Potential output fell in the immediate aftermath of previous recessions and the potential growth rate remained below the pre-recession rate for five-six years before normalizing. This persistent impact likely reflects the prolonged adjustment of inputs to their new steady-state values, as most of the impact on potential was through lower investment and labor force participation rates while post-recession TFP tended to be resilient.

Figure 4. Effects of Previous Recessions on Potential Output

Impact of recessions on potential output
(percentage points, cumulative; years since recession)



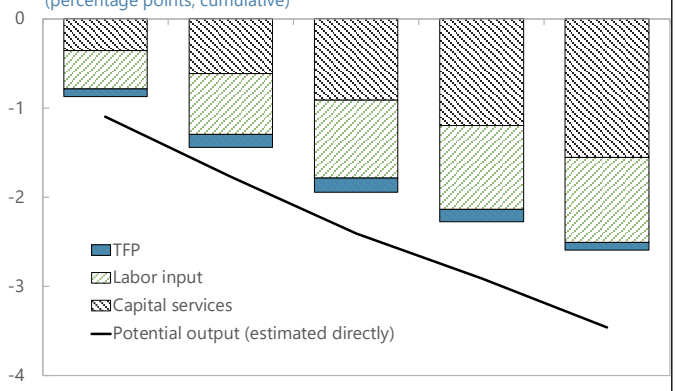
Impact of recessions on factors of production
(percent, cumulative; years since recession)



Source: IMF staff calculations.

6. These results suggest a moderate impact on potential of the COVID-19 shock. Using previous recessions as a benchmark but scaling the current episode for its smaller effects on overall output, the estimated impact on potential ranges from 2.5 to 3.5 percent (Figure 5). The lower end of the range was obtained by aggregating the estimated impact from each factor of production and the upper end from the estimate using overall output directly. The effects on the growth rate of potential output are largest in the immediate aftermath of the shock, with a slow normalization back toward the previous potential growth rate. This is principally due to the historical experience of lower investment rates over the medium term and thus slower capital accumulation, and secondarily to lower labor force participation.

Figure 5. COVID-19 Impact on Potential Output
(percentage points, cumulative)



Source: IMF staff calculations.

7. Unique factors operating during this episode will influence the degree of scarring. These include: 1) the synchronized, global nature of the shock which may suggest a larger impact as potential in other economies is also affected; 2) the large policy response in Korea which may buffer the medium-term impact; 3) the sudden stop in cash flows for many firms due to shutdowns early in the outbreak; and 4) deeper structural shifts in the organization of supply chains and in demand across sectors. These latter two factors could lead to scarring through destruction of firms and worker-firm relationships, mismatch of workers' skills with available employment opportunities, and uncertainty and worsening in balance sheets that together constrain investment. These transmission channels are highly relevant for

Korea given the large proportion of SME debt for which firms' cash flows do not cover debt service, and Korea's product and labor market rigidities which may place frictions on the adjustment of supply toward new sectoral patterns of demand, especially in the services sector. On the other hand, transmission through investment may be smaller than after the late 1990's recession, in which a financial system crisis factored significantly. There could also be some positive effects on growth, as Korea has great potential to capitalize on the shift toward the digitalization of economic activity given its well-developed high-tech industry, strong digital infrastructure, and high rates of digital penetration. Initial data suggests investment has thus far been resilient, supported by the strong demand for Korea's high-tech exports. By contrast, the exit of workers from the labor force, if it persists, implies the possibility of scarring.

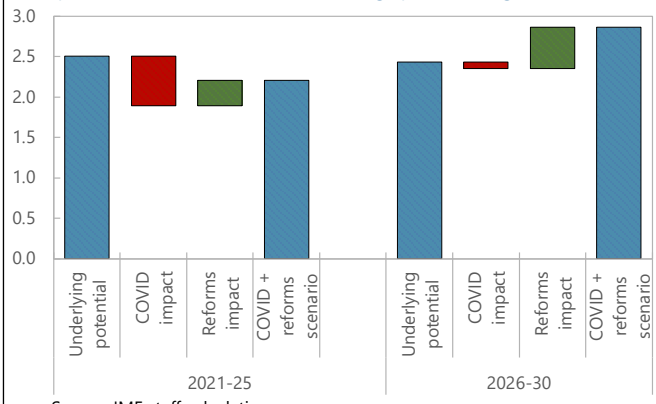
8. Taking into account the features of the current episode and historical experience, staff projects potential growth temporarily dipping below 2 percent before a modest recovery to about 2¼ percent in the medium term, albeit with a wide range of uncertainty. This combines the above pre-COVID projection and the estimated impact of the COVID-19 shock, including an adjustment to take into account that the recession in 2020 was smaller than the average of Korea's previous three recessions. The near-term potential output estimate also incorporates the effects of shutdowns and re-openings, leading to a temporary dip in potential growth in 2020 and rebound in 2021. The potential growth rate is then projected to drop below 2 percent before normalizing by 2026. As this episode is unique, with its full effects yet to be experienced, any assessment is necessarily preliminary. There is also uncertainty surrounding the quantitative estimates, as the standard errors of the two approaches discussed above encompass a medium-term impact of between 1½ and 5 percent. The size and speed of the ongoing recovery will also influence assessment of the degree to which the effects are temporary or longer-lasting.

9. Given the immediate impact on actual output and effects on potential output that cumulate over time, the output gap is estimated to have widened to about 2.5-3 percent of GDP in 2020. This estimate embodies the same uncertainty described above regarding decomposition at this early stage of the shock's impact into temporary components not affecting potential and longer-lasting effects that will. Nevertheless, the output gap estimate is consistent with the cumulative projected actual growth in 2019–20 of about 1 percent, employment and labor force participation that remain below previous trends, measured capacity utilization in manufacturing below pre-COVID levels, and absence of price pressures reflected in low underlying inflation and below-target inflation expectations.

10. The drag of COVID-19 on potential output heightens the urgency of reforms to facilitate reallocation of resources toward fast-growing sectors and increase labor utilization. Restrictive regulations in product and labor markets have long been highlighted as a factor explaining Korea's low productivity in services and among small firms, and longstanding recommendations to reduce regulations and increase labor market flexibility remain pending (IMF, 2019; OECD, 2018; Vitale and others, 2020; World Economic Forum, 2019). To quantify the potential impact of reforms, a scenario was elaborated using empirical estimates from Kim and Loayza (2019) on productivity-enhancing reforms and from Dao and others (2014) on labor market reforms. Reforms are assumed to raise drivers of productivity to the 75th percentile among OECD countries, and to close one third of the male-female labor force participation gap. The reforms would principally affect the following areas: broadening access

to advanced education, easing restrictions on hiring and firing of workers on open-ended contracts, improving regulatory quality, strengthening childcare benefits, and reducing tax wedges faced by two-earner couples and part-time workers. The scenario points to sizable possible gains to long-run output, about 12 percent when assessed over a 30-year horizon, as in many cases such reforms may take several years to be fully implemented and their effects could take several more years to materialize. Under a scenario encompassing both the COVID-19 shock and assuming implementation of reforms begins promptly, the economy could return to roughly the pre-COVID path of potential output by 2030 (Figure 6). However, this scenario also illustrates the likely difficulty in avoiding a slowdown in potential growth in the next few years, as the cumulative impact of reforms would only offset that of the COVID-19 shock after a period of several years.

Figure 6. Medium-Term Potential Output Scenarios
(production function model; annual average percent change)



Source: IMF staff calculations.

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FISCAL RULES IN KOREA—SOME CONSIDERATIONS[1]

A fiscal rule is a long-lasting numerical constraint on a government's finances to promote prudent fiscal policies. A well-designed fiscal rule often includes a debt anchor and implementable operational rules to strike a balance between flexibility, simplicity, and enforceability.

In the case of Korea, long-term fiscal planning and fiscal adjustment are needed to cope with the challenge of rapid aging. After the rapid increase in fiscal spending in response to the COVID-19 shock, a fiscal rule could also guide the post-pandemic fiscal consolidation and help anchor public expectations on the future debt path.

The government has recently proposed a fiscal rule that features a gross debt anchor at 60 percent of GDP, and a flexible consolidated deficit target of 3 percent of GDP. The proposal also includes escape clauses that would suspend the application of the rule under extraordinary circumstances and a provision to temporarily ease the deficit target by 1 percent of GDP in case of a slowdown.

The proposed flexible 60-percent-of-GDP gross debt anchor is prudent from the debt sustainability perspective and appears broadly appropriate from the perspective of the optimal debt level literature.

The 3 percent of GDP deficit target under the proposed rule is unlikely to stabilize the debt near 60 percent of GDP. Therefore, the scope for countercyclical fiscal policy under the rule will hinge critically on the design of the "slowdown provision", which has yet to be specified in the implementing regulations. An expenditure rule (i.e., a path for annual ceilings on expenditure, in lieu of a deficit target) could be considered to achieve countercyclicality without reliance on a slowdown provision, but it would raise other implementation challenges such as the need for rule adjustments in response to major tax policy changes.

Other design features, such as the designation of an independent institution (i.e., fiscal council) to monitor, review, and enforce the fiscal rule, and provisions subjecting major modifications of the rule to National Assembly approval, could enhance the credibility of the fiscal rule.

A. Background

1. Fiscal rules are widely used to discipline fiscal policy discretion. At the conceptual level, it is well understood that incumbent governments may have a bias toward higher present spending, neglecting the benefit of prudent fiscal policy in preparing for future challenges, such as a sudden growth slowdown and population aging. This bias often leads to suboptimal fiscal outcomes, including excessive deficits and higher government debt. Fiscal rules can be used to curb suboptimal fiscal expansion and preserve fiscal space through strengthening the government's commitment to prudent fiscal policy. Globally, more than 90 countries have adopted some form of fiscal rules (IMF 2018b).

2. A well-designed fiscal rule usually includes a *debt anchor* and *operational rules*, striking a balance between flexibility, simplicity, and enforceability. The *debt anchor* establishes

[1] Prepared by Si Guo.

the medium or long-term fiscal objectives. It is usually expressed as a debt-to-GDP ratio target, which is a key indicator for fiscal sustainability and easily observable. Once a debt anchor objective is determined, one or more *operational rules* are needed to help guide the government to achieve this objective. These operational rules usually feature targets or limits on fiscal balances, spending, or revenue, which are under more direct control of the incumbent government (compared to the debt level, which is in part a function of previous governments' fiscal performance).

3. In the context of Korea, the fiscal challenge arising from population aging points to the need for a long-term fiscal plan, possibly guided by a formal fiscal rule. The fiscal pressure from aging, and the consequential need for a long-term fiscal (consolidation) plan, is well documented. For example, NABO (2020) concludes that (without major policy changes), government debt will increase to 158.7 percent of GDP by 2060. IMF staff projections have arrived at similar magnitudes (IMF 2018c). Korea has a strong track record of fiscal prudence. However, the relatively large adjustment needs and the long haul over which this effort will have to be maintained suggest that a fiscal rule could be helpful to guide policy over time. In addition, against the backdrop of a rapid increase in the fiscal deficit in response to the COVID-19 shock, a fiscal rule could help guide the post-pandemic fiscal consolidation and anchor expectations of the future debt path.

B. The Korean Government's Fiscal Rule Proposal

The Proposed Rule

4. Korea's government proposed a fiscal rule in October 2020. The proposed rule consists of a debt anchor set at 60 percent of GDP and a 3-percent-of-GDP consolidated deficit ceiling as the operational rule. [2] The debt and deficit targets are "soft" limits, which are governed by the formula below:

$$[\text{Government debt} / 60\%] * [\text{Consolidated Fiscal Balance} / (-3\%)] \leq 1. \qquad (1)$$

5. Under the rule, "government debt" is defined as the sum of gross central and local government debt (denoted as D1 debt). D1 stood at 37.7 percent of GDP as of end-2019.[3] The consolidated fiscal balance refers to the fiscal balance including social security funds (SSF). The consolidated balance was -0.6 percent of GDP in 2019 and is projected to weaken to -4.4 percent of GDP in 2020, reflecting the fiscal response to the COVID-19 shock.

6. Compared to fiscal rules with a "hard" ceiling on the debt and deficit ratios, the "flexible" targets in Korea's proposed rule (1) provide for a "debt brake" mechanism—when the debt-to-GDP ratio rises, the deficit ceiling will be automatically tighter.

[2] More details about the proposed rule can be found in the official press release available at http://english.moef.go.kr/pc/selectTbPressCenterDtl.do?boardCd=N0001&seq=4993.

[3] Central government debt was about 36.4 percent of GDP as of 2019. Because local government borrowing was restricted in Korea, the difference between D1 and central government debt and D1 has been stable at 1.5 to 2 percent of GDP historically.

7. The operational set-up for the proposed fiscal rule also includes a few escape clauses and a provision for economic slowdowns. The escape clauses mainly cover "extraordinary challenges", such as "a war, a large disaster or a global economic crisis". Under those circumstances the fiscal rule "will not apply for the year, and the ratios are to be recovered gradually over the four years that follow". The provision for economic slowdowns is defined as follows: "when an economic slowdown requires expanded fiscal spending to stimulate growth, support employment and promote production, the three percent consolidated fiscal balance deficit rule will be eased by one percentage point to a four percent deficit."

8. Conditional on parliamentary approval, the proposed rule would take effect from 2025 and is to be reviewed every five years.

Debt Dynamics under the Proposed Rule

9. The distinction between the *consolidated deficit* and the debt-creating *managed deficit* complicates the projection of gross government debt under the proposed rule. The consolidated fiscal balance is the sum of the managed balance and SSF balance. The managed balance accounts for the difference between non-SSF revenue and expenditure. It is called "managed" balance because the government has more direct control over this aggregate. The SSF accounts are tied to the existing legislation over which the government has less control. In 2019, the SSF balance was KRW 42.4 trillion (or 2.2 percent of GDP), mainly reflecting the surplus from the National Pension Fund (NPF).[4] However, the SSF balance-to-GDP ratio is expected to gradually decline and eventually turn negative in early 2040s as public pension expenditure increases. The projection of gross government debt crucially depends on the sign of the SSF balance:

- **From 2020 to the early 2040s: During this period, the annual SSF balance is expected to be positive.** The SSF surplus in year t will be reflected in the increase in SSF reserve assets from year t-1 to t, while the increment in gross government debt between year t-1 and t will equal the size of the managed deficit (rather than the consolidated deficit) in year t.[5] Therefore, when the SSF balance is positive, the annual increase in gross government debt is larger than the size of the consolidated deficit.
- **From early 2040s to the late-2050s: During this period, the annual SSF balance is expected to be negative.** The SSF deficit in year t will be reflected in the reduction in SSF reserve assets, while the increment in gross government debt between year t-1 and t will again equal the size of the managed deficit. In this case, the annual increase in gross government debt is smaller than the size of consolidated deficit.

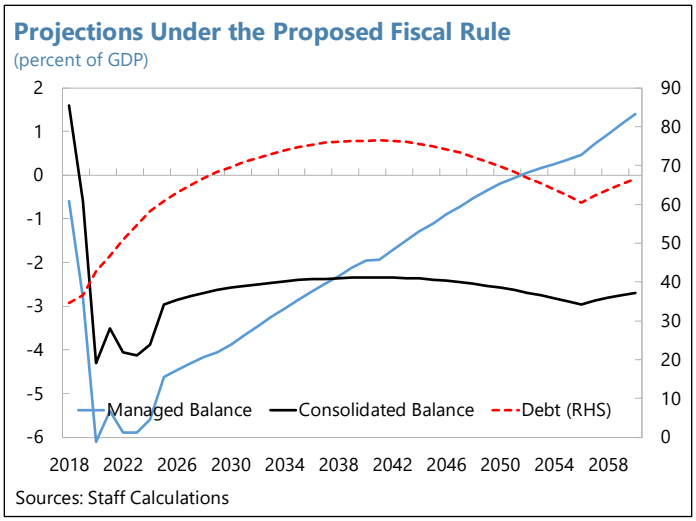
[4] The decomposition of SSF balance in 2019: Pension Fund (KRW 42.7 trillion), Korea Teachers Pension Fund (KRW 0.3 trillion), Industrial Workers' Accident Compensation Insurance and Prevention Fund (KRW 1.6 trillion) and Employment Insurance Fund (KRW -2.2 trillion).

[5] This also assumes that the deficit is financed by government debt instead of the reduction in government financial assets. It also assumes that there is no additional accumulation of government financial asset that has to be financed by debt issuance.

- **Beyond the late-2050s. During this period, the annual SSF balance is expected to be negative, and the SSF reserve assets are expected to have been depleted.** It is assumed that the managed and SSF deficits will have to be financed by government debt.[6] The increment in gross government debt between year t-1 and t will be equal to the size of consolidated deficit.

10. The evolution of gross government debt for 2020-60 is projected under plausible macroeconomic assumptions and the proposed fiscal rule. First, for the projections up to 2024, we follow the proposed medium-term outlook published in the 2021 budget proposal. Government debt is expected to rise to about 58 percent of GDP by end-2024. Second, for subsequent real GDP growth rates, we broadly follow the assumptions in MoEF's 2020–60 long-term projection (the scenario with medium population growth): average real GDP growth rates are assumed to be 2.3 percent, 1.3 percent, 0.8 percent and 0.5 percent per year in the 2020s, 2030s, 2040s and 2050s. Third, we assume that the SSF balance will decline from 2.2 percent of GDP in 2019 to around -4.1 percent of GDP in 2060. This is based on the "status quo" assumption that there will be no major changes to pension policies. Fourth, we assume that the SSF reserve assets will be depleted by around 2057, beyond which annual SSF deficits will have to be financed by government debt. Fifth, average annual inflation rates are assumed to be 1.5 percent. Last, for 2025-2060, we assume that the government will try to maximize its deficits such that (1) is always binding, i.e. Debt/60%*Consolidated Deficit/3%=1. We make this assumption because the declining SSF balance during 2020–2060 will imply that merely keeping (1) binding will already require a non-trivial increase in managed balance. More aggressive consolidation efforts are possible but probably a less natural assumption.

11. Under the proposed rule and the assumptions described above, the government's gross debt would peak at around 75 percent of GDP by early 2040s. This highlights that equation (1) only imposes a flexible ceiling on the government's debt-to-GDP ratio: when the consolidated balance is higher than -3 percent of GDP, the debt-to-GDP ratio can exceed 60 percent of GDP without violating the rule. The projected fiscal path can be summarized in three stages:



- **From 2025 to the early 2040s, the consolidated balance will gradually improve towards -2 percent of GDP, as the rising debt-to-GDP ratio implies a tightening constraint on the consolidated deficit according to (1).** Because the SSF is expected to be in surplus till late 2030s, the debt-creating managed

[6] This is an assumption that staff deems most plausible for passive projection purposes. However, there is currently no legal requirement for the government to finance SSF deficits after the depletion of the funds' assets. Potentially, parametric reforms (such as increases in the retirement age or contribution rates) could help improve the financial sustainability of the SSF and reduce or even eliminate the need for financing from the government budget.

balance will be mostly lower than the consolidated balance and is projected to be around -3.3 percent of GDP during 2025-2040, resulting in a rise in debt-to-GDP ratio over time.[7]

- **From the early 2040s to the late-2050s, the debt-to-GDP ratio is projected to decline.** This is because when the SSF balance will turn negative, the limit on consolidated deficits under the proposed rule will imply an increasingly tighter limit on managed deficits.
- **Beyond the late-2050s, the SSF reserve assets will be depleted. The** debt-to-GDP ratio will rise again because SSF deficits will have to be financed by government debt (the managed balances will be in surplus and offset some of the SSF deficits).

12. The projection implies a non-trivial consolidation in discretionary spending and/or additional revenue measures. The managed fiscal balance would increase from an average of -1.5 percent of GDP during 2017-19 to about 1.4 percent of GDP in 2060. The magnitude of adjustment is much more demanding if we compare the managed balance in 2060 to the average balance of 2020–24 (-5.8 percent of GDP), as the latter is affected by the policy stimulus in response to the COVID-19 shock.[8]

C. Staff Assessment

Debt Anchor

13. There is no single point estimate for the "right" level of debt for an advanced economy like Korea. From the perspective of debt sustainability, the IMF's Debt Sustainability Analysis (DSA) uses 85 (60) percent of GDP as an indicative threshold to signal government debt vulnerability in advanced (emerging) economies. The underlying rationale for these thresholds is that the probability of a crisis rises substantially when government debt exceeds them, although a breach does not mean that a crisis will necessarily occur. The academic literature on the "optimal" debt level weighs the pros and cons of issuing public debt from a welfare maximization perspective (Box 1). Public debt helps smooth government tax rates and expenditure and serves as the safe assets for the economy, at the possible cost of crowding out private investment, raising future tax rates and implications on inequality. While some studies point to the desirability of a negative net debt target, this conclusion is far from unanimous.

14. The proposed flexible 60-percent-of-GDP gross debt anchor is prudent from a debt sustainability perspective and appears broadly appropriate from the perspective of the optimal debt level literature. Strict implementation of the proposed fiscal rule could lead to a

[7] With government debt at 75 percent of GDP, real growth rate of 1 percent of GDP per year, and inflation of 1.5 percent, the managed balance that stabilizes debt-to-GDP ratio is about -2 percent of GDP.

[8] The implied adjustment of the *primary* managed balance will depend on the interest rate-growth differential (r-g). The average real interest rate during 2015-2019, calculated as the difference between effective borrowing interest rate, was about 1 percent. A large output gap following the pandemic and population aging suggest that the real interest rate could be lower in the near and longer term. Assuming a real interest rate of 0.5 percent annually from 2020–60 implies a consolidation in the *primary* managed balance by 7.6 percent of GDP by 2060 from the 2020–24 average.

peak in the debt-to-GDP ratio of around 75 percent of GDP in early 2040s—a level that is still considered to be well within the "safe" debt thresholds for advanced economies. From a debt sustainability standpoint, even a somewhat higher debt anchor would most likely be sustainable, although it would imply somewhat less room for fiscal policy maneuver in case of an adverse shock. From the perspective of the optimal debt literature, which generally suggests that the optimal net debt level is negative, a 60-percent-of-GDP gross debt may be slightly preferred over a higher debt anchor, though this conclusion is not definite (Box 1).

Operational Target: The Proposed 3% "Soft" Deficit Ceiling

15. A general concern with deficit rules is that fiscal policy may become procyclical. This can happen, for example, if political pressure pushes the government to run deficit levels close to the deficit limit specified by the fiscal rule. If that is the case, the government may not have room to provide additional fiscal support in case of a recession because the deficit limit becomes binding. Similarly, when there is an economic boom, the higher revenue is not automatically saved to provide for some countercyclical fiscal withdrawal. This could be costly for Korea, given its growth volatility and the limited room for using monetary policy if the current low-interest rate environment extends into the medium and long term.

16. The "soft" deficit nature of the proposed rule does not fully address concerns about possible fiscal procyclicality. In particular, with annual nominal GDP growth of 3.5~4.5 percent and SSF balances around 1.5 percent of GDP, running a 3 percent of GDP consolidated deficit will imply a 4.5 percent of GDP managed deficit, which stabilizes the public debt at a level that exceeds the 60 percent of GDP anchor.[9] When debt stays above the anchor, equation (1) is more likely to be binding. In these circumstances the "soft" limit on deficits becomes "harder", leaving less space for deficits to rise in case of a downturn.[10]

17. Under the proposed rule, the scope for countercyclical fiscal policy will hinge critically on the design of the "slowdown" provision. The details of the provision are expected to be specified later during the implementation stage. One practical challenge will be how to define an "economic slowdown" to allow sufficient flexibility in providing fiscal support during a cyclical downturn, while avoiding excessive usage of the provision in "normal" times. In particular, in the context of a structural deceleration in economic growth due to income convergence and a shrinking working age population, pressures could arise to apply this provision frequently, even in the years

[9] The exact debt-stabilizing consolidate deficit depends on the nominal GDP growth rate and the SSF balance. In our projection, stabilizing the public debt at around 60 percent of GDP during 2026-30 would require the managed deficit to be less than 2.5 percent of GDP, which is translated to a consolidated deficit that is less than 1 percent of GDP.

[10] This discussion implicitly assumes that actual deficits will be close to the 3 percent of GDP deficit "ceiling". This may not necessarily be the case in practice. For example, it is possible that the government decides to prudently target an average deficit of 1 percent of GDP, even though the announced deficit ceiling is 3 percent of GDP. If this is the case, debt will stabilize at a level lower than 60 percent of GDP, and a temporary breaching of the 3-percent ceiling is possible under equation (1). However, if the government is actually targeting a 1-percent-of-GDP deficit, it would be more desirable to set the "soft" deficit target in equation (1) closer to that level. This is because in practice, political pressures may keep actual deficits close to the ceiling specified in the fiscal rule.

when the growth performance is robust from a cyclical perspective. Another design challenge for the provision will be how to achieve fiscal savings in "good" times to avoid procyclicality in a cyclical upswing.

Box 1. Quantitative Studies on Long-Term Optimal Debt

Quantitative studies on the long-term optimal government debt emphasize the liquidity benefits of government debt. The basic assumption is that private agents (e.g. households) face idiosyncratic income risks and imperfect financial markets. The benefit of higher government debt is that it provides households another asset for precautionary savings, which makes self-insurance easier (Aiyagari and McGrattan, 1998). Another benefit is that—other things equal—raising government debt implies less need for raising taxes today. Therefore, higher government debt relaxes the liquidity shortage of households and firms that otherwise would have to borrow more in the (potentially frictional) private market if there is a tax hike today (Azzimonti and Yared, 2018).

But higher debt is not costless. Three types of costs are explicitly considered in the quantitative literature.[1] First, all else equal, a higher government debt level may result in a higher interest rate and lower private investment (crowding out effect). Second, a higher debt level also implies higher interest payments, which will have to be financed through distortionary taxes. Third, a higher market interest rate caused by higher government debt also favors richer households (who have more savings and assets) and hence exacerbates inequality.

Overall, the desirable long-term government debt level is a quantitative question. Studies in this area, which are mostly calibrated to U.S. data, derive a broad range of optimal long-term debt levels from -100% of GDP (Floden 2001, Vogel 2014) to 145% of GDP (Azzimonti and Yared 2018), depending on modeling details, especially the types of costs considered and the efficiency of government transfers. However, once all three types of costs mentioned above are considered in the cost-benefit calculation of higher government debt, the results of the quantitative studies generally indicate that the optimal government debt level would be negative for the United States.

Some caveats should be taken into account when interpreting the quantitative results from the literature and their implications for Korea. First, almost all the studies cited above are calibrated to the U.S. economy. Second, in this literature, "government debt" refers to "net" debt instead of "gross" debt. Hence, an open question is what the suitable measure of "net" debt is. We think that the suitable measure of net debt should be the amount of gross debt netting out liquid financial assets – as liquidating non-financial assets, such as government buildings, is likely to affect other critical government functions. By this measure, Korea's net government debt position is about -21% of GDP as of 2019.[2]

[1] There are obviously other types of costs, such as higher debt crisis risks and the consideration of intergenerational redistribution. However, these types of costs are typically not explicitly accounted for in this line of literature.

[2] Data is from FY2019 National Account Settlement Report. Liquid government assets such as cash, deposit and securities amounted to 59 percent of GDP as of 2019. A big chunk of these assets was in the form of the reserve assets of National Pension Scheme (NPS). On the liabilities side, government debt was about 38 percent of GDP.

18. An expenditure rule in lieu of a deficit target could be considered to achieve countercyclicality without reliance on a slowdown provision, albeit it would raise other implementation challenges. Under expenditure rules, revenue fluctuates with the economic cycle, while expenditure growth is subject to a pre-determined ceiling path. As a result, the fiscal deficit is larger (smaller) when the economy is in a downturn (boom), to allow fiscal policy to mitigate the

cycle. Unlike deficit rules, however, key parameters of an expenditure rule (e.g. the growth rate of expenditure ceiling) may have to be updated in response to major tax policy changes so that the expenditure targets remain aligned with the new revenue outlooks. Expenditure rules can also induce lower public investment if governments choose to cut capital spending to remain in compliance with the expenditure ceiling (IMF 2018a).

D. Other Design Issues

19. Monitoring and enforcement. Several countries have created independent fiscal councils to help monitor the implementation of fiscal rules (for example, Netherlands, Chile, Colombia and Sweden, to name a few). Enforcement is more challenging (as it is hard to design and execute sanctions in case of breach), though objective and well-communicated assessment reports from a dedicated fiscal council can create incentives for compliance with fiscal rules by raising the reputational costs of a breach. In this regard, a simple and transparent fiscal rule carries the benefit of facilitating monitoring and enforcement. In Korea, the monitoring role could be performed by an independent fiscal council that is outside of the government. Another option is for the National Assembly Budget Office (NABO) to take on this role. The fiscal rule proposed by the government is appropriately based on easily observable fiscal targets (debt and deficit). Therefore, monitoring and enforcement will be most important for the proper application of escape clauses and the "slowdown" provision.

20. Provisions to relax the rule. Ideally, escape clauses should strike a balance between flexibility and credibility, allowing the government to temporarily deviate from a fiscal rule in case of rare events that are outside of the government's direct control. However, experience from other countries has shown that defining such circumstances can be difficult in practice. Though natural disasters and national security contingencies can be explicitly specified in escape clauses, other contingencies (such as a major recessions) usually fall into an "exceptional circumstances" category that is often not well defined and prone to different interpretations. The fiscal rule proposed by the Korean government includes escape clauses for events such as wars, disasters, and a global economic crisis. The rule also includes a provision to relax the deficit target in case of economic slowdowns. While ensuring "flexibility" may require a certain extent of ambiguity in the determination of eligible events,[11] the criteria for identifying an "economic slowdown" should be easily observable and demanding to avoid excessive relaxation in response to relatively minor cyclical fluctuations. The application of the escape clauses could be left subject to confirmation by parliament or at least require approval by an independent fiscal council or similar external entity to bolster credibility and ensure political buy-in for temporary relaxations of the rule.

21. Transition Issues. Starting implementation of the fiscal rule from 2025 onward, as proposed by the government, is broadly appropriate as it will allow for sufficient and flexible fiscal support in the aftermath of COVID-19 shock until the economy has recovered. The medium-term budget

[11] For example, in many countries, fiscal rules do not have a specific escape clause for a pandemic. Instead, a general escape clause could be triggered by classifying the COVID-19 shock as an "unusual event outside the control of government".

outlook published in the 2021 budget proposal forecasts debt- and deficit-to-GDP ratios of 58.3 and 4 percent, respectively, for 2024. To meet the restriction imposed by the proposed rule as expressed in equation (1), the deficit in 2025 could not exceed 2.9 percent of GDP, thus requiring a nontrivial fiscal tightening relative to 2024. A smoother transition path would be desirable, which could be achieved if the adjustment starts earlier (i.e., in 2023 or 2024), provided that the recovery from the COVID-19 shock is well underway by then.

22. Periodic Reviews. The proposed rule appropriately allows for a review of the parameters of the debt and deficit targets every 5 years. Currently, it appears that the revision of the rule would be delegated to the executive branch. Revisions to key parameters of the rule should be assessed by an independent entity (such as a fiscal council or NABO) and then approved by the parliament.

23. Communications. As discussed in Section B, given the reality of demographic changes, the proposed rule will likely imply over time a non-trivial reduction in non-SSF spending or an increase in public revenue collection (as share of GDP). Presenting the increasing fiscal pressure arising from population aging and slowing potential growth in a transparent and intuitive way can help generate broader understanding and buy-in for the necessity of a fiscal rule in Korea.

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FISCAL POLICIES FOR REINFORCING KOREA'S CLIMATE MITIGATION STRATEGY[1]

The Korean authorities intend to leverage the COVID-19 recovery to transform their economy with a focus on becoming a global digital leader, transitioning from a carbon-dependent to a green economy, and enhancing social inclusiveness.[2] *The Korean New Deal (KND), announced in July 2020, provides a series of new policy interventions to help achieve these ambitions.*

In terms of the envisaged transition to a green economy, Korea's climate mitigation strategy encompasses several broad objectives, including achieving carbon neutrality by 2050 and reducing greenhouse gas (GHG) emissions 24.4 percent below 2017 levels by 2030. Many specific policy measures to make headway on these objectives are already implemented or have been announced, including Korea's Emissions Trading System (ETS)—the largest in scale outside the EU—covering about three quarters of domestic emissions; the recently announced Green New Deal (GND), which is a component of the KND; standards for the average emission rates of vehicle sales fleets and tax exemptions for EVs and HVs; and a renewable portfolio standard (RPS) requiring generators to increase their renewable share in the electricity mix.

Achieving Korea's climate objectives will require further strengthening of the mitigation framework in the period ahead. Additional measures should be effective, cost-efficient, build off and complement existing policies, and flexibly accommodate possible constraints on the acceptability of higher energy prices. With these criteria in mind, this paper lays out policy options for the authorities, presented as a comprehensive package that combines enhanced carbon pricing at the national (i.e., economy-wide) level and readily adjustable fiscal incentives to reinforce mitigation and other policies at the sectoral level. Articulating a clear, forward-looking policy framework for the achievement of Korea's climate ambitions, especially regarding carbon pricing, will be important to provide adequate incentives for private investment in the development and use of green technologies.

At the national level, the authorities could consider in Phase 4 of the ETS a trajectory of emissions caps fully aligned with meeting the 2030 emissions target; underpinning the ETS with exogenous and progressively rising price floors and ceilings; and a transition to full allowance auctions. These reforms would: (i) better align emissions with long-term carbon neutrality; (ii) promote across-the-board incentives for low-carbon investment for which a robust price signal is essential; (iii) improve compatibility with other instruments overlapping with the ETS (e.g., RPS); and (iv) raise additional revenues, which could help promote innovation in green industries, fund the clean energy transition, and lower taxes on work effort.

The reinforced ETS could be complemented at the sectoral level with feebates to enhance mitigation incentives in the transport, power, industrial, and building sectors (some elements of a feebate already apply in transportation). Feebates apply a revenue-neutral, sliding scale of fees on products or activities with above average emission rates and a sliding scale of rebates on products or activities with

[1] Prepared by Ian Parry. The author is grateful to Andreas Bauer for very helpful comments and suggestions and to Khamal Clayton and Si Guo for assistance on data and policy background.

[2] Ministry of Economy and Finance (2020).

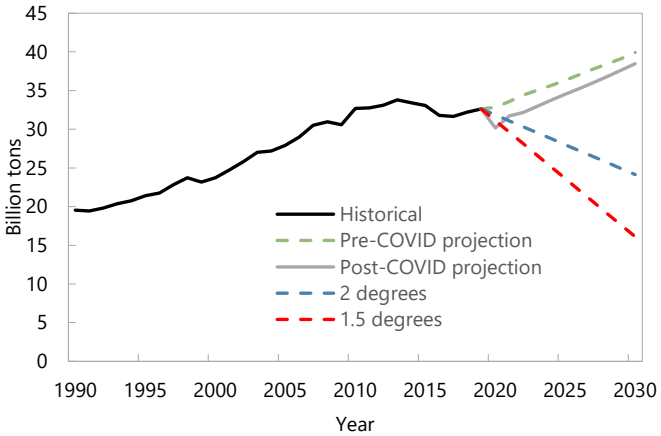
below average emission rates. Feebates: (i) can cost-effectively promote the full range of responses for reducing emissions intensity within a sector; (ii) avoid a fiscal cost to the government; (iii) avoid significantly higher (and politically challenging) energy prices; and (iv) are compatible with existing regulatory standards. A feebate variant could also promote carbon storage in the land use sector.

The paper concludes by discussing briefly the ongoing international debate on trade and coordination aspects of carbon mitigation. A key issue on the trade front is border carbon adjustment (BCA), which the EU plans to introduce in 2023 and Canada, the UK, and the United States are currently considering. BCAs help to alleviate the adverse impacts on industrial competitiveness from carbon-price-induced increases in energy prices and reduce the risk of 'emissions leakage'. The authorities should consider whether a BCA for energy-intensive, trade-exposed (EITE) industries might be an appropriate instrument for Korea, at some future point, perhaps after early experiences with an EU BCA. The coordination issue relates to discussions about an additional international mechanism to complement the Paris Agreement by scaling up action among key emitters in a multilateral way. One potential mechanism for this is an international carbon price floor (ICPF) among large emitters. Korea might usefully contribute to the international dialogue on an ICPF and other complementary mechanisms.

A. Introduction

1. The window of opportunity for containing global climate change to manageable levels is closing rapidly. Global carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions must be cut 25–50 percent below 2018 levels by 2030 to be on track with containing projected warming to 1.5°–2°C above preindustrial levels with rapid reductions to emissions neutrality thereafter. Due to the pandemic-induced crisis, global emissions in 2020 are projected to fall about 8 percent below 2019 levels. However, without strong mitigation policies global emissions are likely to start rising again in 2021 as economies recover (Figure 1). With governments bringing forward investment plans to boost their economies, the pandemic has added to the urgency of ensuring this new investment is efficiently allocated to low-carbon technologies—this requires strengthening carbon pricing or equivalent measures to level the playing field for clean technologies

Figure 1. Global Fossil Fuel CO2 Emissions Trends



Source: IEA (2020), Fund staff estimates, IPCC (2018).

2. The Korean authorities have already announced a series of important emission mitigation goals. In its Intended Nationally Determined Contribution (INDC) submitted in September 2015 for the 2015 Paris Agreement, Korea set a medium-term goal of reducing GHG emissions by 37 percent from

business-as-usual (BAU) emissions of 851 million tons CO_2 equivalent ($MtCO_{2e}$) in 2030[3]—this target would imply cutting GHGs 22 percent below their 2017 level of 709 $MtCO_{2e}$. Last December, Korea updated and submitted its first NDC under the Paris Agreement. The updated target is to reduce GHGs 24.4 percent below 2017 GHG emissions by 2030. Earlier, Korea's President Moon Jae-In had announced a long-term goal of carbon neutrality by 2050, matching and in some cases exceeding the ambition of other large emitters.[4] Supplementary targets at the sectoral level in Korea include:

- Increasing the share of renewable power generation to 20 percent by 2030 and 30–35 percent by 2040 (up from 3 percent in 2017);[5]
- Increasing the number of EVs on the road to 3 million by 2030 (about 4 percent of the in-use fleet) and the number of HVs to 850,000.[6]

Policies for making headway on all these objectives (see below) are outlined in the third *Energy Master Plan* (adopted in June 2019 for the period up to 2040) and the eighth *Electricity Plan* (adopted in December 2017 for the period up to 2030).[7]

3. Korea also has the ambition to become a leader in the development and use of green technology. The Green New Deal (GND) announced by President Moon Jae-In in July 2020 sets aside public funding of KRW 42.7 trillion from 2020 to 2025 for green projects. The GND is one of three components of a broader Korean New Deal (KND) focusing the recovery from the pandemic on expanding employment and technological opportunities in growth sectors of the future—the other two components are investment in the digital economy and a strengthened employment and social safety net. [8] The GND contains projects for, among others, buildings; tree planting; renewables; and clean technology research such as green hydrogen and carbon capture, usage, and storage (CCUS). The GND is projected to leverage an additional KRW 30.8 trillion in local government and private funding and create 659,000 jobs (see Annex Table A1 for more details on the GND).

[3] See Government of Korea (2016).

[4] The EU, Japan, U.K., and the U.S. have also set carbon neutrality targets for 2050, while China has announced this target for 2060. See www.iea.org/reports/world-energy-outlook-2020/achieving-net-zero-emissions-by-2050. Carbon neutrality allows for a positive level of gross emissions but only if they are offset by processes to remove emissions from the atmosphere (e.g., afforestation, directly capturing emissions from the atmosphere).

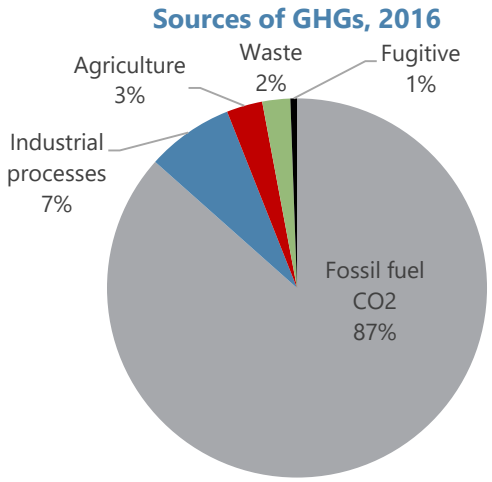
[5] The envisioned electricity generation mix in 2030 would be 24 percent nuclear, 36 percent coal, 19 percent natural gas and 20 percent renewables (MOTIE 2017).

[6] An intermediate target is 1.13 million EVs and 200,000 HVs by 2025, up from 91,000 and 5,000 each by the end of 2019. Unlike some other countries Korea has not set a target for the full phase out of internal combustion engine sales (see https://theclimatecenter.org/actions-by-countries-phase-out-gas).

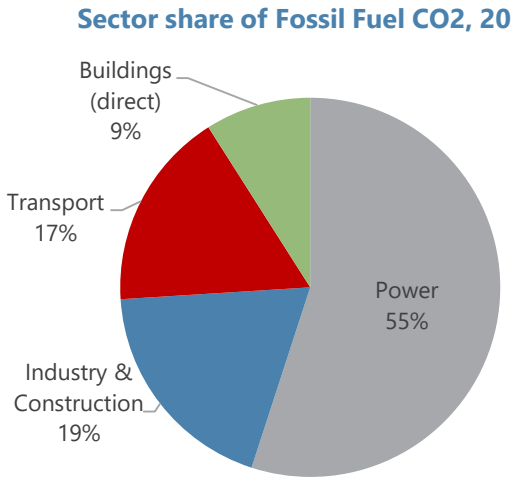
[7] See MOTIE (2019) and MOTIE (2017) respectively.

[8] Government of Korea (2020a).

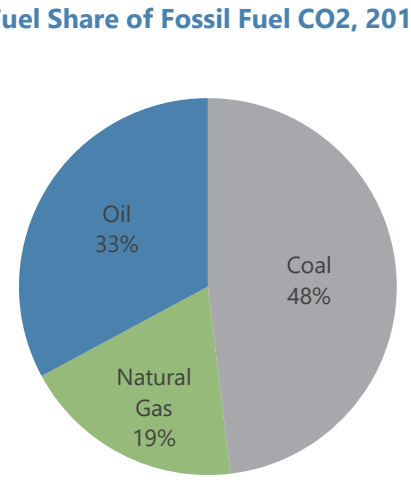
Figure 2. Korea: Breakdown of GHG Emissions



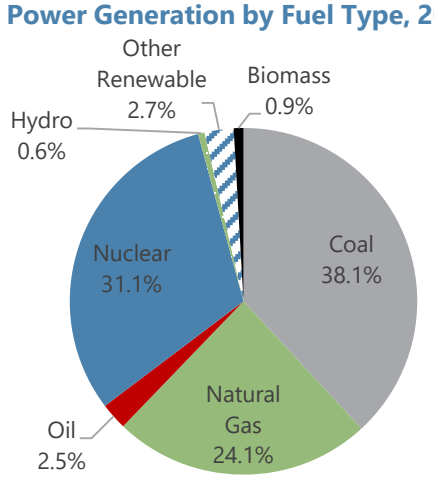
Source: UNFCCC (2020).



Source: Fund staff estimations.



Source: Fund staff estimates.



Source: Fund staff estimates.

4. Korea's GHG emissions arise mostly from fossil fuel CO_2 combustion. Fossil fuels accounted for 87 percent of Korea's 694 million tons in GHG emissions in 2016. Another 7 percent of GHGs were from industrial processes like cement production and fluorinated (F-) gases, 3 percent from agricultural sources, 2 percent from waste (e.g., methane leaks at landfills), and 1 percent are fugitive emissions (leaks from fuel extraction, storage, processing, and distribution). By sector, power generation accounted for 55 percent of fossil fuel CO_2 emissions in 2018, industry and construction 12 percent, transportation 17 percent, and (residential and commercial) buildings 9 percent—indirect emissions from electricity use in buildings are however 2.5 times the direct emissions.[9] By fuel type, coal accounted for 48 percent of fossil fuel emissions in 2018, oil 33 percent, and natural gas 19 percent. And in the power sector, coal accounted for 38 percent of generation in 2018,

[9] IEA (2020).

natural gas 24 percent, nuclear 31 percent, oil 2.5 percent, hydro 0.6 percent, and non-hydro renewables 2.7 percent.[10]

5. Staff projections suggest that with currently planned mitigation efforts, fossil fuel CO_2 emissions will increase 5 percent between 2018 and 2030.[11] Korea's CO_2 emissions increased by 161 percent between 1990 and 2018 (Figure 3), reflecting in part strong growth in the manufacturing sector.[12] Although GDP is projected to increase by another 25 percent between 2018 and 2030, the energy intensity of GDP is expected to fall 19 percent due to gradually improving energy efficiency and an assumption that energy demand will increase by less than GDP.[13] Emission growth is projected to be much higher in large emerging market economies over this period—47 percent in China and 37 percent in India. In absolute terms, without new or strengthening of existing mitigation policies, Korea is projected to be the 7th largest global emitter of CO_2 in 2030, and the fourth largest emitter in per capita terms (see Figure 3).

6. Korea's main policy for mitigating GHGs is the Emissions Trading System (ETS) launched in 2015, the first national ETS in East Asia. Table A2 in Annex I provides details on the design features of the ETS. The system in Phase 3 (2021–2025) will apply to 685 companies—principally power generators and large industrial firms (e.g., iron and steel, petrochemicals, cement, oil refineries, nonferrous metals, paper, textiles, machinery, mining, glass and ceramics) covering 73 percent of national GHGs, up from a coverage rate of 70 percent in Phase 2 (2018-2020).[14] The ETS cap cumulated over the three years of Phase II was 1,796 $MtCO_{2e}$, or on average 599 $MtCO_{2e}$ a year. In Phase 3 the annual average emissions cap will be reduced 4.7 percent relative to 2017–2019 ETS emissions. Allowances are largely given away for free (based on companies' 2011–2013 emissions) though 10 percent will be auctioned in Phase 3[15]—EITE industries will continue to receive

[10] Following recent investment in coal plants, and a 12 percent downward revision in needed generation capacity for 2030, there is currently excess generation capacity which provides headroom for a rapid expansion of renewables (Webb and Kim, 2018).

[11] IMF staff have developed a spreadsheet tool to project emissions on a country-by-country basis and the emissions, fiscal, and economic impacts of carbon pricing and other mitigation instruments. The model starts with recent data on use of fossil and other fuels by major energy sector and then projects fuel use forward using (post-COVID) GDP projections and assumptions about: (i) the income elasticity of demand for energy products; (ii) technological progress that improves energy efficiency and the productivity of renewables; and (iii) future international energy prices. The impact of carbon pricing (and other policies) on fuel use depends on their proportionate impact on future energy prices and fuel price responsiveness—price elasticities are between -0.5 to -0.8 based on empirical evidence and results from energy models. See IMF (2019a and b) and Parry and others (2020) for descriptions and applications of the model.

[12] For example, Korea is the fifth largest car manufacturing country (OICA 2019).

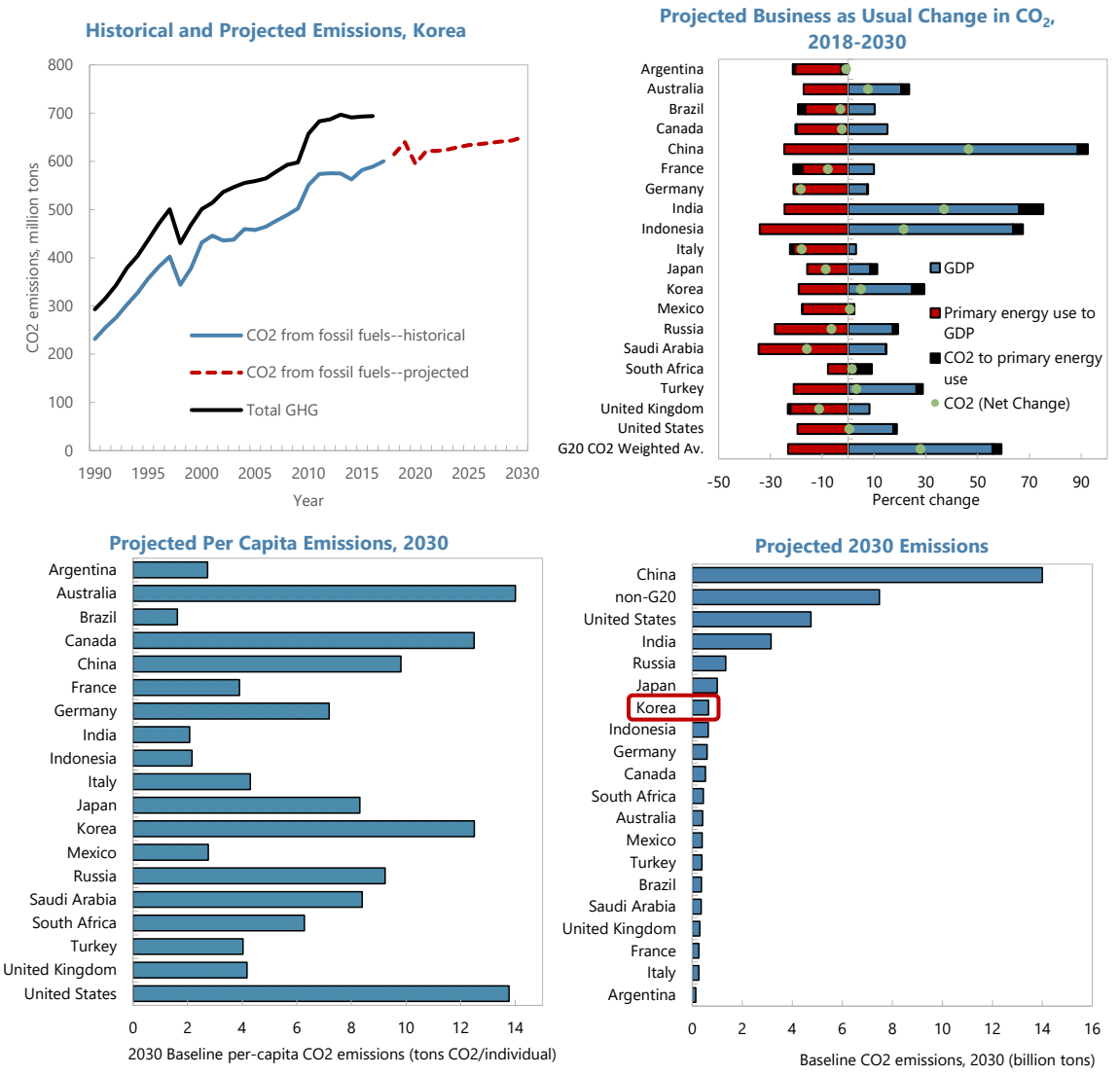
[13] This accounts for a 7 percent fall in emissions between 2019 and 2020 due to the global pandemic. CAT (2020) projects 2030 GHG emissions in Korea will be between 7 percent lower and 4 percent higher than 2018 (depending on the eventual impact of the COVID-19 crisis). Government of Korea (2019) previously projected faster growth of energy-related emissions—an increase of 22 percent between 2016 and 2030.

[14] Companies with over 125 kilotons, and installations with over 25 kilotons, of annual CO_2 equivalent emissions are covered by the scheme. The construction, public, waste, and domestic aviation sectors are also covered and all six Koyoto GHGs, though other emissions are small relative to CO_2.

[15] For comparison, 57 percent of allowances will be auctioned over the current phase (2013-2020) of the EU ETS (ICAP 2020b).

100 percent free allowance allocations.[16] Auctions are subject to a minimum price based on recent emissions prices. Various banking and borrowing provisions, and other market stability provisions, are designed to limit allowance price volatility.

Figure 3. Fossil Fuel CO_2 Emissions Trends



Source: Fund staff estimates.

7. Other policies provide additional incentives for renewables, low emission vehicles, and energy efficiency.

[16] EITE sectors are defined along the following criteria: (i) trade intensity of at least 10 percent and the ETS increases production costs for the industry by at least 5 percent; or (ii) production cost increases exceed 30 percent; or (iii) trade intensity exceeds 30 percent.

- The Renewable Portfolio Standard (RPS), in place since 2012, requires the 23 major electric utilities power (i.e., those with over 500MW) to increase their renewable share in the electricity mix to 10 percent by 2022.[17]

- Korea is tightening its vehicle emissions standard to 97 grams (g) of CO_2 per km by 2020 for passenger vehicles (80 percent of the new vehicle fleet), which is comparable to new EU standards, and to 166 g CO_2 per km for light trucks (20 percent of the fleet).[18] EVs and HVs also benefit from exemption of: (i) local acquisition tax (7 percent of vehicle price, which can save up to KRW 1.4 million); (ii) national individual consumption tax (5 percent of vehicle price, which can save up to KWR 3 million for an EV and KWR 4 million for an HV).

- For the building sector, Korea is gradually applying stricter energy conservation designs to new structures, while for industry the focus is on energy efficiency and clean fuel and materials.[19]

8. Korea also imposes significant excises on fossil fuels, although (as in other countries) these generally undercharge, or only just charge, for non-carbon externalities. Unlike most other countries, Korea imposes a significant coal tax, recently increased to KRW 46 per kg, equivalent to US$2 per gigajoule (GJ) or $21 per ton CO_2. Local air pollution damages (i.e., elevated mortality risks for exposed populations) from coal use in Korea would warrant a tax almost twice as high however—these damages are estimated at $3.8 per GJ. Excises on gasoline are KRW 770 per liter, equivalent to US$0.64 per liter or $272 per ton CO_2, while excises on (road) diesel are KRW 540 per liter equivalent to $0.45 per liter or $166 per ton of CO_2. Despite these high taxes, retail fuel prices for diesel are still somewhat less than prices needed to reflect supply costs, non-carbon environmental costs, and general consumption taxes, while gasoline prices just about reflect these factors.[20] Other countries generally undercharge for coal, gasoline, and diesel fuel, before even counting global warming costs (see Figure 4).

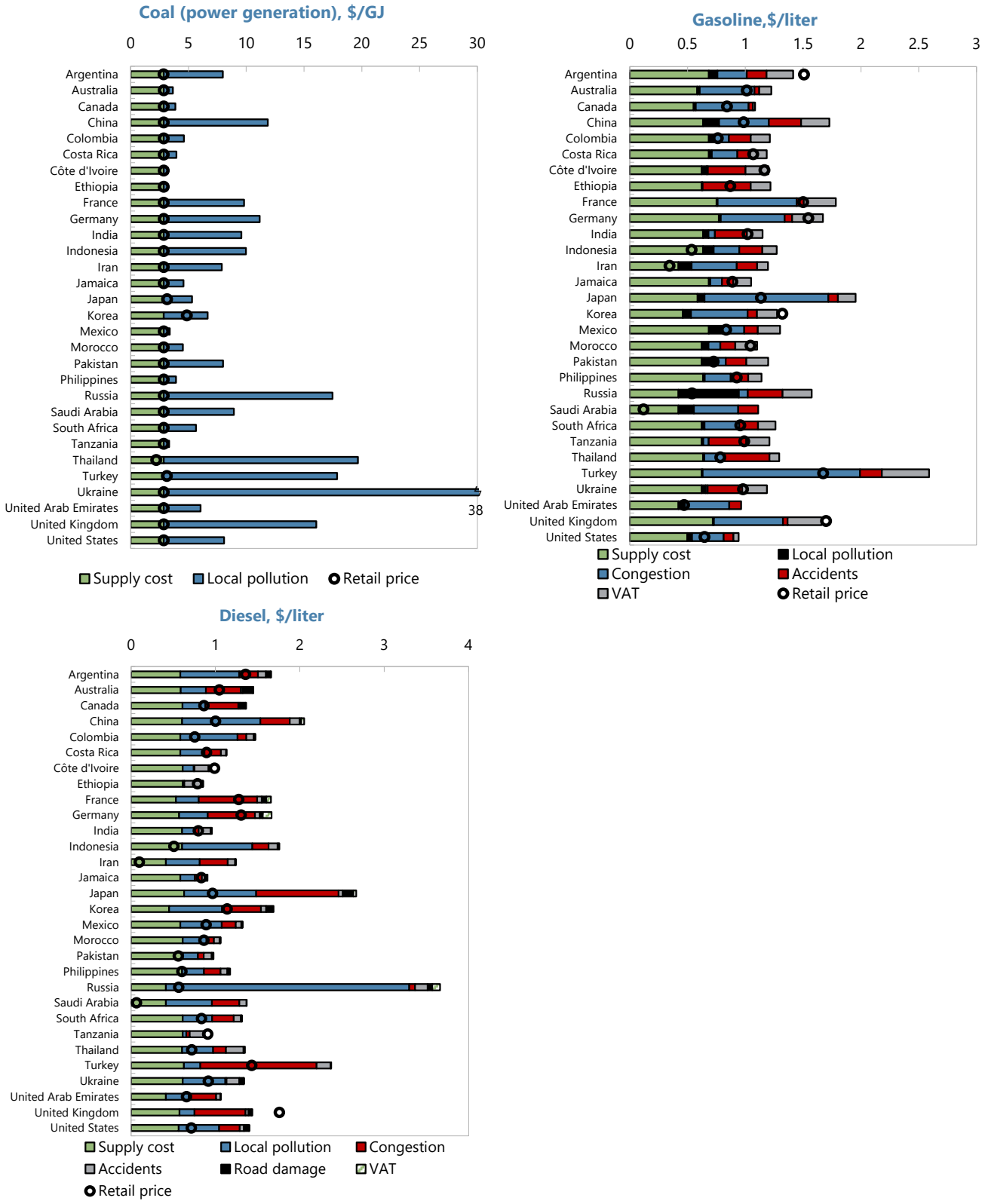
[17] Korea New and Renewable Energy Center (2019). "New energy" technologies (e.g., coal-fired integrated gasification combined cycle plants) could also count towards meeting the requirement but they are expected to play only a minor role at best. To help meet their compliance requirements, generators can purchase Renewable Energy Certificates from other generators that exceed the RPS requirement.

[18] These targets represent a reduction in emission rates of 31 percent and 15 percent relative to respective emission rates in 2013. Standards will tighten to 89 (cars) or 158 (trucks) g CO_2 per km by 2025, and 70 (cars) or 146 (trucks) g CO_2 per km by 2030. Credit trading is permitted among manufacturers. See www.transportpolicy.net/standard/south-korea-light-duty-fuel-economy-and-gh.

[19] APERC (2019), Ministry of Environment (2018).

[20] Some level of fuel taxation is efficient to reflect external costs of driving including traffic congestion, accidents, and local air pollution—at least until more efficient instruments like km-based charging systems on congested roads are widely applied. See Parry and others (2014) for an extensive discussion of efficient fuel taxes and methods for quantifying them.

Figure 4. Current Prices, Supply, and non-Carbon Environmental Costs, Selected Fuels and Countries, 2015



Source: Coady and others (2018).

9. Achieving Korea's mitigation objectives will require further strengthening of this policy framework in the period ahead. For example, emissions caps in phase 4 of the ETS will need to be aligned with 2030 commitments and current policies will need reinforcing to meet sectoral targets (e.g., for renewables)—see below. This paper lays out policy options for the authorities, presented as a comprehensive package that includes enhanced national-level (i.e., economy-wide) carbon pricing and feebates at the sectoral level, building on and reinforcing the existing regulatory and fiscal framework. Section B discusses strengthening the ETS; Section C discusses sectoral policies; Section D briefly covers BCAs and international coordination; and Section D summarizes the policy advice

B. Strengthening Korea's ETS

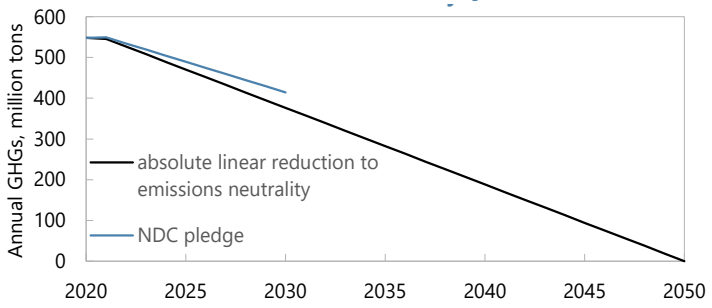
10. Carbon pricing has a critical role to play in climate mitigation. Pricing:

- Provides across-the-board incentives for firms and households to reduce energy and shift to cleaner fuels (by reflecting the cost of carbon emissions in the prices of fuels, electricity, and goods);
- Automatically minimizes mitigation costs (by equalizing the cost of the last ton of CO_2 reduced across fuels and sectors);
- Redirects new investment to clean technologies (if there is a robust and rising price signal);
- Mobilizes potentially substantial government revenues (which can be used to address distributional concerns and to boost the economy); and
- Generates substantial domestic environmental benefits (e.g., reductions in local air pollution mortality).

11. The authorities can rely on the existing ETS as their central tool for carbon pricing in Korea. The ETS already has relatively good coverage compared with pricing schemes in most other countries (see Table 1). However, there is room for further strengthening the ETS as emissions caps are not fully aligned with intermediate mitigation goals, future emissions prices are uncertain, and revenue opportunities for the government are not fully exploited.

12. Consistency with a linear pathway to emissions neutrality would imply tightening the ETS emissions cap. On a linear pathway from current emissions to emissions neutrality in 2050, the ETS emissions cap would average 509 million tons over 2021-2025, or 7 percent below annual emissions in Phase 2, and 416 million tons over 2026-2030, or 24 percent below Phase 2 (Figure 5). On a linear pathway consistent with

Figure 5. Korea: ETS Emissions Caps Under Pathways to Emissions Neutrality

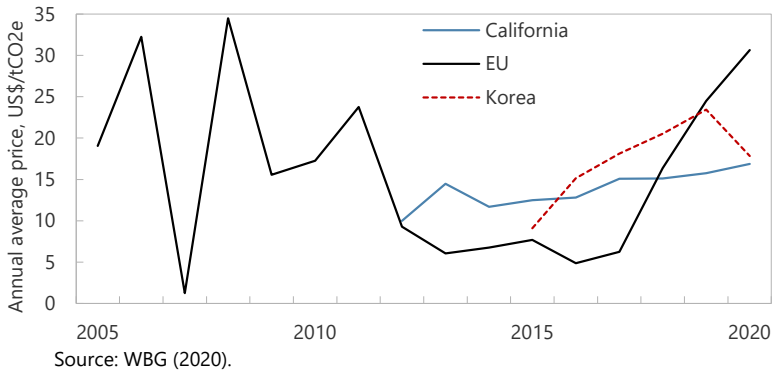


Source: Fund staff estimates.
Note. 2020 emissions is the annual cap in Phase 2 scaled up 3 percent due to expanded coverage from 2020.

Korea's NDC pledge for 2030, the average cap would be 19 percent lower than the Phase 2 average.[21] For comparison, in the third phase of the EU ETS, the annual emissions cap is set to decline by 2.2 percent each year between 2021 and 2030 and beyond, though a faster contraction in the cap will now be needed in light of the recent strengthening of the EU's mitigation pledge for 2030.[22] Korea's ETS could be strengthened by: (i) scaling back the cap by a fixed amount each year (an absolute ton reduction or a percent reduction as in the EU); and (ii) ensuring alignment of the trajectory of emissions caps with emissions pathways consistent with medium- and long-run long run emissions targets.

13. Recent allowance prices in the Korean ETS have been broadly in line with comparators and carbon pricing schemes more generally (Figure 6 and Table 1), but uncertainty about future prices could hold up low carbon investments desired by the government. In addition, the ETS is not fully compatible with overlapping mitigation instruments which tend to reduce emissions prices (rather than emissions) given the fixed cap. The minimum auction price could be set exogenously (rather than depending on previous emissions prices) with a price floor that ramps up predictably over time. An exogenous price floor would increase certainty over emissions prices and lower the risk that overlapping policies (e.g., the RPS) lower allowance prices (if the floor is binding, overlapping instruments lead to automatic withdrawal of allowances from the system).[23] If future emissions caps are tightened, an exogenous price ceiling (which puts additional allowances into the system) may also be needed to limit risks of a backlash against high energy prices. Another way to increase price certainty would be to link the Korean ETS with other trading systems (e.g., in the EU), but then prices would be largely determined outside of Korea—it may be preferable to retain discretion over setting the bands for domestic emissions prices (which can be adjusted according to national circumstances and progress on pricing elsewhere).

Figure 6. History of Prices in ETSs



Source: WBG (2020).

[21] Some backloading of emissions reductions to later in the transition period (than on a linear pathway) may be appropriate (given the long-lived nature of existing fossil fuel capital like coal plants) though this would imply a larger cumulative amount of emissions during the transition.

[22] The pledge was raised from 40 to 55 percent below 1990 levels by 2030.

[23] See Flachsland and others (2018) for discussion of price floor mechanisms.

14. The Korean ETS does not take full advantage of fiscal opportunities from carbon pricing, which in turn can imply higher overall costs for the economy and adverse distributional effects.

Table 1. Selected Carbon Pricing Schemes, 2020

Country/Region	Year Introduced	Price 2020, $/Ton CO_2	Coverage of GHGs Million Tons	Coverage of GHGs Percent
Carbon taxes				
Chile	2017	5	58	39
Colombia	2017	4	46	24
Denmark	1992	26	25	40
Finland	1990	68	41	36
France	2014	49	172	35
Ireland	2010	28	32	49
Japan	2012	3	909	68
Mexico	2014	<1-2	381	47
Norway	1991	3-53	47	62
Portugal	2015	26	16	29
South Africa	2019	7	512	80
Sweden	1991	119	44	40
Switzerland	2008	99	6	33
Emissions Trading Systems				
California	2012	17	375	85
European Union	2005	31	2,249	45
Germany	2021	29	238	31
Korea	2015	18	489	70
New Zealand	2008	14	45	51
Regional GHG Initiative	2009	5	108	18
Carbon price floors				
Canada	2019	22	71	9
United Kingdom	2013	22	136	23

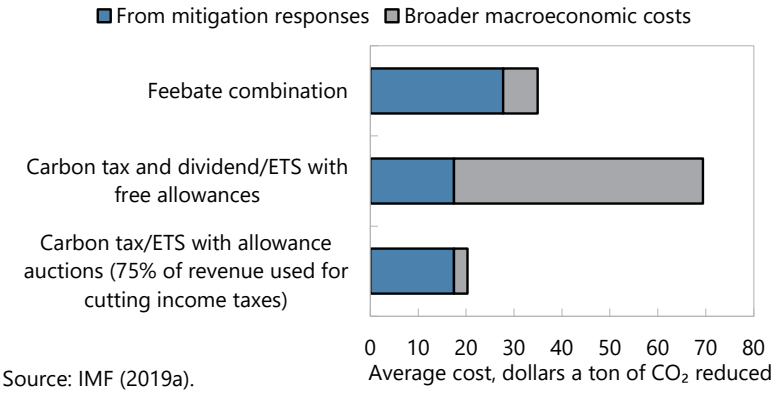
Source: WBG (2020) and Fund staff estimates.

- Free allowance allocations reduce potential revenue from allowance auctions and thus divert revenues away from the government budget. These revenues could be used to boost growth and employment, for example, by lowering taxes on work effort and creating incentives for innovation and socially productive investment, including in green technology where Korea aspires to take a leading position. Full allowance auctions in the Korean ETS in 2019 would have raised revenues of about 0.5 percent of GDP. A recent IMF assessment for the United States suggests that the most cost-effective policy—for a given nationwide emissions reduction—is by far an ETS with allowance auctions, or a carbon tax, with the bulk of revenues used to cut distortionary taxes on labor and business income or otherwise increase economic efficiency (Figure 7). Policies like feebates (explained below) that exploit opportunities for reducing emission rates and improving energy efficiency, but without a significant impact on energy prices, can also be more cost-effective than pricing schemes with free allowances that forego the economic efficiency gains from revenue recycling.[24]

[24] By raising energy prices, carbon pricing slightly contracts overall economic activity as it increases the general price level, which in turn reduces the real returns to work effort and investment. This causes some compounding of distortions in factor markets created by taxes on labor and capital income. In contrast, feebate and similar policies have much smaller impacts on energy prices, and hence cause smaller macroeconomic costs, because they do not involve the pass through of tax revenue or allowance rents in higher energy prices. A substantial analytical literature has explored these issues—see, for example, Goulder and others (1999), Parry and Williams (2012).

- Another drawback of free allowance allocation is that it can have adverse distributional consequences. Allowance rents in non-EITE sectors may be largely passed forward in higher consumer prices, creating windfall profits for firms and their shareholders (who tend to be concentrated in higher income groups).[25] In many cases, a key motivation for free allowance allocations is that they provide assistance for EITE industries. However, such assistance might be provided more efficiently through other means (see below).

Figure 7. United States: Efficiency Costs of $50 Carbon Tax or Equivalent Instruments, 2030



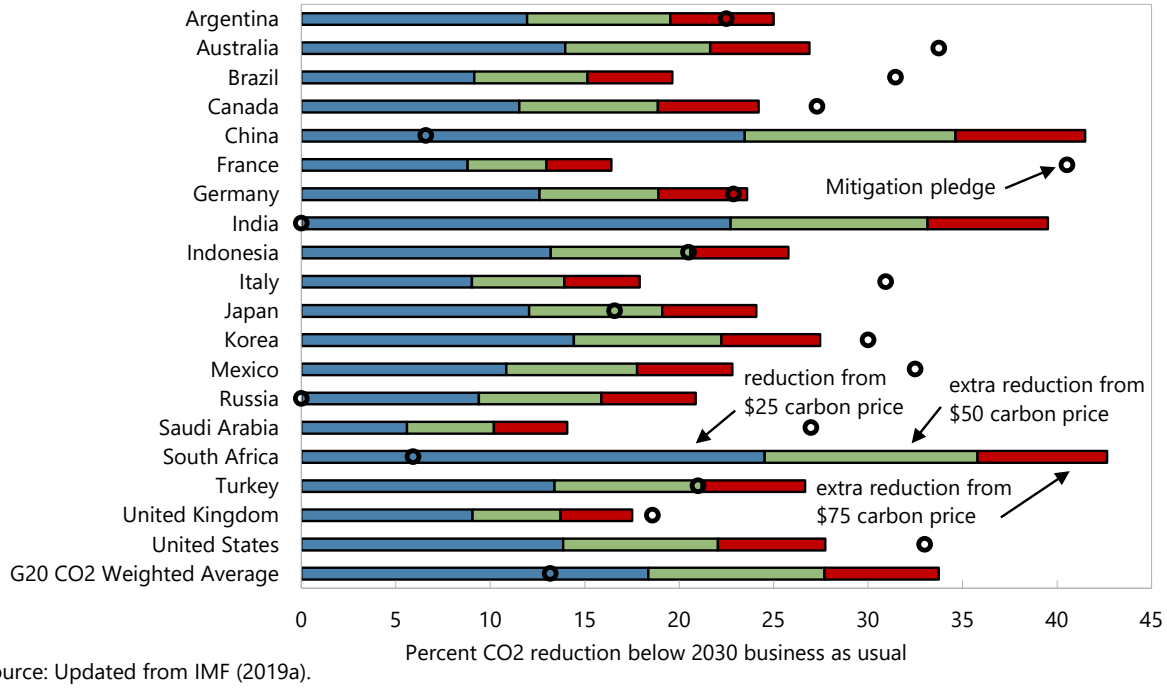
Source: IMF (2019a).
Note: All policies reduce economywide CO_2 22 percent below baseline levels. ETS with free allowance allocations ignores indirect revenue gains from business taxes on allowance rents.

15. High carbon prices are generally needed to achieve substantial emissions reductions, in Korea and other countries, if pricing is the only instrument used. For illustration, meeting Korea's NDC pledge exclusively through carbon pricing would require raising the 2030 CO_2 price by more than KRW 83,333 ($75) per ton on all fossil fuel CO_2 emissions from the current level ($18 per ton), and applying similar pricing or equivalent measures to other GHGs. CO_2 emissions are somewhat more responsive to pricing in Korea than in most other G20 countries (see Figure 8). This is due mainly to the higher share of coal in CO_2 emissions in Korea, implying that other countries would need even higher prices than Korea for meeting a comparable emissions target. Prices elsewhere may increase sharply in the next decade—for example, Canada has announced it will ramp up its carbon price to US$135 by 2030 and there will be upward price pressure in the EU ETS following the recent tightening of the EU's 2030 emissions target.

16. High carbon prices are often subject to acceptability constraints because of the impact on energy prices. For instance, an illustrative $50 per ton carbon price in 2030 would increase coal prices in Korea 156 percent, natural gas prices 33 percent, and retail electricity prices 36 percent. Higher electricity prices may also be at odds with long-term objectives for decarbonization through electrification of transportation and heating. Pump prices for gasoline would only increase 4 percent however, and the proportionate increases in energy prices tend on average to be about as large for other G20 countries as for Korea (Table 2).

[25] Parry (2004).

Figure 8. CO_2 Emissions Reductions for Mitigation Pledges and from Carbon Pricing



Source: Updated from IMF (2019a).
Note. Mitigation pledge is from Paris Agreement or subsequent national pledge. Price is additional to any existing pricing.

17. A comprehensive policy strategy could enhance the feasibility of stronger carbon pricing in support of Korea's mitigation objectives. Past experiences with energy and carbon pricing reform across the globe suggests that acceptability challenges can be overcome with a comprehensive approach that combines different policy instruments and levers:[26]

- A balance between national level pricing and reinforcing sectoral instruments, which are less efficient but often politically more acceptable (see below);
- Transparent, productive, and equitable use of carbon pricing revenues—for example, a carbon price of $50 applied to all fossil fuel CO_2 in Korea would raise revenues of 1.4 percent of GDP in 2030 with full allowance auctions;
- Assistance for vulnerable groups (low-income households, displaced workers, vulnerable regions, EITE industries—see below); and
- Extensive consultations with key stakeholders to garner their support and programs informing the public of the rationale for reform and how they benefit (e.g., from recycling of revenues and improved local air quality).

[26] See Coady and others (2018).

Table 2. Impact of $50 per ton Carbon Tax on Energy Prices in 2030, G20 Countries

Country	Coal		Natural gas		Electricity		Gasoline	
	BAU price, $/GJ	% price increase	BAU price, $/GJ	% price increase	BAU price, $/kWh	% price increase	BAU price, $/liter	% price increase
Argentina	2.9	211	2.6	100	0.08	40	1.2	10
Australia	2.9	148	8.5	33	0.10	53	1.2	11
Brazil	2.9	156	2.6	99	0.12	6	1.3	9
Canada	2.9	173	2.6	94	0.10	8	0.9	13
China	2.9	159	8.5	32	0.09	51	1.1	9
France	4.9	84	7.9	35	0.12	2	1.7	6
Germany	5.2	91	7.9	34	0.13	14	1.7	6
India	2.9	159	8.5	20	0.09	65	1.2	10
Indonesia	2.9	165	8.5	27	0.11	53	0.5	26
Italy	5.2	91	7.9	35	0.13	14	1.8	6
Japan	2.9	158	8.5	33	0.11	32	1.3	8
Korea	2.9	156	8.5	33	0.14	36	1.4	4
Mexico	2.9	156	2.6	110	0.09	55	0.9	13
Russia	2.9	134	6.6	36	0.13	20	0.8	12
Saudi Arabia	2.9	162	6.6	40	0.19	28	0.5	23
South Africa	2.9	145	6.6	17	0.07	78	1.1	13
Turkey	2.9	159	6.6	41	0.09	32	1.4	8
United Kingdom	5.7	101	7.9	35	0.13	10	1.6	6
United States	2.9	170	2.6	103	0.08	39	0.7	15
Simple Average	3.4	146	6.4	50	0.1	34	1.2	11.0

Source: IMF staff calculations.
Note: BAU prices are retail prices estimated in Coady and others (2019), including preexisting energy taxes, and adjusted for projected changes in international reference prices. BAU prices for coal and natural gas are based on regional reference prices. BAU prices for electricity and gasoline are from cross-country databases. Impacts of carbon taxes on electricity prices depend on the emission intensity of power generation. GJ = gigajoule; kWh = kilowatt-hour.

18. In summary, carbon pricing should remain the centerpiece of Korea's mitigation strategy, but it could be strengthened by aligning Phase 4 remissions caps with the 2030 emissions target, setting exogenous and progressively rising floor and ceiling prices under the ETS to enhance price certainty, and transitioning to full allowance auctions. These refinements would be mutually reinforcing and would increase the effectiveness of carbon pricing at cutting emissions and promoting low-carbon investment, enhance compatibility with overlapping instruments, while providing more revenue to support the GND or other budgetary priorities. A flexible approach may be needed however, for example price floor and ceiling trajectories may need to be adjusted in response to future progress technology development and on carbon pricing in other key emitting countries.

C. Sectoral-Based Policies

19. Sectoral mitigation instruments have a critical role to reinforce carbon pricing, though insofar as possible they should rely on the price mechanism to contain costs on the economy.

Acceptability constraints on pricing imply a need for sectoral instruments. And even with aggressive carbon pricing, additional instruments may be needed to achieve sectoral targets, especially for sectors with low responsiveness of emissions to pricing (this will imply some divergence in implicit carbon prices across sectors). Broader market failures (e.g., associated with clean technology infrastructure networks, or knowledge spillovers from new technologies) may also warrant additional policies, though often these should be targeted at specific technologies (e.g., power grid extensions, battery storage). Where the objective of sectoral instruments is to mimic key behavioral responses that would be induced by pricing, ideally, they would be designed flexibly, allowing firms and households to choose responses that minimize costs for a given emissions reduction.

20. The discussion below focuses on feebates as a sectoral instrument that can complement Korea's ETS. Feebates apply a sliding scale of fees to products or activities with above average emission rates and a sliding scale of rebates to products or activities with below average emission rates. Feebates can maintain revenue neutrality over time through updating of the 'pivot point', that is, the emission rate above/below which fees/rebates apply. Feebates reduce the emissions intensity of products or activities but without the same demand response as carbon pricing (e.g., reductions in electricity demand or in vehicle km driven), as they do not involve the pass through of carbon tax revenues or allowance rents in higher energy prices. For the same reason however, they may have greater political traction than pricing. Feebates are the fiscal analogue of emission rate regulations but they are automatically cost effective (regulations require extensive credit trading to be cost effective) and they provide ongoing incentives to reduce emissions (the average firm has no incentive to go beyond the standard under regulation). Feebates also promote a wider range of mitigation responses than clean technology subsidies and they avoid a fiscal cost. The discussion takes in turn applications of feebates to the sectors of road transportation, power, industry, buildings, and forestry—other emissions sources including from agriculture, F-gases, and waste sites are discussed in Annex II.

Transportation

21. Replacing EV and HV tax exemptions with a more comprehensive feebate would provide stronger incentives for progressively and cost-effectively decarbonizing the vehicle fleet as envisaged in the GND, while avoiding a fiscal cost to the government. For passenger vehicles, a comprehensive feebate would apply a fee to vehicle sales given by:

$$CO_2 \text{ price}$$

$$\times \{CO_2/\text{km} - CO_2/\text{km of the new vehicle fleet}\}$$

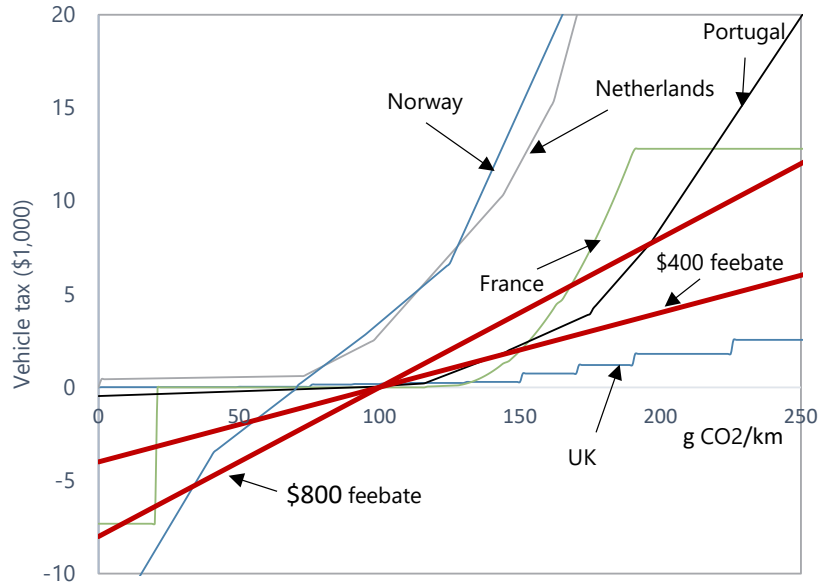
$$\times \{\text{lifetime vehicle km of the average vehicle}\}$$

Certified CO_2/km emissions by model type (currently used to administer vehicle emissions standards) can provide the data needed to assess the fees and rebates for each vehicle. The feebate has several desirable features as it:

- Promotes the full range of behavioral responses for reducing emission rates—shifting from high emission to low emission conventional vehicles and from these vehicles to EVs and HVs (EV and HV subsidies only promote the latter responses)—as there is always a continuous reward (lower taxes or higher subsidies) from switching from any vehicle with a higher emission rate to one with a lower emission rate[27];
- Is cost effective as the reward is always proportional to the reduction in the emission rate; and
- Maintains (approximate) revenue neutrality (unlike EV and HV subsidies which have a net fiscal cost)—by definition, fees offset rebates as the average CO_2/km in the formula is updated over time.

22. For illustration, a feebate with a price of $400 per ton CO_2 would apply a rebate of $4,000 for EVs and HVs and a fee of $4,000 for a vehicle with CO_2 emission rate of 200 g CO_2/km. These rebates and fees would be twice as high under a feebate with a price of $800 per ton.[28] Some European countries with elements of feebates generally impose even higher taxes on high emission vehicles than these illustrative feebates (Figure 9). Subsidies for EVs and HVs would decline over time as the average fleet emission rate declines, which is appropriate as the cost differential between clean vehicles and their gasoline counterparts falls over time (e.g., with improvements in battery technologies[29]). Gauging how fast the average emission rate falls in the future in response to a given feebate price is tricky given uncertainty about how the composition of vehicle sales is affected

Figure 9. CO_2-Based Components of Vehicle Taxes, Selected Countries



Source: ACEA (2018) and Fund staff estimates.
Note. Feebates assume fleet average emission rate of 100 g CO_2/km and discounted lifetime driving of 100,000 km.

[27] Vehicle manufactures are therefore rewarded for going beyond the CO_2/km standard (and penalized for falling short of it). The current system does include elements of a feebate in the sense that conventional vehicles are subject to a 5 percent excise while EVs and HVs are not. The system, however, provides only blunt incentives to reduce emissions—for example, conventional vehicles with the same price pay the same tax even though they may have very different emission rates.

[28] For comparison, current tax exemptions in Korea provide a subsidy for EVs of up to $4,000.

[29] EV battery costs have declined 90 percent over the last decade (see www.bloomberg.com/graphics/2020-peak-oil-era-is-suddenly-upon-us).

by changes in relative vehicle prices—the feebate price is, however, easily scaled up if needed to speed up the adjustment.

Electric Utilities

23. The current RPS is insufficient for meeting renewable energy targets in power generation. Studies suggest that under current policies Korea will fall short of meeting its targeted 20 percent renewable energy share by 2030.[30] The RPS ratio is however expected to be raised to meet mid-to-long-term renewable energy targets— a 20 percent renewable energy share by 2030 and 30 to 35 percent by 2040. The RPS could be reinforced with a feebate applied to electric utilities. Under a feebate scheme for this sector, utilities would be subject to a fee depending on the average emissions associated with the power generation they purchase given by

$$\begin{aligned} &CO_2 \text{ price} \\ &\times \{CO_2/kWh - \text{industry-wide average } CO_2/kWh\} \\ &\times \text{electricity sales} \end{aligned}$$

The feebate cost-effectively, and in a revenue-neutral way, promotes the full range of responses for reducing emission rates per kWh. These include improving generation efficiency and shifting of fuels from coal to gas and from these fuels to fossil plants with CCUS and renewables.[31] In contrast, the RPS promotes only the last of these responses. A feebate would complement the RPS in the sense that utilities would be rewarded (through rebates) for going beyond the RPS standard. Indeed, there seems ample potential to accelerate the transition to carbon-free generation in Korea, with the right incentives in place.[32] Fast action to de-carbonize electricity generation is a critical first step for reducing emissions in other sectors, where electrification will play an important role.

24. For illustration, a feebate with a price of $50 per ton would currently apply a subsidy of 3.5 cents per kWh for zero-carbon electricity and a fee of 1.4 cents per kWh for coal plants (see Figure 10). Natural gas generation would receive a subsidy of 1.5 cents per kWh. Subsidies for renewables and natural gas, however, would decline over time (eventually turning into a fee in the case of gas), while the fee on coal would increase, as the average emission rate of electricity declines over time.

[30] See for example APERC (2019). CAT (2020) projects a renewable energy share of 8-17 percent in 2030 under current policies.

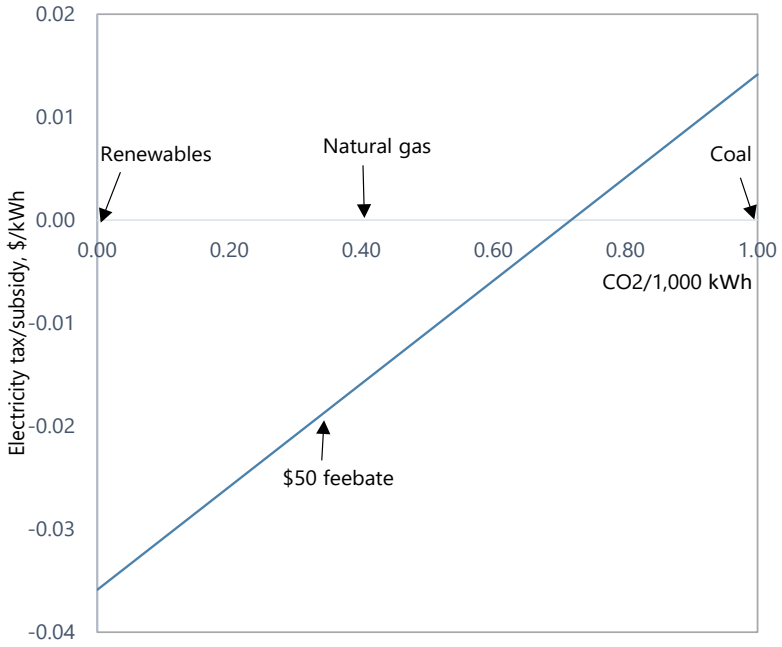
[31] In principle, shifting to nuclear power would be another option though Korea plans to phase out nuclear by 2083.

[32] Some studies suggest that a renewable share of more than 50 percent of generation in 2030 would be feasible for Korea (Climate Analytics, 2020), largely due to the expansion of solar photovoltaics and wind.

Industry

25. Feebate schemes for industries could be considered to reinforce incentives for reducing emissions if the government faces constraints on carbon pricing. The burden of carbon pricing on industry—prior to compensation schemes like free allowance allocations—consists of the costs of cutting emissions (e.g., from switching to cleaner but more expensive technologies) and the, typically much larger, allowance purchase payments for remaining emissions (see Annex III). Under a feebate scheme the latter component would be absent for the average firm and in this sense the feebate could be easier to scale up. Specifically, under a (revenue-neutral) feebate firms would pay a fee (or receive a transfer) given by

Figure 10. Illustrative Feebate for Electric Utilities



Source: Fund staff estimates.

$$\begin{aligned} &CO_2 \text{ price} \\ &\times \{CO_2/\text{production} - \text{industry-wide average } CO_2/\text{production}\} \\ &\times \text{production} \end{aligned}$$

For a given industry, the feebate would apply to the same firms as currently covered by the ETS, thereby limiting extra administration as emissions for these firms is already monitored. Annex III provides illustrative comparisons of the impacts of carbon pricing and feebates on production costs in the steel and cement industries.

Buildings

26. Improvements in the energy efficiency of new and existing buildings, and appliances used in buildings, reduce both direct emissions and (through lowering electricity demand) indirect emissions.[33] These improvements may however be hindered by possible market failures (e.g., liquidity constraints, cost-benefit mismatches between owners and renters, unawareness or uncertainty of energy savings from renovation).[34] The Korean government sets energy efficiency

[33] Promoting electricity conservation is still important, even if power generation were fully decarbonized, to ensure demand/supply balance given constraints on renewable generation sites.

[34] See for example Arregui and others (2020).

standards for a wide range of products (e.g., air conditioners, washing machines, TVs, lighting, refrigerators); provides tax credits for energy efficiency upgrades in buildings; sets codes for the design, construction, alteration, and maintenance of buildings; and improves consumer awareness of energy efficiency through labelling programs.[35] The GND also includes incentives and resources for green remodeling and the construction of energy-efficient facilities.

27. Various feebate schemes could complement existing measures by strengthening incentives for energy efficient and low carbon appliances and equipment. For example, sales of refrigerators, air conditioners, and other energy-consuming products could incur a fee given by:

$$\begin{aligned} &CO_2 \text{ price} \\ &\times CO_2 \text{ per unit of energy} \\ &\times \{\text{energy consumption per unit} - \text{industry-wide energy consumption per unit for the product}\} \\ &\times \text{number of units} \end{aligned}$$

For refrigerators, for example, the energy consumption unit would be kWh per cubic foot cooled (and the number of units would be cubic feet). A similar scheme applying taxes to gas- and oil-based heating systems, and a subsidy for electric heat pumps, could accelerate the transition to zero-carbon heating systems. Again, feebate schemes can avoid a fiscal cost; the carbon prices in feebate programs across different product categories are easily harmonized to promote cost effectiveness (under regulatory approaches there is no automatic mechanism for equating incremental mitigation costs across programs); and these schemes provide ongoing incentives to go beyond current standards.

Forestry

28. Ideally, forestry policies should cost-effectively promote, nationwide, the three channels for increasing forest carbon storage. These include: (i) afforestation; (ii) reducing deforestation; and (iii) enhanced management of tree farms (e.g., planting larger trees, longer rotations, fertilizing, tree thinning).[36] Expanding forest coverage generates other environmental co-benefits beyond carbon storage such as biodiversity preservation and reduced risks of water loss, floods, soil erosion, and river siltation.

29. A national feebate program could cost-effectively promote all responses for increasing carbon storage without a fiscal cost to the government. The policy would apply, to landowners, a fee given by:

$$\{CO_2 \text{ rental price}\}$$

[35] MOTIE (2015).

[36] Korea's updated NDC envisions projects to enhance the capacity of carbon sinks in the forestry sector but it lacks a mechanism to automatically, and cost-effectively, promote all such opportunities.

× {carbon storage on their land in a baseline year ─ stored carbon in the current year}

This scheme would reward all three channels for enhancing carbon storage, either through reduced fees or increased subsidies (unlike, for example, an afforestation subsidy which just rewards one channel). Feebates can be designed—through appropriate scaling of the baseline over time[37]—to be revenue-neutral in expected terms. Feebates should involve rental payments—on an annualized basis, a CO_2 price times the interest rate[38]—rather than large one-off payments for tree planting, given carbon storage may not be permanent (e.g., due to subsequent harvesting or loss through fires, pests, windstorms). While still rudimentary, forest carbon inventories are estimated through a combination of satellite monitoring, aerial photography, and on-the-ground tree sampling.[39]

D. Trade and International Perspectives

30. There is an active debate on trade and international coordination aspects of carbon mitigation and Korea—being a large industrialized country and a leader on the green transition—might usefully engage in this debate. The trade issue relates to the use of BCA, which the EU plans to introduce in 2023 and Canada, the U.K. and U.S. are currently considering.[40] The coordination issue relates to debate about an additional international mechanism to complement the Paris Agreement by scaling up action among key emitters in a multilateral way.

31. BCAs have three main rationales.[41] First, they help to alleviate the adverse impacts on industrial competitiveness from carbon-price-induced increases in energy prices, which can be critical for enhancing the political viability of carbon pricing. Second, they reduce the risk of 'emissions leakage', that is, partially offsetting increases in emissions in overseas countries induced by domestic mitigation policy.[42] Third, at an international level, they might encourage (through BCA exemptions for those with adequate pricing) stronger carbon pricing in other countries. The last rationale would have limited relevance for Korea, at least if Korea were acting unilaterally.

32. A BCA would impose charges for the embodied carbon in imports and, if the primary motivation is to address competitiveness and leakage concerns, it might be limited to products competing with EITE industries. These industries account for over 90 percent of emissions embodied in all Korea's manufacturing exports.[43] A BCA can be more effective at assisting

[37] See Parry (2020) for details.

[38] Periods might be defined as averages over multiple years given that carbon storage might be lumpy during years when harvesting occurs.

[39] See Mendelsohn and others (2012), Parry (2020) for further discussion of design issues for forestry feebates.

[40] For example, the U.S. Administration's Climate Plan contains a proposal for a BCA (see https://joebiden.com/climate-plan). Worldwide, only one BCA has been implemented to date, applying to the embodied carbon in imported electricity under California's ETS (e.g., Pauer 2018).

[41] For example, Morris (2018).

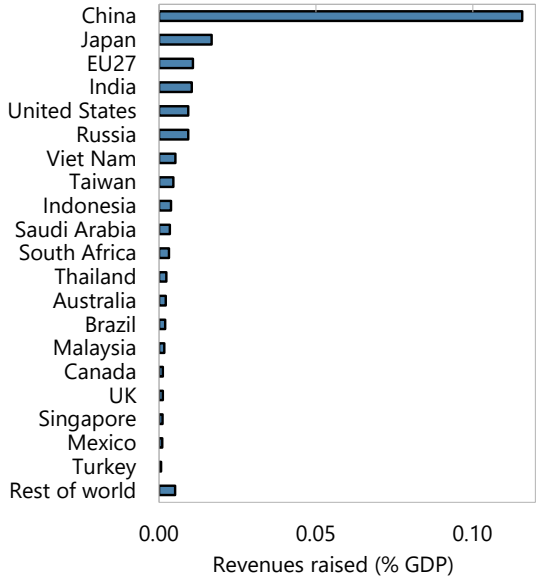
[42] One estimate suggests the leakage rate for carbon pricing in Korea (i.e., the increase in overseas emissions per unit reduction in domestic emissions induced by pricing) is 22 percent (IMF 2021, Ch. 2).

[43] OECD (2021).

EITE industries than free allowance allocation—under the latter the base of the compensation declines over time with deeper emissions reductions (Annex III). For illustration, a $50 BCA applied by Korea would have raised revenues of about 0.4 percent of GDP in 2015.

33. Concerns about BCAs revolve around administrative burdens and legal risks. A BCA would be administratively burdensome if it applied to imports of every product from every trading partner, but administration is much simpler if it is limited to EITE industries. Other design issues include whether to allow rebates for individual overseas exporters that are less carbon intensive than the industry average, how to adjust charges for carbon pricing or mitigation measures in trading partners, and whether to rebate charges for embodied carbon in exports—but all should be practical from an administrative perspective. Another concern about BCAs is the possibility of legal challenges at the World Trade Organization (WTO), or retaliation by trading partner. These legal risks are difficult to gauge ahead of time, but limiting the BCA to EITE industries might enhance the prospects for legality under trade law.[44] The authorities should consider whether a BCA might be an appropriate instrument for Korea, following early experiences with the prospective EU BCA, as an interim measure to more comprehensive international pricing—revenues from the BCA could help to fund Korea's clean energy transition.

Figure 11. Revenue from %50 BCA, 2015



Source: OECD (2021).

34. Although the 2015 Paris Agreement was a landmark achievement in international cooperation, an additional international mechanism is likely needed to stay on track with climate stabilization goals. The Paris Accord helped to galvanize the development of climate mitigation objectives at the country level and in some cases strong policies to implement these objectives. Even if all parties achieved their emissions pledges however, this would be cutting global emissions about 10 percent below projected levels for 2030 whereas emissions reductions of 28 percent and 55 percent would be consistent with a linear emissions pathway to 2°C and 1.5°C respectively.[45] One difficulty with the agreement is that there are many signatories (195) and targets are difficult to compare. Another difficulty is that countries acting unilaterally have limited incentives to scale up mitigation action due to concerns about competitiveness and free rider issues. A complementary international mechanism to the Paris Agreement should be effective, that is, contain a concrete plan to deliver the needed emissions reductions by 2030. And it should facilitate

[44] Reducing carbon leakage is a potential legal justification for trade measures like BCAs under GATT Article 20 (e.g., Flannery and others 2020).

[45] Updated from IMF (2019a).

negotiation, that is, it should be limited to a few key countries and a small number of transparent parameters.

35. One potential complementary mechanism is an international carbon price floor (ICPF) among large emitters. An agreement focused on China, the EU, India, and the US would cover nearly 70 percent of global emissions, or on the G20, would cover 80 percent of emissions. And focusing the agreement on a carbon price floor would have several key attractions: (i) this is an efficient and easily understood parameter; (ii) a simultaneous increase in effective carbon prices would help to address competitiveness and free rider concerns and avoid pressure for BCAs; (iii) the arrangement could be designed equitably, with stricter requirements for higher income countries and/or transparent technological or other assistance for lower income countries; and (iv) the arrangement might be designed flexibly to accommodate different approaches (e.g., ETSs, combinations of pricing, feebates, regulations) at the national level if they achieved equivalent emissions outcomes as would have been achieved by implementing the price floor. An ICPF could be highly effective in scaling up mitigation.[46] Korea might usefully contribute to international dialogue among large emitting countries on complementary mechanisms to the Paris Agreement.

E. Summary of Recommendations

- **Achieving Korea's goals of greening and de-carbonizing its economy will require further strengthening of the current policy framework**. This could be achieved through a comprehensive package of measures at the national (i.e., economy-wide) and sectoral level. Possible elements of such a package include:

- Aligning the trajectory of annual emissions caps with the 2030 emissions target.

- Underpinning the ETS with an exogenous and automatically rising floor price and ceiling.

- Transitioning to full auctioning of ETS allowances with revenues used to fund the clean energy transition and/or lower the burden of taxes on work effort.

- Replacing tax exemptions for EVs and HVs with a more comprehensive, revenue-neutral feebate to enhance incentives for low-emission vehicles;

- A feebate to reinforce incentives for shifting to carbon free power generation;

- Feebate schemes for the industrial sector to provide incentives for cleaner technologies with limited impacts on competitiveness and emissions leakage;

[46] For illustration, price floors of $75, $50, and $25 per ton respectively in 2030 for the three largest projected global emitters alone (the United States, China, and India) would be sufficient to keep G20 emissions in line with a 2°C target. See Parry (2020).

- Feebates to reinforce incentives for switching to carbon free space heating and more energy-efficient appliances and machinery;
- Considering whether a BCA might be an appropriate instrument for Korea, at some future point, perhaps after early experiences with an EU BCA.; and
- Contributing to multilateral dialogue on possible international arrangements among large emitters to complement and reinforce the Paris Agreement.

Table 3. Korea: Recommended Fiscal Instruments to Reinforce the Country's Mitigation Strategy

Sector	Instrument
Economy-wide	Align emissions caps in Phase 4 of the ETS with the 2030 emissions target; set an exogenous and progressively rising price floor underpinning the ETS; and transtion to full allowance actions. Auction revenues can be used for: (i) supporting the clean energy transition; (ii) lowering taxes on work effort and investment.
Power	Introduce feebate: a sliding scale of fees/rebates on generators with above/below average CO_2/kWh to complement the RPS and accelerate shifting to cleaner fuels, without a new tax burden on the average generator.
Road transport	Implement a fully comprehensive feebate for passenger vehicles: a sliding scale of fees/rebates applied to all vehicles with above/below average CO_2/km to build off existing fiscal incentives and complement emissions regulations. The feebate price can be set aggressively to promote EVs and HVs without a new tax burden on the average motorist or fiscal cost.
Industry	Introduce feebates: a sliding scale of fees/rebates on firms with emission rates above/below the industry average emission rate. Feebates can provide powerful incentives for cleaner production processes without a large tax burden on the average firm which lessens concerns about competitiveness and emissions leakage.
Buildings	Supplement energy efficiency regulations and building codes with: (i) a tax-subsidy scheme promoting shifting from natural gas/oil heating systems to electric or other clean fuel systems; (ii) feebates to promote more efficient appliances and lighting.
Forestry	Introduce a nationwide feebate applied to landowners equal to an (annualized) CO_2 price times the difference between forest carbon storage on their land in a baseline period and carbon storage in the current period. This promotes the full range of mitigation responses with no burden on the average landowner or fiscal cost to the government. Forest carbon inventories are monitored with satellite and aerial imagery and on the ground sampling.
Trade/international	Consider a BCA for EITE industries (in place of free allowance allocations) but also promote dialogue on a (far more effective) carbon price floor for scaling up action among large emitting countries.

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Annex I. Supplementary Information on Korea's Mitigation Policies

Table A1. Korea: Elements of the Korea Green New Deal

	Funding 2020-2025, KRW trillion		Employment gains, thousands	Examples of projects
	Public	Local government and private		
Green infrastructure	**12.1**	**18.0**	**387**	
Public buildings	6.2		243	Retrofit public rental housing, daycare centers, cultural factities, and schools with renewable equipment (e.g., solar panels) and high performance insulation.
Ecosystem restorations (terrestrial, marine, and urban)	2.5		105	Urban afforestation (e.g., barriers against fine dust and between roads and pavements); restore ecosystems in national parks, damaged urban areas, and tidelands.
Clean and safe water	3.4		39	Upgrade water supply systems (through ICT and AI), sewage treatment plants, water purifcation plants, and water pipelines.
Low carbon and decentralized e	**24.3**	**11.5**	**209**	
Smart grids	2		20	Advanced metering for 5 million appartments; reducing emissions from diesel generation; underground cables for power/telecommunications in school zones and
Renewable energy and fair transition	9.2		38	Feasibility studies for offshore wind; support to households, industry, and farmers for renewable investment; support for transitioning coal dependent regions to renewable energy.
Expanding electric and hydrogen vehicles	13.1		151	Support for: (i) 1.13 million EVs (cars, buses, trucks) charging stations (15,000 rapid, 30,000 slow); (ii) 0.2 million hydrogen vehicles and 450 charging facilities; (iii) fuel cell plants and hydrogen distribution infrastructure; and (iv) scrappage of old diesel cars and the transition
Innovation in green industry	**6.3**	**1.3**	**63**	
Encouraging green industry	3.6		47	Support: (i) R&D, testing and commercialization for 123 SMEs in environmental and energy sectors; (ii) complex of startups for improving environmental, transportation and residential infrastructures; (iii) regional hub for green technologies; (iv) energy use monitoring technolgies; and (v) facilities preventing fine dust.
R&D and financial sector	2.7		16	Support: commercialization of CCUS by 2023 and technologies for using captured CO_2; development of recycling processes (e.g., for old machinery, engines, special vehicle exhausts); and green businesses and operations.
Totals	**42.7**	**30.8**	**659**	

Source: Government of Korea (2020).
Note. ICT: information and communication technology; AI: artifical intelligence; LPG: liquefied petroleum gas.

Table A2. Korea: Elements of the Korea Green New Deal

Design issue	Details
Phases	Launched January 1 2015. 1st phase: 2015-2017. 2nd phase: 2018-2020. 3rd phase: 2021-2025.
Coverage (as of 2019)	685 large emitters (for Phase 3). 64 subsectors from 6 sectors: power generation, industry, buildings, waste, domestic Industry includes iron and steel, petrochemical, cement, oil refinery, nonferrous metals, paper, textile, machinery, mining, glass, ceramics, and others. Inclusion thresholds: company >125,000 tons CO_2/year, facility >25,000 tons CO_2/year. 73 percent of GHGs All six Kyoto gases (CO2, CH4, N2O, PFCs, HFCs, SF6), though CO_2 is by far the most important.
Emission caps, mn tones CO_{2e}	Phase 1: 2015: 540; 2016: 560; 2017: 567; total: 1,686 (includes 88 reserve permits). Phase 2: 548 per year; total: 1,796 (includes 153 reserve permits). Phase 3: 609 per year; total 3,045. Reserve permits are for new entrants, market stabilization, and early action.
Allowance allocation	100, 97, and 90 percent of allowances given free to non-EITE sectors in Phase 1, 2 and 3 respectively; EITE sectors receive 100 percent free allowances in all phases. Allocations 28 out of 69 sub-sectors receive 100 percent free allowances
Auctions and revenue	3 percent of allowances for non-EITE entities auctioned intially (the first regular auction was January 2019) rising to 10 percent in Phase 3. Only non-EITE industries can bid and no one entity can buy more than 30 percent of the total allowances. Revenue collected in 2019 was
Minium auction price	Determined by : {[average allowance price over the previous three months] + [average price of last month] + [average price over the previous three days]}/3.
Banking and borrowing	From Phase 2 to Phase 3 banking is limited to the higher of: (i) the net annual amount of allowances sold in Phase Two; and (ii) company- and facility-specific limits, of 250,000 and Borrowing is allowed only within a single trading phase and is restricted (e.g., in 2018, 15 percent of an entity's obligations).
Market stability provisions	Third parties (e.g., financial institutions) can participate in secondary trading markets to increase liquidity. An Allocation Committee can intervene in the event of allowance price volatility (e.g., when market allowance price of six consecutive months is at least three times higher than the average price of the two previous years) through stabilization measures (e.g., additional allocation from the reserve, changing borrowing and offset limits).
Offsets	In Phase 3 entities can cover 5 percent of their emissions with offsets with up to half of the offsets from overseas projects.
Monitoring and enforcement	Annual emission reports must be submitted within three months from the end of a compliance year with emissions verified by a third-party. Penalties for non-compliance are up to three times the average allowance price in the compliance year.
Institutions involved	Ministry of Environment: supervises the ETS; Ministry of Economy and Finance: chairs the Allocation Committee; Korea Exchange: supervises trading markets; Greenhouse Gas Inventory and Research Center: maintains a registry and provides technical support.

Source: ICAP (2020).

Annex II. Pricing Miscellaneous Emissions Sources

1. This Annex briefly discusses emissions from agriculture, waste and fluorinated (F-) gases.

2. *Agriculture*. Agricultural GHGs can be reduced through several channels. Reducing livestock herds (particularly beef and dairy cattle, but also pigs) reduces methane releases from enteric fermentation and nitrous oxide emissions from manure while reducing crops reduces nitrous oxide emissions from soils, especially where there is intensive chemical fertilizer use. At the consumer level, shifting from meat and dairy products to plant-based and poultry diets would reinforce mitigation incentives.

3. Pricing could be based on proxy estimates of emissions but a compensation scheme for the farm sector may be needed to enhance acceptability and limit emissions leakage. Direct monitoring of farm level emissions is not currently practical, but emissions can be estimated indirectly using farm-level data (on livestock herds, feed, crop production, fertilizer use, and acreage) and default emissions factors.[1] Emissions taxes may face strong political opposition and could cause significant emissions leakage as the tax burden reduced the international competitiveness of Korean farmers. A feebate approach is worth studying, perhaps based on GHG equivalent emission rates per hectare or nutritional value. Another approach would be to combine an emissions fee with the revenues recycled to the agricultural sector in the form a rebate proportional to the value of farm output. This scheme would cost-effectively promote all behavioral responses for reducing the emissions intensity of farming and, from an administrative perspective, the fees and rebates could be integrated into collection procedures for business tax regimes for farmers. Demand responses at the household level might be promoted through taxes on meat and dairy products though there may be some lessons to be learned by the mixed success of previous experiences with 'sin' taxes.[2]

4. *Waste*. For emissions leakage from waste sites (due to the bacterial decomposition of organic waste) the case for fiscal instruments over regulation is less compelling. One reason is that landfills are predominantly managed by the public sector. Another is that mitigation responses are limited—they include capturing the methane for flaring, for use in energy, and diverting waste for recycling and re-use—and are relatively straightforward to specify in regulation. Indeed, the EPA finalized standards to reduce methane emissions from new, modified, and reconstructed municipal solid waste landfills in 2016 though requirements were postponed in 2019.

5. *F-gases*. These gases could be progressively phased out through taxation. These chemicals, which are used in refrigerants, foams, aerosols, and fire extinguishers, were developed as a substitute for ozone-depleting chemicals but have warming potentials hundreds of times higher than CO_2. Unlike other GHGs in the Paris Agreement, HFCs have other international negotiations—under the 2016 Kigali Agreement, advanced countries are required to reduce HFCs 85 percent

[1] IPCC (2019).

[2] See Batini and Fontana (2020).

(relative to 2011-2013 levels) by 2036 (though the United States has not yet ratified the treaty). In 2015, the United States prohibited HFCs for uses where acceptable alternatives were available, however enforcement of this rule was suspended in 2018. Phasing in a tax on HFCs (in proportion to the global warming potential of the gas) would be an administratively straightforward way to progressively reduce their use and would be a more flexible than a regulatory approach.[3]

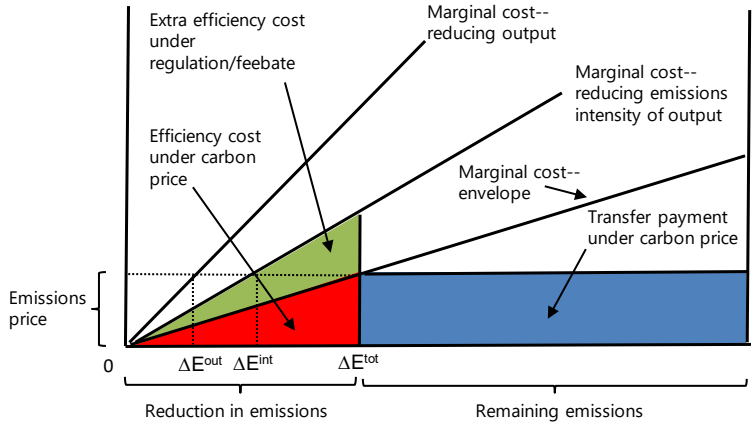
[3] Denmark, Norway, Poland, Slovenia, Spain, for example, have implemented these taxes with rates equivalent to around US$5-40 per tonne of CO_2 equivalent (e.g., Brack 2015).

Annex III. Burden of Carbon Mitigation Policies on Industries

Conceptual Analysis

1. The burden—or increase in private production costs—for industries from carbon mitigation policies is depicted graphically in Figure A1. Here the upper, middle, and lower curves are respectively the marginal cost of reducing emissions through reducing domestic industry output, reducing the emissions intensity of output and the envelope of these two curves. A carbon pricing policy reduces emissions by ΔE^{tot}, with ΔE^{int} and ΔE^{out} coming from reduced emissions intensity and reduced output respectively. The burden of carbon pricing on industries has two components. One is the economic efficiency cost of the behavioral responses (the red triangle in Figure A1) reflecting the resource cost of adopting cleaner (but costlier) production methods. The other is the transfer payment, for example, payments to the government for emission allowances to cover remaining emissions (the blue rectangle).

Figure A1. Burden of Carbon Mitigation Policies on Industry



2. Alternative mitigation instruments to carbon pricing are less efficient but may impose a much smaller burden on industries. A feebate applied to an industry reduces emissions intensity but (to an approximation) has no impact on output as, unlike a carbon price, it does not charge for remaining emissions. The burden of the feebate (for the same industry emissions reduction as under the carbon price) includes a higher efficiency cost (the extra green triangle in Figure A1) but there is no transfer payment—the overall burden is therefore generally lower under the feebate.

Illustrative Impacts of Carbon Pricing and Feebates on Production Costs for Steel and Cement

3. *Steel*. Traditionally steel is produced using an integrated process involving heating coal to form coke, feeding coke and iron ore into a blast furnace, and using an oxygen furnace to purify the molten metal—the process produces about two tons of CO_2 per ton of steel.[1] Alternatives include an electrified process using scrap metal, and emerging technologies—for example, applying CCS, or feeding an electric furnace with iron made by direct reduction (e.g., using natural gas). These alternatives produce CO_2 emissions of about 0.3–0.4 tons per ton of steel.

[1] Unless otherwise noted, all data in this Annex is taken from van Reijven and others (2016).

4. A carbon price of $50/ton of CO_2 would increase the cost of integrated production by about $100/ton of steel through the first-order transfer payment, about one sixth of recent steel prices.[2] And it would increase the cost under alternative technologies by about $20/ton of steel.[3] In contrast, under a feebate the cost increase for integrated production (given an assumed industry average emission rate of 1 ton of CO_2 per ton of steel) would increase $50 per ton of output, while alternative technologies would receive a subsidy of about $30 per ton of output.

5. *Cement.* Most cement is produced using traditional kilns to decompose calcium carbonate into clinker and CO_2 and then using mills to mix clinker with other minerals like limestone and grinding it—the process produces about 1 ton of CO_2 per one ton of cement, with process emissions contributing about 70 percent of these emissions. Alternatives include state-of-the-art plants in terms of energy efficiency, currently about 10 percent of production, and CCS—either post-combustion (where CO_2 is extracted from exhaust gases) or oxy-combustion (where fuel is burned with a mixture of pure oxygen and exhaust gases). State-of-the-art plants largely eliminate non-process emissions. Post- and oxy-combustion reduce emissions about 55 and 85 percent respectively, while increasing capital costs by about 25 and 100 percent respectively.

6. A carbon price of $50/ton of CO_2 would increase the cost of traditional production about $50 per ton of cement, or about 40 percent,[4] while increasing the price of more efficient and CCS-fitted plants by $30, and $8–25 per ton of output respectively through the first-order transfer payment. In contrast, a feebate with price $50/ton of CO_2 would only increase the cost of traditional production by $5 per ton of cement, while providing a subsidy to more efficient and CCS-fitted plants of $10 and $18–35 per ton of output.

[2] See ww.focus-economics.com/commodities/base-metals/steel-europe.

[3] Technology switching is more likely to take the reform of retrofitting existing plants, rather than scrapping plants and building new ones, given that existing steel factories can potentially produce for several decades. Incentives will vary across plants, for example with local fuel and electricity prices.

[4]Cement prices are currently around $125 per ton (www.ibisworld.com/us/bed/price-of-cement/190).