International Carbon Price Floor Arrangements

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*The views expressed in IMF Working Papers are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

Abstract

This paper suggests policymakers (among a coalition of willing countries) consider the possibility of carbon price floor arrangements to complement the submission and revision of emissions mitigation pledges under the 2015 Paris Agreement. The economic and pragmatic case for agreements over emissions prices rather than emissions targets, and over price floors rather than price levels, is discussed. Issues in operationalizing the agreement are also considered, including monitoring 'effective' carbon prices which account for non-uniform emissions pricing and broader fiscal policy affecting the energy sector.

1. Introduction

197 parties submitted greenhouse gas (GHG) mitigation pledges for the 2015 Paris Agreement on climate change and a typical pledge among G20 countries is reduce emissions by around 30 percent by 2030 relative to emissions in a baseline year (see below). Under the Agreement, countries are required to report (every two years starting in 2018) progress on meeting these pledges and to submit revised pledges every five years, which are expected to be progressively more stringent.[1] The key practical issues (for countries taking these pledges seriously) are what specific policy actions are now needed and how obstacles to these actions might be overcome.

It is widely recognized among analysts and policymakers[2] that carbon pricing is easily the most effective instrument for exploiting potential behavioral responses across sectors, firms, and households to reduce energy-related carbon dioxide (CO_2);[3] raises substantial revenues

[1] The Agreement came into force on November 4, 2016, following ratification by over 55 countries accounting for over 55 percent of GHGs (see http://unfccc.int/paris_agreement/items/9444.php).

[2] See, for example, Krupnick et al. (2010), Parry et al. (2016), and www.carbonpricingleadership.org/carbon-pricing-panel.

[3] These emissions currently account for around 70 percent of global GHGs (e.g., UNEP 2016).

(see below); and can be straightforward administratively (e.g., as an extension of existing fuel taxes).[4] Many countries and regions have implemented, or are implementing, carbon pricing (see Table 1), though even when China introduces nationwide emissions trading in 2017 three quarters of global emissions will still be unpriced[5], and existing prices (e.g., $15 per ton of CO_2 or less in trading systems) are well below what is needed (see below).

At an international level, a key barrier to greater coverage, and higher levels, of emissions pricing is the free rider issue, that is, the reluctance of one country to incur abatement costs and losses in competitiveness from unilateral actions providing (global climate) benefits for all countries.[6] The Paris Agreement does not address the free rider issue in the sense that mitigation pledges are not enforceable (i.e., there are no penalties for countries failing to meet them).

Underpricing at an international level is familiar from other contexts, particularly where countries compete for mobile tax bases, and here some progress has been made through tax floor agreements (e.g., for indirect taxes in the European Union). The carbon pricing analog would be a coordinated CO_2 price floor among a coalition of willing (presumably large emitting) countries, complementing the Paris process, and based on an arrangement where it is in countries own interest to negotiate and implement a meaningful price (as others are bound by this price and individual countries benefit from the collective pricing by all countries).

This paper takes a look at some of the rationales for carbon price floor arrangements and the practicalities of operationalizing them. Some themes of the discussion include:

- Coordination over emissions prices, rather than emissions quantities, is generally preferable on economic grounds (e.g., it provides more certainty for mobilizing low-emission investment);

- Coordination over price floors rather than price levels provides flexibility which has appeal on both efficiency grounds (e.g., higher carbon prices are efficient for countries with high fiscal needs or high domestic environmental co-benefits) and pragmatic grounds (e.g., countries where aggressive pricing is more politically acceptable should not be held back);

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[4] For example, Calder (2015) and Metcalf and Weisbach (2009).

[5] WBG (2016).

[6] There is an extensive literature (see, for example, Benchekorun and Long 2012 and Hovi et al. 2015 for reviews) on international environmental agreements, much of which uses game theory to explore conditions under which agreements might be sustainable in the presence of free rider incentives.

- A measure of 'effective' carbon prices, accounting for possible non-uniform pricing of emissions across fuels and sectors and broader fiscal policy affecting energy (e.g., fuel excises) should be tracked to provide countries with flexibility in meeting the agreement and detect possible chiseling on the agreement;

- Conventions are needed for measuring effective carbon prices (e.g., to disentangle the influence of deliberate policy actions from changing economic conditions) but the analytical practicalities should be manageable; and

- Price floor agreements can accommodate carbon taxes and (with supplementary price safeguards) emissions trading systems (ETS).

The main message therefore, is that it is an opportune time for willing parties to consider how carbon price floor arrangements might be developed to enhance and strengthen momentum for mitigation under the Paris process.

2. Rationales for International Carbon Price Floors

This section briefly discusses the choice between quantity and price based mitigation targets and between price floor and price level agreements.

A. Price vs. Quantity Targets

Mitigation submissions for the Paris Agreement generally take the form of quantity targets to be achieved by a particular year. Among the G20 countries (who collectively accounted for 82 percent of global, energy-related CO_2 emissions in 2014[7]) a typical pledge is to reduce GHG emissions by around 15 to 40 percent by 2030, or 2025 for Brazil and the United States (Table 2, second column). For some countries, this reduction is relative to business as usual (BAU) emissions[8] in 2030, while in other cases it is relative to emissions in 1990 or 2005 (implying more stringent targets if BAU emissions are rising over time). In China and India, targets are for reductions in the emissions intensity of GDP (to accommodate rapid and uncertain GDP growth).

Quantity targets provide certainty over emissions, which may have political appeal, but as discussed below CO_2 price targets are generally preferable on economic grounds, and may be

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[7] IEA (2016a), Table II.4.

[8] That is, future emissions with no new mitigation policy initiatives beyond those implicit in recent fuel use data.

easier to agree internationally. Given the reality of the Paris Agreement (which resulted from over two decades of negotiation), the practical issue is whether it can be strengthened through a complementary pricing agreement among a sub-group of willing countries.

Economic Considerations

Economic analysis suggests that any annual emissions targets are best met on average over time (with predictable emissions prices) rather than rigidly adhered to on a year-to-year basis (with volatile prices).

Quantitative emissions targets are efficient when marginal environmental damages from emissions rise rapidly above a threshold level, suggesting that emissions should be held below the threshold regardless of abatement cost uncertainty.[9] This condition might apply to some flow pollutants with localized damages (e.g., that pollute a water body beyond its assimilative capacity). But it does not really apply to climate change where one country's emissions are a small fraction of global emissions and damages depend on the atmospheric stock of emissions (which has been accumulating since the Industrial Revolution), implying marginal damages from one country's annual GHGs are essentially constant. In other words, what matters is reducing cumulative emissions over time, and the least costly way to do this is to equate (the discounted value of) incremental costs at different points in time.[10] This price predictability is also viewed as critical for mobilizing investments with high upfront costs and long-range emissions reductions.[11]

International Negotiations

Initial estimates of the CO_2 emissions reductions in 2030 (or 2025) below projected BAU emissions for that year implied by the Paris targets vary widely (Table 2, sixth column) from around 20 percent or less in Argentina, India, Russia, and Turkey to around 50 percent or more in countries like Australia, France, and United Kingdom. Meeting these commitments will be challenging enough and strengthening them—which would be necessary for meeting the ambitious temperature stabilization targets in the Paris Agreement[12]—even more so, not

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[9] See, for example, Weitzman (1974).

[10] For example, for the United States Fell et al. (2012) estimate that, for a given cumulative CO_2 emissions reduction over time, price stability lowers discounted abatement costs by around a quarter relative to a policy with fixed annual emissions caps (and price volatility).

[11] Borenstein et al. (2016).

[12] According to UNEP (2016), existing emissions commitments are in line with containing long-run, mean projected warming to 3.0-3.2^{O}C, while meeting the Paris goal of containing projected warming to 2.0^{O}C implies global GHG emissions in 2030 should be around 42 billion tons compared with projections of 56 billion tons if (unconditional) Paris pledges are met. Nordhaus (2016) suggests the 2.0^{O}C target would be especially

least because of the reluctance of one country to be too far out in front of others. One obstacle under a quantity-based agreement is the difficulty of negotiating over numerous country-level targets and another is the lack of penalties for setting a relatively weak target.

Both obstacles may be less daunting under a pricing agreement. For one thing, this agreement could (initially) be limited to a small coalition of large emitters (rather than the 197 signatories to the Paris Agreement)[13] and could focus on one parameter, the price target for participants. For another, countries have a self-interest in voting for a meaningful price because this binds all participants—a higher price reduces emissions for all members, thereby conferring collective benefits on each individual country.[14]

B. Price Floor vs. Price Level Agreements

It is often suggested[15] that, on cost effectiveness grounds, carbon prices at a point in time should be equated across regions and countries, for example through harmonized carbon taxes or linked emissions trading systems (ETSs). This section discusses some reasons why differentiated pricing regimes may be preferable, including the heterogeneity in prices implied by the Paris pledges, the domestic environmental and fiscal impacts of carbon pricing, and political realities.

Prices implied by the Paris commitments

Estimated emissions prices needed to meet the Paris pledges are large for many countries, around $70 per ton of CO_2 in 2030 (in US $2015) or more in twelve G20 countries according to Parry et al. 2017) though the considerable dispersion in needed prices (much lower, for example, in China and India than in typical advanced countries) is the important point here. This dispersion reflects both the differing stringency of commitments and characteristics of

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challenging (e.g., it assumes development and widespread deployment later in the century of technologies that on net remove emissions from the atmosphere).

[13] EU experience with indirect taxes, for example, suggests it is easier to reach agreement among a smaller group of countries and that later participants are accepting of the initial provisions. Once the group becomes large, agreement on major reforms becomes more challenging (e.g., since enlargement of the EU, attempts to reform tax floors for energy products have stalled).

[14] See, for example, Cramton et al. (2016). Weitzman's (2014) analysis suggests that countries will tend to vote for an emissions price in the ballpark of the global environmental damages from carbon.

[15] For example, WBG (2016), Ch. 4.

national energy systems.[16] From a pragmatic perspective—not least given obstacles to a global carbon market[17]—an international regime may need to accommodate countries requiring significantly different prices to meet their mitigation commitments.

Domestic environmental benefits from carbon pricing

Some degree of differentiation in carbon prices can also be efficient, when account is taken of the domestic environmental benefits, including (most importantly) reductions in mortality rates from exposure to fossil fuel outdoor air pollution and (less importantly) reductions in traffic congestion, accidents, and road damage to the extent higher road fuel prices reduce vehicle use (and these externalities are not fully reflected in fuel taxes). There are far more efficient instruments for reducing these externalities, for example, local air pollution could be efficiently addressed through Pigouvian charges on emissions or upfront charges on fuel use combined with credits for downstream mitigation (like sulfur dioxide 'scrubbers' at coal plants) and traffic congestion through progressively rising and falling fees on busy roads during the rush hour. Until these ideal pricing policies have been comprehensively implemented it is appropriate (as consistent with long established principles in public finance[18]) to account for (unpriced) domestic environmental benefits when assessing the efficiency impacts of carbon pricing policies.

Figure 1 shows, for G20 countries in 2013, estimates of the (second-best) efficient prices for coal, natural gas, gasoline, and (road) diesel needed to cover supply costs, global warming—assuming (for illustration) a damage value of $40 per ton of CO_2[19]—domestic externalities, and (where applicable) general consumption taxes applied to other household products. For coal, the local air pollution damages are more than the global warming costs for ten countries and more than double global warming costs for six countries (e.g., densely populated China where there is a lot of population exposure to emissions) though damages are modest in other cases (e.g., sparsely populated Australia). For natural gas, air pollution damages are small in all cases (due to much lower emission rates than for coal) relative to carbon damages, while

[16] For example, the relative responsiveness of emissions to pricing tends to be greater in heavy coal users like China, India, and South Africa.

[17] For example, some emerging market economies may lack the institutional capacity to credibly monitor ETSs; there are compatibility issues in linking ETSs (e.g., due to exchange rate fluctuations); and countries may be reluctant to link as they lose control over domestic emissions prices. Moreover, linking can reward countries with low mitigation ambition through financial inflows creating perverse incentives. See, for example, ADB (2016), PMR (2014).

[18] See Harberger (1964).

[19] Based on updating US IAWG (2013).

road fuels, especially for diesel, tend to be underpriced (e.g., due to large externalities from congestion and accidents in the case of gasoline vehicles).

The figure underscores the ample scope in many countries for significant domestic environmental benefits from carbon pricing, at least to the extent emissions reductions come from reduced use of coal or road fuels, effectively implying negative costs from carbon pricing up to a point.[20] These potential benefits however differ considerably across countries, implying that countries with relatively high benefits may wish to price carbon more aggressively than others, at least until more efficient instruments are comprehensively implemented, though this will likely be a long time.[21]

Fiscal considerations

Potential revenues from carbon pricing to meet Paris mitigation pledges are substantial—typically around 1-3 percent of GDP or more in 2030 across G20 countries (Parry et al. 2017). Shifting taxes off labor and capital and onto fossil fuels might (up to a point) be efficiency improving, even leaving aside the environmental benefits (this is termed the 'double dividend'). Taxes on labor and capital distort the overall *level* of economic activity (by reducing the returns to work effort and investments in human and physical capital) and its *composition* (e.g., by promoting informality, spending on tax favored goods like housing, untaxed fringe benefits).[22] Lowering these taxes through recycling of carbon pricing revenues alleviates both types of distortion and, up to a point, the resulting efficiency gains can outweigh efficiency losses from the impact of higher fuel prices on contracting economic activity and compounding tax distortions in factor markets.[23] Accurately quantifying the efficiency impacts of carbon tax shifts is challenging however, as they depend on which taxes are being cut (e.g., personal income, payroll, consumption, corporate income) and there is limited evidence on the empirical magnitude of broader tax distortions in different countries. The practical point, nonetheless, is that high carbon prices can be appealing as a source of large, easily-collected

[20] See Parry et al. (2014) for further discussion.

[21] With the odd exception (e.g., Chile) countries have yet to impose prices on air pollution emissions set at their estimated Pigouvian levels—emissions control regulations are common (and are reflected in the emissions rates underlying the damages in Figure 1), but they still leave some emissions unpriced.

[22] See, for example Saez et al. (2012).

[23] See, for example, Bento et al. (2013), Parry and Bento (2000), Parry et al. (2014).

revenue, especially when revenues from broader taxes are constrained (e.g., due to a large concentration of economic activity in the informal sector).

Political considerations

The political acceptability of carbon pricing may differ considerably across countries[24], suggesting the desirability of a flexible regime accommodating countries that are willing and (politically) able to price emissions more aggressively than others. A problem with linked ETSs in this regard is that it imposes a uniform emissions price across countries—one country can unilaterally reduce emissions by tightening its own cap or (if the cap is set regionally) purchasing allowances to withdraw them from the system, but in both cases emissions prices are increased across all participating countries, potentially generating opposition from those opposed to higher prices.

3. Operationalizing Issues

An important consideration for carbon price agreements is that (e.g., for political or competitiveness reasons) at the country level certain emissions sources may be subject to lower or zero prices[25], and the effectiveness of a direct carbon price might be partially undermined—or enhanced—by changes in broader fiscal policies (e.g., fuel taxes, exemptions for household fuels from general consumption taxes) affecting the energy sector. It is potentially important therefore to track measures of 'effective' carbon prices to account for these factors and serve as a check on chiseling.[26] The measurement of effective carbon prices and their role in international agreements is discussed below.

The focus is on fossil fuel CO_2 emissions which are straightforward to measure (e.g., from fuel use and CO_2 emissions factors)—the pricing agreement might be progressively extended over time as administrative capacity is developed to reliably price other GHGs (e.g., from agriculture, changes in land use).

A. Measuring Effective Carbon Prices

[24] This may partly explain the wide dispersion in carbon prices. For example, CO_2 prices in 2016 were above US $50 per ton in Finland, Norway, Sweden, and Switzerland, between about $10 and $25 per ton in eleven other national and regional pricing schemes, and less than $10 per ton in 17 other programs (WBG 2016).

[25] For example, Sweden imposes a tax of $131 per ton of CO_2 on motor and heating fuels in the household and service sectors, a tax of $105 per ton of CO_2 for heating fuels used by industry, and no tax for industry emissions covered by the EU ETS (Susan Åkerfeldt, personal communication).

[26] That is, undermining a direct carbon price through special provisions or reductions in broader energy taxes.

The contribution of direct carbon pricing to effective carbon prices is sometimes calculated from a weighted average of CO_2 prices, where the weights are the share of total emissions facing a particular price. And similarly, the contribution of pre-exiting energy taxes (e.g., fuel excises) have been included by expressing them in carbon tax equivalents and again weighting them by the share of the covered emissions.[27]

However, ideally the relative environmental effectiveness of the pricing components would also be taken into account. For example, ETSs applying to power plants and large industrial sources typically cover only about 50 percent of economy-wide CO_2 emissions but (because these sectors account for a disproportionately large share of low-cost mitigation opportunities) might have, say, 75 percent of the effectiveness of an (equivalently-scaled) pricing policy covering all emissions, implying that the ETS price should be weighted by 0.75 rather than 0.5 in measuring the effective nationwide price. Conversely, the contribution of a fuel tax to the effective carbon price will be smaller the less responsive the fuel to carbon pricing. A highly simplified analytical framework for measuring effective carbon prices is first discussed, followed by some illustrative calculations.

Simplified analytical framework

The effective carbon price is defined here as the CO_2 price of a comprehensive and uniform carbon pricing scheme having the same effect on CO_2 emissions as any existing pricing scheme and system of energy taxes/subsidies. Suppose, for simplicity, countries use just four fossil fuels—coal, natural gas, gasoline, and road diesel—indexed by i. CO_2 emissions from fuel i are $\beta^i X^i$, where β^i is the emissions factor and X^i is fuel consumption. Assuming explicit or implicit carbon charges are fully passed forward into consumer prices, linear fuel demand curves, and leaving aside cross-price effects among fuels, the effect of existing carbon pricing and fuel taxes on CO_2 is:

$$(1)\ \sum_i \beta^i \cdot \frac{dX^i}{dp^i} \cdot t^i$$

where p^i is the price of fuel i and t^i is the tax rate including any carbon charge (if the fuel is covered by an ETS). The expression in (1) is the change in fuel use induced by the existing

[27] OECD (2015) provide these calculations for over 40 (mostly advanced) countries using quite detailed tax data.

carbon price/energy tax system, multiplied by the emissions factor, and aggregated over fuels.

If there were simply a uniform carbon price of τ per ton of CO_2, and no other price distortions in fuel markets, the impact on emissions would be the following

$$(2)\ \tau \sum_i (\beta^i)^2 \cdot \frac{dX^i}{dp^i}$$

given that the carbon price increases the fuel price by $\tau\beta^i$. Equating (1) and (2) gives (with a little manipulation) the effective carbon price, τ^E:

$$(3)\ \tau^E = \frac{\sum_i s^i \cdot \eta^i \cdot t^i / p^i}{\sum_i s^i \cdot \eta^i \cdot \beta^i / p^i}$$

where $s^i = \beta^i X^i / \sum_i \beta^i X^i$ is the share of fuel i in total emissions and $\eta^i = (dX^i/dp^i)(p^i/X^i)$ is the price elasticity of demand for fuel i (evaluated here at current fuel use and prices).

Illustrative calculations

The formula in (3) is implemented here using country-level data from Parry et al. (2017). This includes: projections of fuel use and fuel prices; estimates (assumed constant in real terms across future periods) of fuel taxes or subsidies[28] including implicit carbon charges on fuels covered by ETSs; and price elasticities (based on empirical evidence and results from energy models) for coal and natural gas of -0.35 and for road fuels of -0.5. Figure 2 indicates the results for years 2015, 2020, and 2030. There are a couple of noteworthy points.

First, within a given year, effective carbon prices (all expressed in US $2015) vary considerably across countries. For example, in 2015 they are $27 per ton in the UK, $38 in Italy and $48 in France but less $10 per ton in Australia, Canada, China, India, Japan, Korea, Mexico, Russia, South Africa, Turkey and the US. Given such wide dispersion, harmonizing effective carbon prices is likely a non-starter for practical purposes. But nor is it desirable because (following from earlier discussion) existing energy taxes may, to some extent, be addressing domestic environmental and fiscal needs, which depend on national conditions.[29]

[28] This picks up the combined effect of fuel excises, any favorable treatment for household fuels under value added or general sales taxes, and possible price setting by state-owned enterprises.

[29] In principle effective carbon prices could be defined net of taxes needed to charge for domestic externalities (Parry, Heine, Li and Lis 2014) estimate externalities for over 150 countries), though this is likely impractical due to disagreements in measuring externalities (which require, for example, assumptions about how people in different countries value health risks from air pollution).

It makes more sense for countries to agree on minimal increases in their effective carbon prices relative to those in some baseline year.

The second noteworthy point from Figure 2 is that projected effective carbon prices in the BAU can change significantly without any change in fuel taxes and carbon charges, for example, rising relative prices for oil reduce the share of emissions from road fuels and dampen the emissions impact of (constant) road fuel taxes. In France and the UK, for example, effective carbon prices are $29 and $16 per ton respectively in 2030, about 40 percent lower than their corresponding values in 2015. This suggests that countries should agree on increases in effective carbon prices in future periods relative to effective carbon prices in that same year with no policy change, but allowing for changing economic conditions over time.

B. Implementing Price Agreements

The analytical challenges for tracking increases in effective carbon prices over time (relative to a no-policy-change baseline) seem manageable once measurement conventions (like fuel price elasticities, conversions from national to common currencies) have been agreed (presumably through delegation to an independent authority). [30]

Allowing countries to meet a price floor agreement through corresponding increases in effective carbon prices provides them with considerable flexibility as they can implement (direct) uniform carbon pricing, differentiated carbon pricing (so long as lower prices for favored sectors are compensated by higher prices for non-favored sectors), and/or adjusting fiscal policies (e.g., fuel taxes or subsidies) that are already in place.

Price (floor) agreements can also accommodate carbon taxes, which are most naturally levied on all fossil fuels as they enter the economy (in proportion to carbon content at the point of fuel extraction, processing, or distribution and imported fuels). ETSs could also be accommodated, with two provisions. One is that they would need price floors in line with the required minimum, or alternatively current and future emissions caps would need to be set such that projected emissions prices are at least equal to the required floor price. The other is that ETSs are typically implemented downstream on large industrial emissions sources, in

[30] One possibly thorny issue might be the treatment of royalties on fossil fuel extractive industries. At the country level, royalties do not affect domestic fuel use and emissions (at least if countries are price takers in international fuel markets), but if all fuel producing countries levy royalties there must be some impact on emissions at a global level.

which case a price exceeding the minimum is needed to compensate for the lack of pricing of small scale emissions (from vehicles, buildings, etc.).

Including the carbon price equivalents from quantity-based regulations (e.g., for energy efficiency or renewables) on the other hand, would be more challenging as the implicit prices would need to be estimated (by first comparing observed outcomes with those from a counterfactual where regulations do not bind and then assessing the pricing analog that would have the same effect as the regulation). These regulations also promote some of the same behavioral responses that are promoted by carbon pricing and double counting of these responses should be avoided. Moreover, it makes sense to limit the focus to pricing instruments, as price floor agreements are generally for countries with a preference for these instruments over regulatory approaches.

4. Conclusion

A recurring theme of the above discussion is the need for flexible international carbon pricing regimes that can accommodate the considerable heterogeneity in country circumstances and preferences. One additional form of flexibility might be to allow the possibility of two-speed systems, where countries that are already advanced in carbon pricing might initially be subject to a higher price requirement than newcomers that might need a 'catch up' period while they introduce pricing gradually over time. Future experiences in Canada—where provinces are required to phase in a CAN$50 carbon price floor by 2022[31]—should provide valuable lessons for operationalizing the same type of agreement among countries.

Enforcement (i.e., deterring countries from reneging on carbon pricing) remains a potential impediment to an effective carbon pricing agreement. For now, however, countries acting in their own self-interest can make significant progress—mitigation costs need not be large if recycling of carbon pricing revenues is done well, and, accounting for domestic environmental benefits, many countries are better off, on net, from carbon pricing. The priority is to start the process—implement carbon pricing domestically and work out the design details for coordination over time as a coalition of the willing emerges.

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Table 1. Carbon Pricing Schemes Around the World, 2016

Government	year introduced	Price 2015, US$/ton CO2	Coverage, % of GHGs	Government	year introduced	Price 2015, US$/ton CO2	Coverage, % of GHGs
CARBON TAXES				Norway	1991	52	50
Br. Columbia	2008	23	70	Portugal	2015	7	25
Chile	2014	5	42	Sweden	1991	131	42
Japan	2012	3	66	UK	2013	24	25
Mexico	2014	1-4	46	TRADING SYSTEMS			
South Africa	2016	10	80	Alberta	2007	15	45
Switzerland	2008	86	33	California	2012	13	85
In the EU ETS				EU	2005	5	45
Denmark	1992	26	45	Kazakhstan	2013	2	50
Finland	1990	60-65	15	Korea	2015	15	68
France	2014	25	35	N. Zealand	2008	13	52
Iceland	2010	10	50	Quebec	2013	13	85
Ireland	2010	22	40	RGGI	2009	5	21

Source. WBG (2016).

Notes. RGGI is the Regional Greenhouse Gas Initiative in the North Eastern United States.

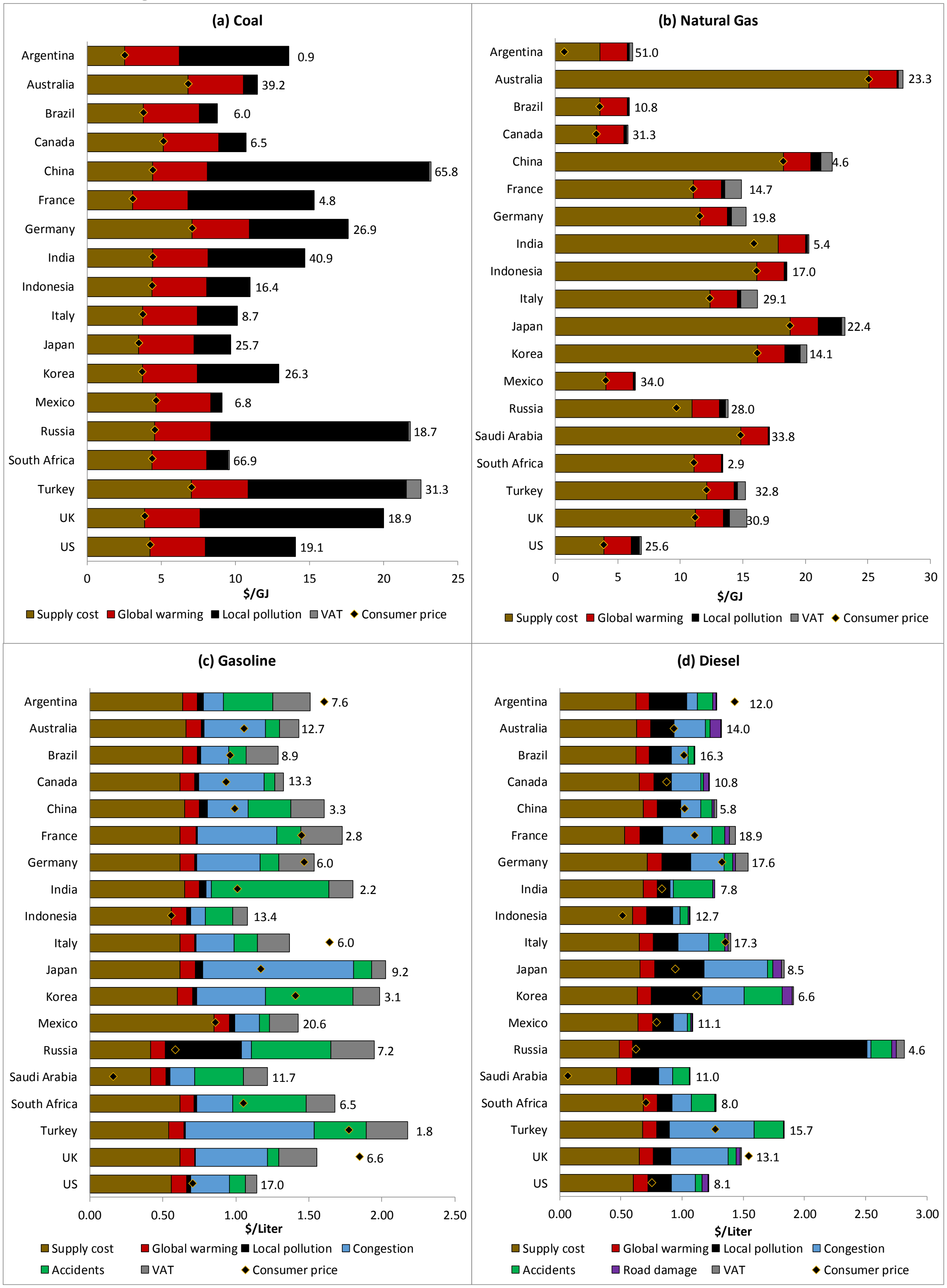
Table 2. Emissions Pledges for Paris, G20 Countries

Country	Mitigation pledge: Reduce…	2013 share of global CO_2	2013 tons CO_2/\$GDP	2013 tons CO_2 per capita	2030[a] Required CO_2 reduction, %
Argentina	GHGs 15% below BAU in 2030	0.6	0.29	4.3	15
Australia	GHGs 26-28% below 2005 by 2030	1.3	0.25	16.7	47
Brazil	GHGs 37% below 2005 by 2025	1.5	0.18	2.3	63
Canada	GHGs 30% below 2005 by 2030	1.7	0.28	15.3	45
China	CO_2/GDP 60-65% below 2005 by 2030	29.0	0.92	6.6	23
France	GHGs 40% below 1990 by 2030	1.0	0.11	5.0	39
Germany	GHGs 40% below 1990 by 2030	2.5	0.20	9.4	35
India	GHG/GDP 33-35% below 2005 by 2030	6.0	0.98	1.5	7
Indonesia	GHGs 29% below BAU in 2030	1.4	0.45	1.7	29
Italy	GHGs 40% below 1990 by 2030	1.1	0.15	5.7	37
Japan	GHGs 25% below 2005 by 2030	4.0	0.25	9.7	28
Korea	GHGs 37% below BAU in 2030	1.8	0.43	11.4	37
Mexico	GHGs 25% below BAU in 2030	1.5	0.35	3.7	25
Russia	GHGs 25-30% below 1990 by 2030	5.0	0.67	10.7	13
S. Arabia	GHGs 130 million tons below BAU by 2030	1.5	0.62	15.7	23
S. Africa	GHGs 398-614 million tons in 2025 and 2030	1.4	1.12	7.9	32
Turkey	GHGs up to 21% below BAU by 2030	0.9	0.34	3.7	21
UK	GHGs 40% below 1990 by 2030	1.4	0.16	7.0	37
US	GHGs 26-28% below 2005 by 2025	16.5	0.30	16.2	30

Source. UNFCCC (2016), IEA (2016b), and Parry et al. (2017).

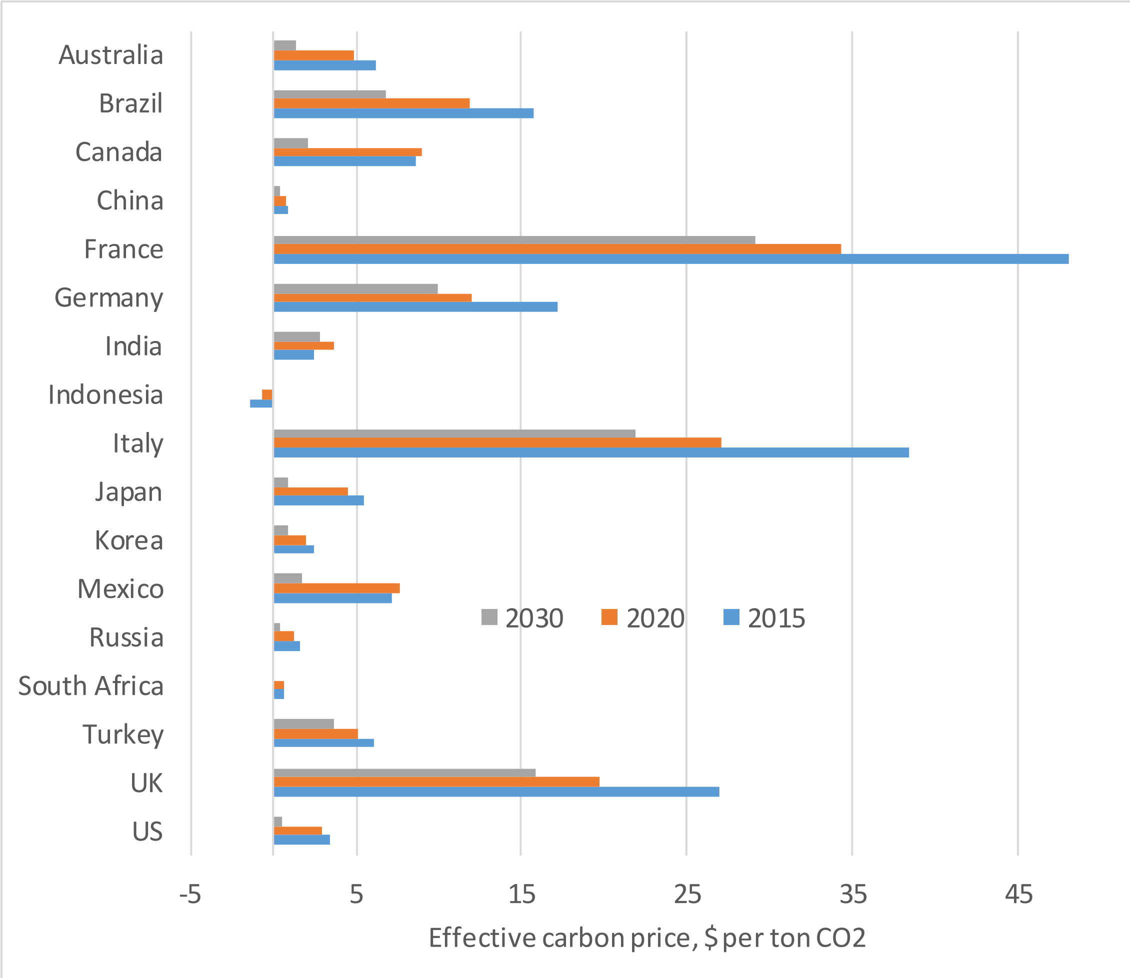
Notes. [a] For Brazil and the United States, figures refer to 2025. CO_2 reductions are assumed to fall in proportion to required GHG reductions, which is reasonable in most cases but not, for example, in Brazil and Indonesia, where much of the emissions reduction would likely come from slowed deforestation. The required CO_2 reductions are based on projections of future emissions in the absence of new policy initiatives and comparisons with emissions implied by mitigation pledge.

Figure 1. Current and Efficient Coal Prices in G20 Countries, 2013



Source. Coady et al. (2017). Note. Figures to the right of the bars are the share of fuels in primary energy.

Figure 2. Effective Carbon Prices in Selected G20 Countries



Source. See text.

Note. All figures are in US $2015.