Chapter 3

Effective carbon rates: Concept and scope

This chapter explains the concept of effective carbon rates, and provides an overview of the methodology and data sources used for their estimation. The treatment of emissions from the combustion of biomass, tax expenditures, fossil fuel support and value added taxes is discussed.

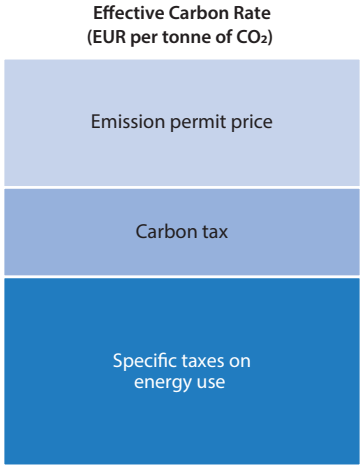
This short chapter defines the concept of effective carbon rates (ECRs) and provides an overview of the data used for their estimation. It discusses the treatment of emissions from biomass in the calculations, and the interaction between ECRs and fossil fuel support. Technical detail on the methodology used to estimate ECRs can be found in the annexes to this report.

Effective carbon rates: Definition

Effective carbon rates are the total price that applies to CO_2 emissions from energy use as a result of market-based policy instruments. They are the sum of taxes and tradable emission permit prices, and have three components (Figure 3.1):

- carbon taxes, which typically set a tax rate on energy based on its carbon content,
- specific taxes on energy use (primarily excise taxes), which are typically set per physical unit or unit of energy, but which can be translated into effective tax rates on the carbon content of each form of energy, and
- the price of tradable emission permits, regardless of the permit allocation method, representing the opportunity cost of emitting an extra unit of CO_2.

Figure 3.1. **Components of effective carbon rates**



Source: OECD (2015c), *Effective Carbon Rates on Energy: OECD and selected partner economies*, https://www.oecd.org/tax/tax-policy/effective-carbon-rates-on-energy.pdf.

Box 3.1. **Interpretation and cross-country comparisons of effective carbon rates**

The effective carbon rates, summarised and discussed in Part I and depicted on a country level in the graphical profiles in Part II of this report, include specific taxes on energy use, carbon taxes and emission permit prices. In other words, they include those taxes and permit prices that alter the relative price of energy use, which is the relevant category of instruments from an environmental pricing point of view, based upon the principle that specific taxes and permit prices can alter relative prices to reflect marginal environmental damages.

Box 3.1. **Interpretation and cross-country comparisons of effective carbon rates** *(continued)*

Consistent application of this approach renders the effective carbon rate profiles amenable to inter-country comparison. Nevertheless, in some cases data limitations limit inter-country comparability. As an example of data limitations, the tax profiles do not account for differentiated VAT rates on energy products. Such differentiated rates alter relative prices and should therefore be accounted for in principle. The section on the "Treatment of tax expenditures, support for fossil fuels and value added taxes" in Chapter 3 discusses this issue in some detail. It is also worth noting that the report allows comparison of specific energy taxes, but not necessarily of total taxes on energy use. To illustrate, if country A and country B have the same excise tax on diesel for road use, but country A applies a lower standard VAT rate than country B, then the total tax rate on diesel for road use is lower in country A than in country B, but the specific rate is the same. This report focusses on the specific rate, for the reasons outlined previously in this box.

A further point is that the three components of the effective carbon rates are included irrespectively of how the revenues raised through these instruments are used. Specific taxes on energy use are included irrespectively of the policy rationale underlying their introduction. For example, specific taxes on energy use contribute to general revenue in their great majority, but in some countries, specific taxes on transport energy are used to fund infrastructure, whereas other countries use road tolls for the same purpose. The first are included in the effective carbon rates, the second are not, as the tax base for road tolls is not transport energy use.

For countries with a currency other than the Euro it is worth recalling ECRs and their components are converted into Euros using the average exchange rate over the 6 months prior to 1 April 2012. When a non-Euro currency appreciates, taxes converted into Euros rise although tax rates within the country do not change. If the appreciation were temporary, a non-Euro country will show higher tax rates in Euros than would be the case for a longer term average. Vice versa, a country with a temporary depreciation of its currency will show lower rates.

Data on the specific taxes on energy use and the carbon taxes are taken from the *Taxing Energy Use* database (TEU database, see also the following section for detail). Consistent with the *Taxing Energy Use* methodology, "the taxes levied on electricity consumption are included into the calculation of effective carbon rates on the fuels used to generate electricity. In cases where a common nominal tax rate is applied to all electricity consumption, the effective tax rate on each underlying energy source (e.g. coal, natural gas, hydro) used to generate electricity is shown. Notably, when there is a general tax on electricity consumption that applies regardless of the generation source, and if carbon energy is a small proportion of the generation mix, the effective tax rate on carbon thus calculated will be high. A tax on electricity consumption that does not distinguish between electricity from carbon sources does not send an effective price signal about the use of carbon" (OECD, 2013, 2015a).

Finally, it deserves emphasis that the report expresses the components of the effective carbon rates in EUR per tonne of CO_2, irrespective of the units in which the statutory rates of these components are set, and irrespective of the different external costs against which the different components could be compared. For example, transport fuel taxes can be seen as a second-best instrument to internalise a range of external costs of road use, including e.g. congestion, noise, and air pollution, in addition to climate damage from CO_2 emissions. This implies that ideally the prevailing taxes on transport energy should be compared to the full range of external costs that they are intended to cover. Such comparison is beyond the scope of the report, but it is nevertheless clear that an effective carbon rate of more than EUR 30 is justifiable. The first reason is that EUR 30 per tonne of CO_2 is a low end estimate of climate costs from carbon alone. The second reason is that other external costs may matter, and these can be high.

Box 3.1. **Interpretation and cross-country comparisons of effective carbon rates** *(continued)*

The message in this report is not that an effective carbon rate of EUR 30 per tonne of CO_2 is necessarily sufficient for internalising external costs. Instead, the message is that a rate below EUR 30 per tonne of CO_2 is too low to reflect conservative estimates of the external climate costs of energy use alone. Higher estimates of external climate costs and inclusion of other external costs can justify significantly higher rates. Major shares of energy use, however, fail to meet this modest level.

Data for estimating effective carbon rates

ECRs are estimated for 41 countries and six sectors: road transport, offroad transport, industry, agriculture and fisheries, residential and commercial and electricity. Tax rates and energy use data are for 2012. Some countries have introduced substantial tax reform since 2012. While such reforms can be mentioned in the country chapters, they are not included in the present discussion for reasons of methodological consistency. Price data for emissions trading systems are for 2012 or the year nearest to 2012 during which the system was operational and price data are available, as is explained briefly in this section and in more detail in Annex A.

Data on two components of the ECRs, namely the specific taxes on energy use and the carbon taxes, are taken from the *Taxing Energy Use* database (TEU database). The TEU database underlies the detailed analysis presented in *Taxing Energy Use: A Graphical Analysis* (OECD, 2013) and *Taxing Energy Use 2015: OECD and Selected Partner Economies* (OECD, 2015a), referred to together as the TEU reports. This database provides comprehensive information on the rates and coverage of carbon and other specific energy taxes in 41 countries. Taxes on energy use are translated from their original units in physical or energy terms to effective tax rates in terms of the carbon content of the fuels to which they apply. The present report adds prices of tradable emission permits, where they apply, to the information on tax rates from the TEU database. In addition, it estimates the share of emissions that are covered by emissions trading systems. The estimates of the coverage of emissions trading systems rely on a specific modelling approach and set of assumptions, a highly detailed discussion of which is in Annexes A and B.

Table 3.1 lists the emissions trading systems that are included in the calculation of ECRs. The systems operate in 30 of the 41 countries and cover approximately 13% of total CO_2 emissions from energy use in these countries.

To make data on emissions trading systems comparable across countries both the share of CO_2 emissions from energy use covered by emissions trading systems, and the emission permit prices, are estimated from detailed system data for 2012. Emissions trading systems that started operating at a later date are evaluated as if they were operational in 2012 and consumption price indices correct prices for inflation. First, emissions data to estimate the coverage of emissions trading systems are taken from verified emissions registries where available; where not, they are approximated by permit allocation data or information on fuel use. Second, emission permit prices are estimated by a yearly average, or as close an approximation as possible given data limitations or the duration of operation of the system. Annex A describes these estimations in detail, including assumptions specific to individual emissions trading systems.

Table 3.1. **Emissions trading systems operate in 30 countries**

Emissions trading system	Country	Introduced in
Beijing Emissions Trading System	China	2013
California Cap-and-Trade Program	United States	2013
Chongqing Emissions Trading System	China	2014
European Union Emissions Trading System	31 European countries; of which 23 OECD member countries	2005
Guangdong Emissions Trading System	China	2013
Hubei Emissions Trading System	China	2014
Korea Emissions Trading Scheme	Korea	2015
New Zealand Emissions Trading Scheme	New Zealand	2008
Québec Cap-and-Trade System	Canada	2013
Regional Greenhouse Gas Initiative	United States (9 north-east and mid-Atlantic US states)	2009
Saitama Prefecture Emissions Trading System	Japan	2011
Shanghai Emissions Trading System	China	2013
Shenzhen Emissions Trading System	China	2013
Swiss Emissions Trading Scheme	Switzerland	2008
Tianjin Emissions Trading System	China	2013
Tokyo Cap-and-Trade Programme	Japan	2010

An emissions trading system generally applies to only a portion of a country's emissions. Its coverage is calculated by country and sector as a share, dividing the sector emissions subject to the emissions trading system by the country's total emissions in that sector. This is done independently of whether the system applies in the entire country or to a subnational jurisdiction. In the case of a supranational ETS (i.e. the EU ETS), shares of coverage have been calculated for the six sectors separately for each country in which the system applies. For subnational trading systems, coverage is calculated as a proportion of national emissions. As a result, this report provides for the first time consistent coverage estimates of emissions trading systems for six economic sectors in the 41 countries.

To construct the effective carbon rate estimate, the coverage and price signals of emissions trading systems are combined with those of taxes from the *Taxing Energy Use* database, across the full range of fuel types and users (see Annex A for more information on how these datasets were combined). This allows for a systematic comparative analysis of the combined price signals that energy users face from both types of market-based mechanisms. In cases where taxes do not apply because a source is subject to an ETS, these taxes are not included in the tax rate shown in the figures.

Treatment of CO_2 emissions from the combustion of biomass

Emissions trading systems frequently treat CO_2 emissions from the combustion of biomass differently than CO_2 emissions from other sources, due to differences in approaches to accounting for their net lifecycle emissions. In several emissions trading systems, CO_2 emissions from the combustion of biomass are not included. In the remaining systems, emissions from biomass are subject to the ETS when emitted by a facility subject to the ETS, but are zero-rated when calculating covered emissions, meaning that no permit needs be surrendered for biomass emissions.

A separate point relates to the treatment of CO_2 emissions from biomass in the results. This report includes results for two different approaches: "Biomass included" calculates total emissions in each country including CO_2 emissions from biomass at the point of combustion, which is the approach taken in the TEU reports (OECD, 2013 and OECD, 2015a), and "Biomass excluded" treats emissions from biomass at combustion as carbon neutral and does not include them in the calculation of total emissions. The subsection on the "Treatment of biomass in the calculations" in Chapter 4 and Annex A provide more detail.

Treatment of tax expenditures, support for fossil fuels and value added taxes

The effective carbon rate analysis considers all emissions trading systems and taxes on energy use in each of the 41 countries covered, including energy which is not subject to either instrument. However, it does not take into account support measures for fossil fuel use that may affect its price. The OECD's database of budgetary support and tax expenditures, discussed in the *OECD Companion to the Inventory of Support Measures for Fossil Fuels 2015* (OECD, 2015b), identifies and documents almost 800 individual policies that support the production or consumption of fossil-fuels in OECD and six selected partner economies. The inventory includes direct budgetary transfers and tax expenditures that provide a benefit for fossil-fuel production or consumption when compared to alternatives. Many of these tax expenditures are included in the *Taxing Energy Use* analysis, and therefore are reflected in the effective tax rates used for the calculation of ECRs.

Including support measures for fossil fuels as measured in OECD (2015b) but not accounted for in the *Taxing Energy Use* work, could affect energy prices in ways not captured in the effective carbon rates. If support measures outweigh the tax and emissions trading components of end-user prices calculated in the present report, energy prices may even turn out to be negative. However, because of the complexity involved in combining taxes and emissions trading systems into effective carbon rates, this report makes no systematic attempt to incorporate support measures for fossil fuels, while noting that removing support for fossil fuels is a very cost-effective policy for reducing CO_2 emissions, and referring interested readers to OECD (2015c) for an in-depth discussion.

Value-added taxes (VAT) affect end-user prices of energy products in many jurisdictions in addition to the three components of ECRs. VAT is usually not specific to energy products: as long as the same VAT rate applies, the relative prices of energy products remain unchanged. Differential VAT rates, however, do change the relative prices of energy products and VAT then becomes a *de facto* specific tax measure. When this is the case, policy makers may want to consider the impact of the differential VAT rates in changing the relative prices of energy products in conjunction with the effective carbon rates. OECD (2015b) provides an overview of the differential VAT rates that apply in the 41 countries. Seventeen countries apply reduced or zero VAT rates on selected energy products. This counteracts the intention to increase the relative end-user prices of energy products, and can mitigate or even offset the effective carbon rate, depending on the relative magnitude of the amount of price differentiation introduced by the differential VAT rate and the effective carbon rate.

The caveats about support measures and the potential impact of VAT notwithstanding, the ECRs are an important component – and in most of the 41 countries analysed, by far the dominant component – of policy-driven carbon pricing.

References

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