How stringent are environmental policies?

POLICY PERSPECTIVES

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How stringent are environmental policies?

A review of OECD work on indicators of environmental policy stringency (EPS)

It is a common perception that environmental policies have become increasingly stringent in response to environmental challenges, both global and local. However, cross-country analysis of the economic effects of environmental policies is held back by the lack of reliable, comparable measures of stringency. This brochure presents new quantitative measures of environmental policy stringency (EPS) developed by the OECD. The EPS indicator is a composite index, derived through the aggregation of information on selected environmental policy instruments, primarily related to climate and air pollution. It covers most OECD countries over 1990-2012, and has recently been extended to BRIICS (Brazil, Russia, India, Indonesia, China and South Africa). While the EPS indicator is a simplification of the multidimensional reality of environmental policies, it is a first tangible effort to measure the stringency of environmental policies internationally over a relatively long time horizon. It shows relatively high and significant correlations with alternative proxies of EPS used in the literature, such as measures of perceived stringency based on survey responses, outcomes and energy prices etc. This brochure provides a description of the OECD approach, the results and its properties as well as empirical applications and ongoing work on this topic.

What is environmental policy stringency (EPS)?

Environmental policies contribute to wellbeing and the long-term sustainability of growth. They strive to achieve environmental objectives that markets fail to deliver. Such policies tend to make pollution and, more generally environmental services, more costly in order to change both producer and consumer behaviour. In this respect, and for the purpose of this work, **stringency can be defined as the strength of the environmental policy signal – the explicit or implicit cost of environmentally harmful behaviour, for example pollution.**

The stringency of environmental policies has been hypothesised to have effects on economic activity, such as, for instance, competitiveness and innovation. Still, actual empirical insights on the effects of stringent policies have been weak and focused on specific policies in specific contexts (Kozluk and Zipperer, 2014). This has left the door open for interpretations that can often serve the interest of the firms and sectors targeted by the policies, to the detriment of economy-wide concerns – potentially both economic and environmental.

To respond to this issue, the OECD has collected data on selected environmental policies over countries and time in order to create a proxy of environmental policy stringency and check its effects on economic performance.

Our approach: The EPS Indicator

The OECD's environmental policy stringency (EPS) indicator aggregates information on selected environmental policies to create a composite measure of relative policy stringency across countries and over time (Botta and Kozluk, 2014) . The indicator focuses on upstream sectors, such as energy and transport, of prime environmental importance and similar relevance across countries. The policies covered are environmentally-related taxes, renewable energy and energy efficiency support (feed-in-tariffs, renewable energy certificates, R&D expenditures), performance standards (emission limit values for coal fired power plants and sulphur content limits in diesel fuels) and information on deposit and refund schemes. Currently, the indicator focuses primarily on air and climate policies.

The indicator is scored on a 0 to 6 scale, where 6 denotes most stringent policies. For each underlying policy instrument, stringency is defined as a higher implicit or explicit price placed on the relevant environmental damage produced by firms or consumers. Policies can alter the costs of pollution in different ways. "Stick" type policies, that directly raise the costs of polluting behaviour, are considered more stringent the higher the taxes or the stricter the standards. "Carrot" type policies, which reward "environmentally-friendlier" activity (thereby raising the relative costs of pollution), are assumed more stringent the higher the support such as feed-in-tariffs or R&D subsidies. Page 5 presents the structure of the EPS indicator including more technical details on the policy instruments and aggregation. Overall, the EPS measure should be treated and used as a proxy for aggregate environmental policy stringency. The following sections show how countries score on the EPS indicator and discuss the properties, advantages, disadvantages and challenges of such an approach.

Data sources and relevant links

EPS indicator website: http://oe.cd/eps

Environmental Policy Stringency data:

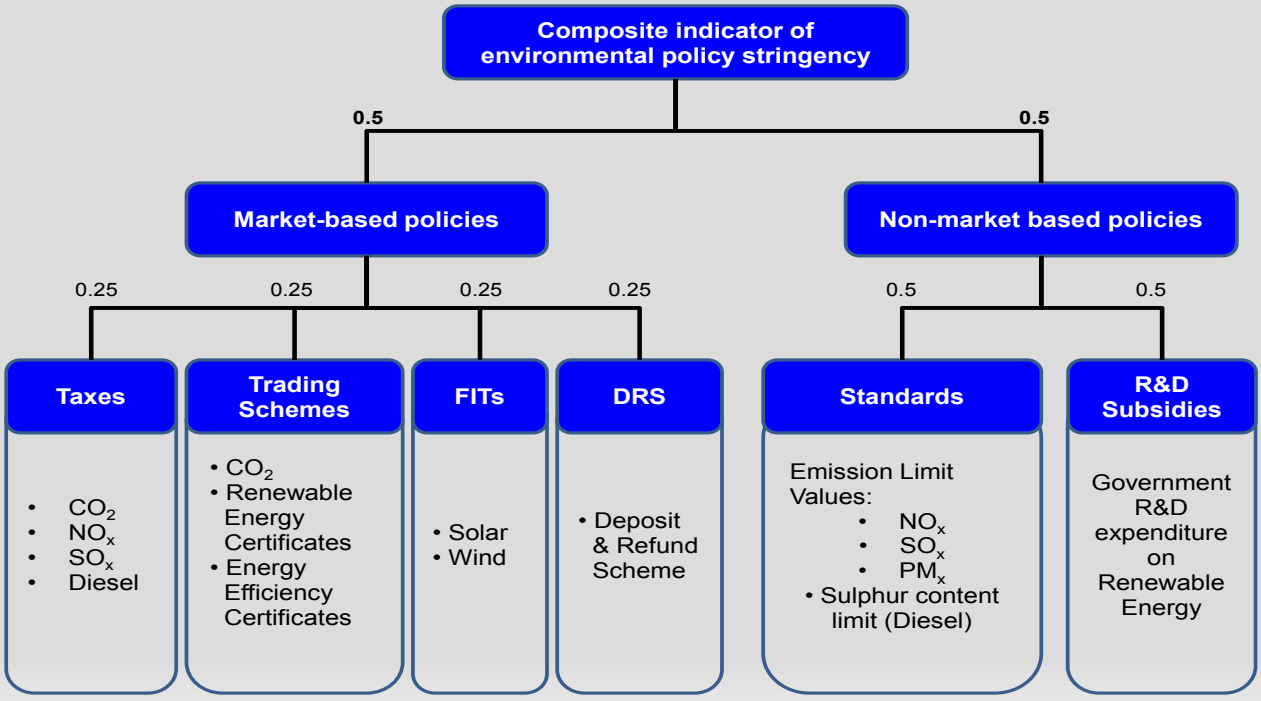
http://stats.oecd.org/Index.aspx?DataSetCode=EPS

THE STRUCTURE OF THE EPS INDICATOR

The overall structure of the EPS index is presented in Figure 1. For each individual instrument, the quantitative or qualitative information is normalised where relevant (e.g. taxes on pollutants from the electricity sector are rescaled using electricity prices). They are then scored on a 0-6 scale increasing in stringency (0 is assigned when the instrument is not present in a country). The thresholds for each bin are determined based on the stringency of the given measures across countries and time. The country scores are then aggregated by instrument type (taxes, trading schemes, emission standards, etc.), instrument category (market-based and non-market based) and further on using equal weights at each stage. In practice, the country rankings are relatively robust to alternative weighting and aggregation. The indicator covers the years 1990-2012 for 24 OECD countries. For federal countries, where some of the key instruments are applied at the sub-national levels, the national indicator is a weighted average of regional policies, where weights are the share of each region in electricity consumption/production.

In 2015, the EPS indicator was extended to cover BRIICS (Brazil, Russia, India, Indonesia, China and South Africa). This required two minor modifications due to data constraints (Kozluk and Timiliotis (2016)). First, the subindicator on deposit and refund schemes was excluded. All other subindicators were reweighted accordingly. Second, public expenditures on R&D in renewable energy for the BRIICS were interpolated at low levels (score of 1). Over the entire sample of OECD countries, the extended EPS indicator is highly correlated to the original one, with a correlation of 0.92 (significant at 1%).

Figure 1. **Aggregation structure of the composite index of EPS**



Note: FITs encompasses feed-in tariffs and feed-in premiums for renewable energy (wind and solar).

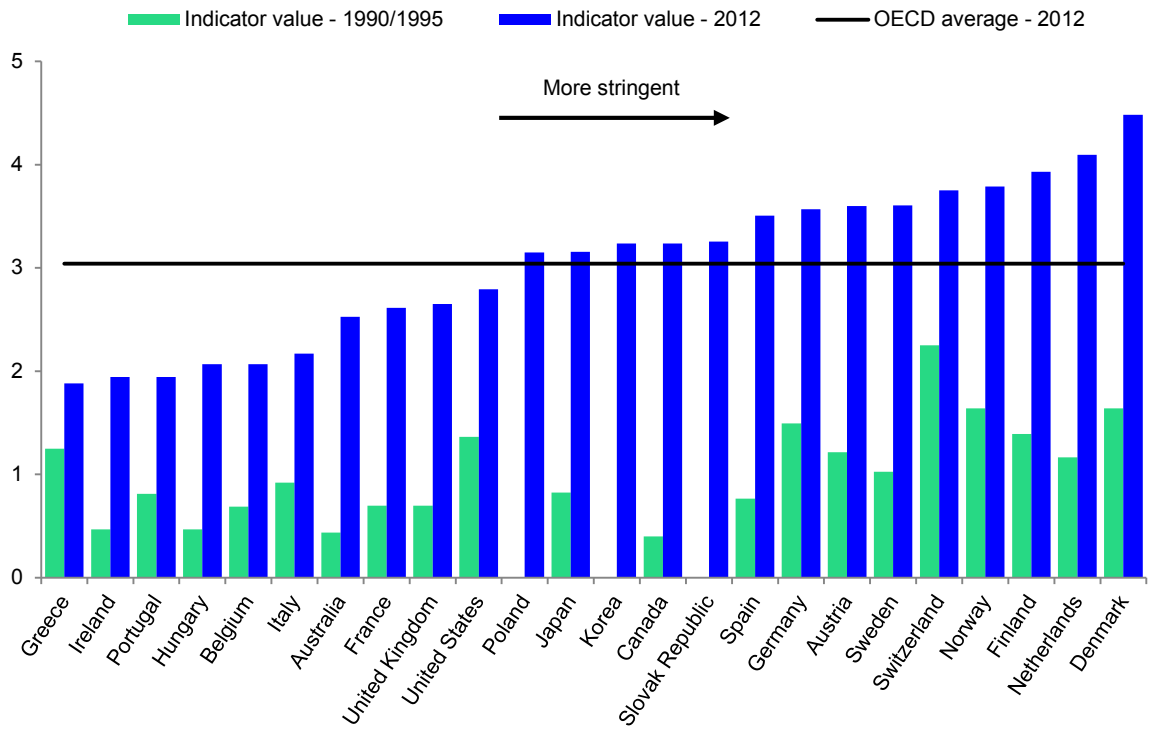
Source: Botta and Kozluk, (2014); OECD/EEA Environmental Policy Instruments www.oecd.org/env/policies/database; OECD-EPAU dataset on Renewable Energy Policies www.oecd.org/env/consumption-innovation/finance.htm.

Environmental policy stringency in OECD countries and BRIICS

Figure 2 displays the EPS indicator scores of OECD countries for the period 1990-1995 and the year 2012. Figures 3 and 4 show the performance of countries on the extended EPS indicator which includes BRIICS. Several patterns can be distinguished:

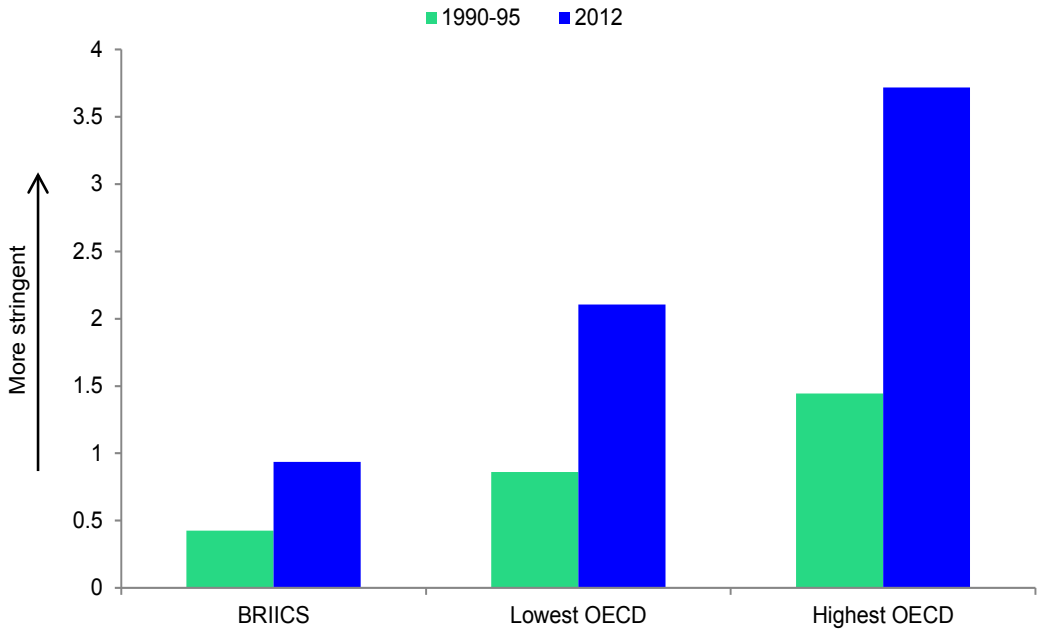
- Environmental policy stringency has been increasing in all OECD countries and BRIICS over the past two decades.
- Environmental policies remain more stringent in OECD countries than in BRIICS.
- Policies, as measured by the EPS indicator, are most stringent in Nordic countries, the Netherlands, Finland and Germany. Among OECD countries, they are least stringent in Greece, Portugal, Ireland and Hungary. Most of the other countries are close to the OECD average.

Figure 2. **Environmental policy stringency in OECD countries**



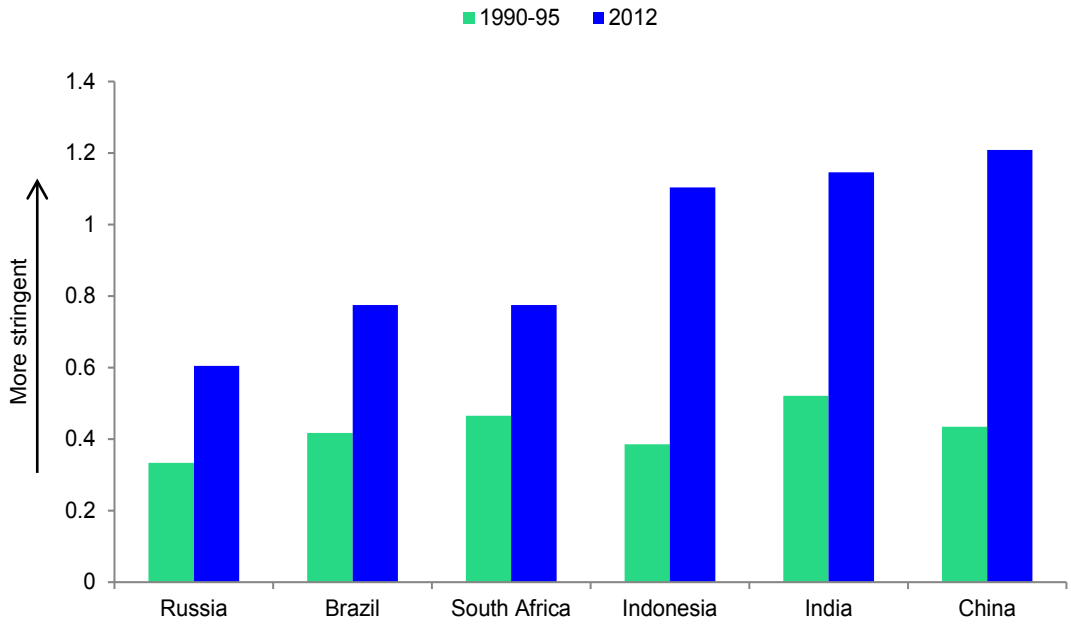
Source: Botta and Kozluk (2014). Figure 3 displays the EPS indicator scores of OECD countries for the period 1990-1995 and the year 2012.

Figure 3. **Environmental policy stringency in OECD and BRIICS**



Note: BRIICS countries are Brazil, Russia, India, Indonesia, China and South-Africa. Lowest OECD countries are Greece, Ireland and Portugal. Highest OECD countries are Finland, Netherlands and Denmark.

Figure 4. **Environmental policy stringency in BRIICS**



The EPS indicator has also been compared with various proxies of environmental performance. Table 1 highlights the correlations with CO_2 intensity of the economy and electricity generation as well as the Yale Environmental Performance Index (EPI).

It also shows a significant positive correlation with GDP per capita, confirming that richer countries tend to have more stringent policies.

Table 1. **Correlations with emission intensity and environmental performance**

	CO_2/GDP	CO_2/KWh	EPI
EPS	-0.41	-0.36	0.26

Note: Spearman correlations calculated with EPS indicator for OECD countries and BRIICS for the period 1990-2012. All correlations are significant at 1% level.

Advantages and disadvantages

The main advantage of the EPS index is that it is a simple proxy, based on actual policies. It concentrates on climate and air policies in key upstream sectors – which are important and relatively comparable polluters across economies.

The underlying assumption is that a stringent approach to environmental issues across a number of key pollutants and industries is representative of a more general preoccupation with environmental issues across all areas.

The policy instruments covered are comparable in a relatively straightforward fashion in terms of stringency. The resulting indicator has broader cross-country and time coverage than other available direct policy measures. It can also be easily updated and expanded once relevant data become available. Moreover, in practice, the indicator is fairly stable with respect to changes and weighting and aggregation. However, such a simple proxy has numerous limitations, due to the many challenges in measuring environmental policy stringency (see p.12).

First, the focus on limited environmental policy areas overlooks other important areas such as water, biodiversity, natural resources or waste. Extending the policies covered will be the subject of future work.

Second, even in the areas of air and climate, some potentially relevant policy instruments have been ignored. For example, tax incentives for "environmentally-friendly" investment, land use regulations or labelling obligations, voluntary approaches (VAs) and other "soft" policy instruments are not covered.

The main issue with these types of instruments is the high level of site specificity and the difficulty in assessing and comparing stringency. For instance, land use regulation is likely to be implemented at lower levels of governments while voluntary approaches are often negotiated between single facilities and local authorities. This heterogeneity, together with the possibility of regulatory capture, makes the comparison of their stringency across time and countries even more problematic. The omission of certain types of instruments weakens the generality of the composite indicator since these instruments are common in some countries, like Japan, where voluntary approaches represent a large share of the tools.

In light of these limitations, it is useful to compare the EPS indicator with other attempts to measure environmental policies across countries and time that are used in the empirical literature. Such approaches differ in many dimensions, but it is possible to classify them according to "where" they attempt to measure environmental stringency (as represented by the bubbles in Figure 5).

Figure 5. **Environmental policy stringency in OECD and BRIICS**

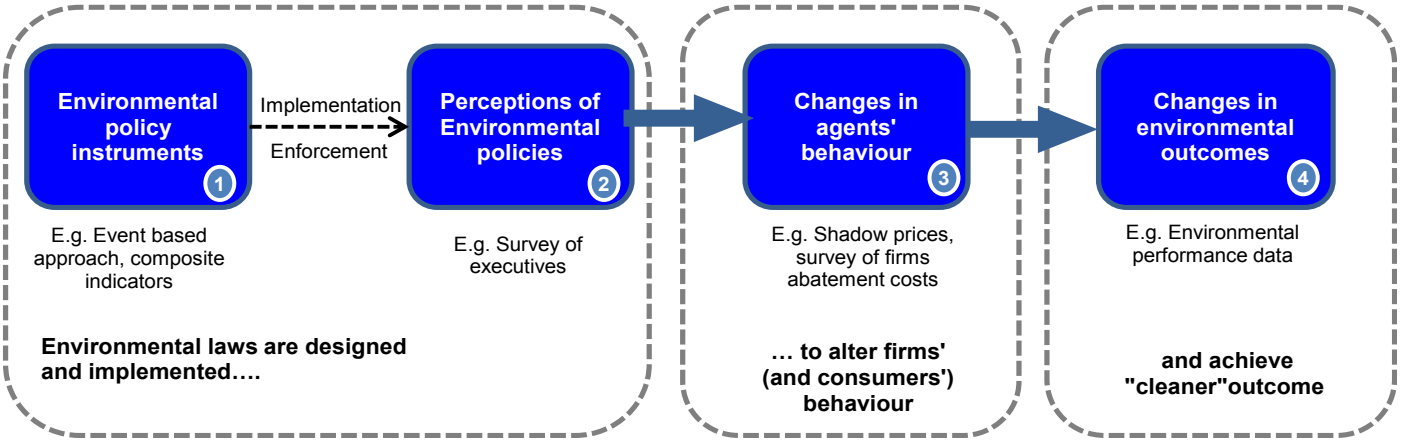


Table 2. **Correlations of extended EPS indicator with other proxies of environmental policy stringency**

Spearman rank correlations over maximum available sample

EPS measure	Correlation with EPS	Sample characteristics
Original EPS	0.92***	OECD countries only, 1990-2012
CLIMI (EBRD)	0.45**	OECD countries and BRIICS, 2008
World Economic Forum's Executive Opinion Survey	0.50***	OECD countries and BRIICS, 2002-2012
Energy Prices (Sato et al. 2015)	0.50***	OECD countries and BRIICS, 1990-2012
Environmental Patents (share)	0.28***	OECD countries and BRIICS, 1990-2012
Landfilled waste (share, Sauvage 2014)	-0.59***	OECD countries and BRIICS excluding Indonesia, 1995-2012

Note: ***, **, * denote significance at 1%, 5% and 10% respectively.

A first set of measures attempts to capture actual taxes, laws and regulations directly. They are the closest to actual policy instruments and include indicators of existence of single policies, their levels (e.g. tax rates) or changes as well as composite measures that aggregate selected information on individual instruments. The main assumption is that it is possible to directly observe environmental regulations, or at least representative elements of them, and that it is possible to represent a country's stance on environmental regulation by summarising selected measures of the enforced laws (Figure 5, bubble 1). Measures attempting to capture perceptions of the stringency of environmental policies are another set, based on dedicated survey questionnaires (bubble 2).

A third set of measures focuses on the first-order consequences of environmental regulations –such as firms' costs, actions and production choices (bubble 3). They include estimates of shadow prices for environmental inputs or environmentally-related expenditures (e.g. on pollution control and abatement), often self-reported.

Finally, environmental performance measures look at the second-level consequences of instruments, that is, the variation in environmental performance of firms, sectors or countries, in order to proxy the stringency of the policy itself (bubble 4).

The EPS indicator aims to capture the stringency of actual policies, so the most relevant comparisons are those from the first and second of the above categories. These also happen to be the measures most widely available across countries and time, even if samples differ from those of the EPS indicator. They include the EBRD's Climate Laws, Institutions and Measures Index and the World Economic Forum's Executive Opinion Survey responses (managers' perceptions on domestic policy stringency). In addition, checks with energy prices, also used as proxies of environmental policy stringency (Sato et al., 2015) and proxies for environmentally-related innovation ("green" patent shares) are provided. As shown in Table 2, correlations are significant, suggesting that each of these measures captures part of the same phenomenon. Each single measure is far from ideal; hence in empirical work checks with alternative measures of environmental policy stringency can be valuable.

CHALLENGES IN MEASURING THE STRINGENCY OF ENVIRONMENTAL POLICIES

Measuring environmental policy stringency is a cumbersome task, not least because of the lack of appropriate data. The main challenges are due to the heterogeneous nature of environmental issues and the various instruments that address them (Brunel and Levinson, 2013; Kozluk and Zipperer, 2014):

Multi-dimensionality is due to the various dimensions of environmental regulations (e.g. across different media, such as air, water, soil), the multitude of available policy instruments (e.g. pricing, command and control instruments, voluntary approaches) and their design and implementation features. Legislators may regulate emissions of a single pollutant through different instruments (e.g. both a tax and a performance standard on NO_x emissions), but often also discriminate the application of regulations according to the sectors, technologies, vintages or sizes of plants or location of activity (e.g. urban area). Environmental regulation can also be implemented at various levels of government.

Sampling arises as the sample of industries subject to policies may be driven by the policies themselves. For example, more polluting industries may represent a lower share of GDP in a country subject to stringent policies precisely because the policies have shifted the industrial structure away from them. Moreover, in sectors indirectly affected by stringent environmental policies (e.g. the service sector may be affected primarily through high electricity prices), these effects are not likely to be correctly assessed as resulting from environmental policies.

Identification is the difficulty in correctly assessing the degree to which the expected consequences of stricter regulations (e.g. increased abatement expenditures or observed lower pollution intensity) can be actually attributed to environmental policy stringency. Observed environmental outcomes can be due to other regulatory instruments (for instance, affecting labour and capital) and country-specific characteristics: geography, market imperfections, skills, level of development, access to technology or trade openness and outsourcing. All these features tend to interact with each other, making it difficult to link measures of relative environmental performance (or abatement expenditures) to actual environmental policies.

Implementation and enforcement are linked to broader characteristics of environmental policies, including their flexibility, depth, predictability and competition-friendliness. Further effects may come from the provisions accompanying the environmental policies (e.g. to smooth the transition) and the discrepancy between the legal and the de facto stringency: the transposition of laws into government actions, levels of fines and lax pursuit of violations. Enforcement may be of particular importance in countries with lower quality of institutions or large unofficial economies – for example in developing countries (Scrieciu, 2015).

Empirical applications

The OECD's EPS index has already been used in empirical work in order to measure the effect of environmental policy stringency on economic outcomes:

- Albrizio et al. (2014) show that the tightening of environmental policies observed in OECD countries had little effect on aggregate productivity growth. Nevertheless, they find that increasing EPS has led to differentiated effects within the economy – the most technologically advanced industries and firms have seen a small, temporary increase in productivity growth whereas the least productive firms have seen their productivity fall. The possible channels for this are firm dynamics (entry/exit and growth), outsourcing and innovation.
- Kozluk and Timiliotis (2016) investigate the Pollution Haven Hypothesis - whether countries with more stringent environmental policies lose out in terms of competitiveness and exports. Using the extended EPS indicator which covers BRIICS, they compare effects on gross exports with those on domestic value added embedded in exports – a Global Value Chain approach. They find no evidence that stringent environmental policies harm aggregate trade and overall country competitiveness. However, environmental policies are found to have a significant effect on trade specialisation. More stringent environmental policies are associated with a competitiveness loss in the most polluting sectors and a reduction in their exports. At the same time they are linked to a comparative advantage in less polluting industries and a boost in exports. Overall, the effects of environmental policies on trade patterns over the past two decades have been found small with respect to effects of other developments, such as trade liberalisation.
- In a similar vein, Sauvage (2014) finds a significant positive relationship between a country's regulatory stringency and its specialisation in exports of "environmental" products.
- Other researchers have used the EPS index to test the effects on innovation (De Santis and Lasinio, 2015); to measure how policy stringency affects CO_2 emissions (Probst and Sauter, 2015); and to estimate the learning curve of renewable energy technologies (Witajewski-Baltvilksa et al., 2015).

Improvements and extensions

The EPS index is work in progress. Despite a number of favourable properties, the coverage remains limited - focusing on air and climate pollutants largely in upstream activities such as electricity production and transport.
While this was a necessary assumption when the indicator was conceived, a natural next step is to look at the possibility of including other major environmental policies. Scoping work to include policies for regulating water pollution is currently ongoing. In parallel, work is being conducted on extending the coverage to other OECD countries not yet covered and further improving the coverage of selected instruments. This work is expected to yield results by late 2016. In light of the recent extensions, Table 3 shows the progress of the data collection process for BRIICS countries.

Table 3. **Mapping of policies covered for BRIICS (so far)**

	Tax				Trading schemes				FIT		ELV				R&D
	CO_2	NO_X	SO_X	Die-sel	Green	CO_2	White	SO_2	Wind	Solar	SO_X	NO_X	PM	Sulphur	Subsidies
Brazil	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Russia	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
India	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Indonesia	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
China	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
South Africa	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

● The information for this variable/country pair is completely collected and up to date.
● The information for this variable/country pair is partially collected with missing values.
● The information for this variable/country pair is not available or does not exist.

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