



Fossil Fuel Subsidies

A Briefing for Education Unions

Zeynep Clulow
November 2023



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Published by Education International - Nov. 2023
ISBN: 978-92-9276-004-5 (PDF)

Cover Design: Education International

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Executive Summary

There is a strong consensus that fossil fuel subsidies (FS) obstruct the attainment of multiple sustainable development goals (SDGs) including poverty eradication (SDG1), global health (SDG3), gender equality (SDG5) and transition to affordable, reliable energy (SDG7) and sustainable consumption and production (SDG12).

Consequently, international organizations, NGOs, policymakers and academics are increasingly calling for the phase-out of inefficient FS¹ as a critical part of efforts to meet ambitious global climate targets. Yet despite a recent increase in demand and the success of multiple countries at subsidy reform, FS have increased in many countries, including some of the world's wealthiest and most advanced democracies. Globally, FS accounted for 6.8 percent of world GDP in 2020 and is expected to continue rising.

In particular, it is well documented that FS are detrimental for educational outputs and outcomes: in general, countries that devote a large share of national income to FS tend to perform poorly in a range of educational outputs and outcomes. Part of the reason behind the negative relationship is that FS spending uses up resources that could be spent on education. Yet this incompatibility also reflects a lack of incentives for policymakers in fossil-rich countries to invest in skills development to support the growth of alternative – including greener and more productive - sectors to fossil industries.

This policy brief explores the FS-education relationship by combining the most comprehensive recent data on FS from the IMF FS database with educational performance and potential confounding factors from the World Bank World Development Indicators databases, resulting in a dataset of 1651 observations after omitting country-years with missing data, spanning 176 countries from 2010 to 2020. Our two-level regression model (consisting of country-years nested in countries) analyses whether, and if so, how, FS spending influences a range of key educational indicators including enrollment in primary school education and attainment of primary, secondary, tertiary and higher education rates across countries' school aged populations, while accounting for a range of national conditions that could influence education.

Our results show that, even when other potential drivers of education are held constant; (i) FS spending does indeed have a significant bearing on two key indicators of educational performance – completion rates of primary and secondary education;

1 While national governments and international organisations have yet to agree on the precise details of what constitutes an 'inefficient' FS, there is broad agreement that the core part of the inefficiency arises because FS encourage the allocation of an economy's resources in a way that hinders growth.

and (ii) the educational effects of FS spending vary widely between different countries. In general, the worst educational effects of FS tend to be concentrated in the poorest countries: In low-income countries, a one-percent increase in the share of GDP spent on FS is associated with a 0.24 and 1.12 percentage point decline in the share of the population aged 25 years and above to have attained primary and secondary education respectively. However, this detrimental effect diminishes with economic development; falling to around 0.10 percent for primary education in medium-income countries and becomes positive in high-income countries.

We also analyse four key countries that, despite spanning a diverse mix of FS spending, educational performance, and economic development, have made important progress in FS reform – namely: Norway, Indonesia, South Africa and India. In-line with the findings of the quantitative analysis, these case studies show that the factors that give rise to and sustain FS and shape their (unique) effects on education vary widely across different countries. These case studies reveal important differences in the facilitating conditions and potential drivers of FS reform. Previous experiences of FS reform show that a general lack of awareness about FS, particularly regarding the level of total income spent on FS - both globally and nationally - as well as a lack of awareness about the broader, multifaceted adverse effects and trade-offs with key aspects of human development are important ongoing obstacles to fossil phase-out. Crucially, many countries that have successfully phased-out FS show that public information can be a critical factor for ensuring the public acceptability of reform. This policy brief argues that better information- particularly targeting young people who will bear most of the future consequences of FS policy - as well as improved transparency and monitoring are likely to increase prospects for global FS phase-out. In addition, it is also important that potential losers of FS reform – notably fossil-intensive industries and poor segments that rely on FS – are provided with and made aware of effective compensatory measures such as appealing employment opportunities in alternative industries and better welfare provision.

Education has a critical role to play in supporting the phase-out of inefficient FS globally. Most obviously, perhaps, educators, coordinated by education unions, should help design and implement extensive education campaigns to teach key stakeholders about the (explicit and hidden) costs of FS and potential benefits of reform. Yet beyond this, a fleet of engineers, natural scientists, energy providers, policymakers and, at some level, general publics, will need to develop a range of green skills for understanding, navigating, designing, implementing and governing a just transition from fossil fuel energies to low carbon energy sources. Skills development, training and knowledge transfer of the latter are key points for education unions to focus on. Relatedly, by increasing public awareness and understanding about FS, education can help cultivate more informed and interested publics who will be better able and motivated to partake in energy decision-making, thereby increasing the transparency and legitimacy of reform.

Education unions could also use their links to local and national educators to access valuable local knowledge and connections for uniting potential beneficiaries of reform by educating them about the potential gains they stand to make from phase-out. Local educators could also play a critical role in providing ground knowledge for identifying the most effective and socially acceptable measures for overcoming the unique set of challenges of reform in different countries. In addition, education unions could tap into international fora that have grown increasingly interested in the importance of FS reform for meeting global decarbonisation and net zero targets. Key focal points in this regard include working with relevant international organizations to develop materials for raising awareness among key stakeholders, improving transparency and disseminating emerging norms and requirements for effective monitoring.



Background

What are fossil fuel subsidies?

Fossil fuel subsidies (FS) are measures that governments take to support the consumption and production of fossil fuels. They are often classified by whether they primarily benefit consumers - by keeping fuel consumption prices below market levels - or producers - by ensuring they receive above market prices through the provision of mechanisms such as tax breaks and cash transfers (Skovgaard & van Asselt, 2019).

Countries that spend highly on FS tend to perform badly on multiple aspects of human development such as healthcare provision, gender equality, energy access, poverty eradication and education. In addition, climate scientists warn that we need to leave at least two-thirds of existing fuel reserves in the ground to prevent catastrophic climate change (International Energy Agency, 2012). Growing awareness about the incompatibilities between FS and sustainable development have resulted in multiple calls for subsidy reform both nationally and globally. Yet despite the rising nominal commitment to phase out and its importance for meeting the ambitious global climate targets set by the Paris Agreement, the share of world income spent on FS has increased since the adoption of the agreement in 2015 (and is expected to continue increasing).²

The growing lag between nominal commitment to phase-out and actual funding for FS has resulted in increased efforts to measure FS as a first step for facilitating subsidy reform. Despite several efforts to quantify FS, however, there is no agreement on the definition of FS or how to obtain reliable data for international comparison. Methodological approaches vary depending on how widely subsidies are defined, the chosen measurement approach and its geographical application. It makes a critical difference whether 'market prices' include or exclude government intervention (taxes) and broader socio-economic, health and environmental damages that arise because of fossil fuel activity. Most past initiatives take an explicit approach, which focuses on pre-tax subsidies that arise when consumers pay fuel prices that are below the opportunity costs of fuel supply. Yet increasing discussion over the wide range of externalities associated with fossil fuels has given rise to recent calls to measure post-tax subsidies that arise because prices do not reflect the cost of implicit damages from fossil fuel activity (Coady et al., 2017; UN Environment Programme, 2019).

² Crucially, this is not just an emerging market issue as FS funding has even increased in some of the strongest economies under governments with strong political commitment to phase out. For example, in the US, FS increased substantially during Obama's time in office despite his ongoing campaign to cut FS in the US and globally (Oil Change International, 2014).

Different methodologies are associated with their respective limitations and translate into different conclusions about the potential costs and benefits of FS and reform. Table 1 summarises the most recent global FS estimates, which range from US\$88 billion (IISD, ODI & OCI 2015) to US\$5.9 trillion (IMF 2021). Strikingly, the IISD, ODI & OCI, OECD and IEA estimates, which omit externalities and focus on either major economies or emerging and developing economies respectively, are only a fraction of the IMF estimate that measures both explicit and implicit subsidies around the world. This study uses IMF data, which includes virtually all countries and the widest range of (implicit and explicit) subsidies of all the FS databases, to quantitatively analyse the relationship between FS spending and educational performance.

Table 1. Leading estimations of global fossil fuel subsidies.

Most recent estimate (year)	Organisation	Subsidy beneficiary	Included externalities	Geography	Limitations
731.7b (2021) ³	IISD, ODI & OCI (fossil fuel subsidies tracker)	Producer	X	82 major economies	Excludes externalities and measures that are not identified at inventory items
697.2b (2021) ⁴	OECD	Producer & consumer	X	OECD + selected G20 economies	Excludes producer subsidies & externalities. Ignores subsidies that do not directly affect prices.
1t (2022) ⁵	IEA	Consumer	X	42 emerging market and developing economies	
5.9t (2021) ⁶	IMF	Producer & consumer	Traffic congestion, climate change, local air pollution	176 (low, medium and high-income) countries	For countries with missing data, FS are extrapolated from regional averages.

3 G20 subsidies to oil, gas and coal production (2021) available from: <https://fossilfuelsubsidytracker.org/>

4 OECD Inventory of Support Measures (2021) available from: https://www.oecd-ilibrary.org/agriculture-and-food/data/fossil-fuel-support_d86aea00-en

5 IEA Fossil Fuels Consumption Subsidies 2022 (2023) available from: <https://www.iea.org/reports/fossil-fuels-consumption-subsidies-2022>

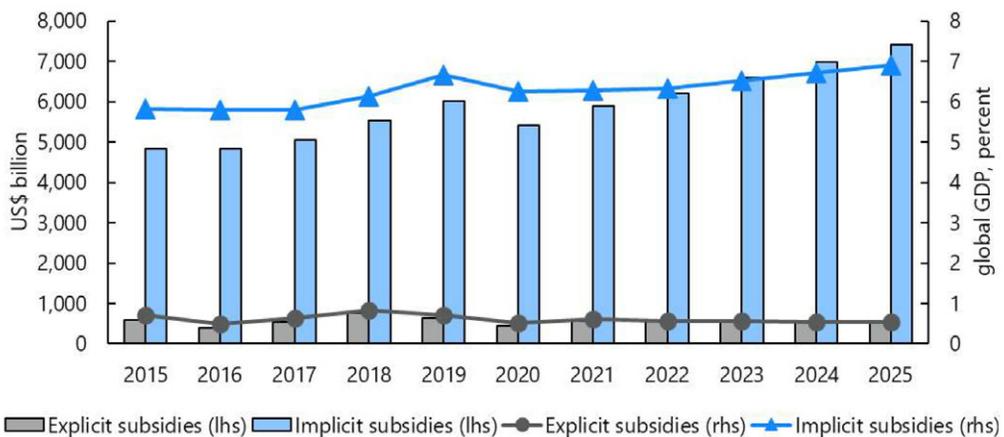
6 IMF Fossil Fuel Subsidies (2022) available from: <https://www.imf.org/en/Topics/climate-change/energy-subsidies>

An overview of the breadth and extent of fossil fuel subsidies globally

Globally, (implicit plus explicit) FS collectively accounted for 5.9 trillion US\$ billion or 6.8 percent of GDP in 2020 (see Figure 1) and are expected to rise to 7.4 percent of GDP by 2025 as the share of fuel consumption in emerging markets increases (Parry et al., 2021). Most subsidies arise from undercharging for externalities, with only around a quarter consisting of explicit measures that allow fuel producers to receive above, or consumers to pay below, market prices. Over the past decade, the share of implicit subsidies from undercharging for associated socio-economic and environmental damages has increased, although this is partly a reflection of improvements in modelling approaches that capture more externalities as well as increasing levels of associated adverse outcomes.

Figure 1: Global fossil fuel subsidy spending in US\$ and as a share of global GDP (2010 to 2020).

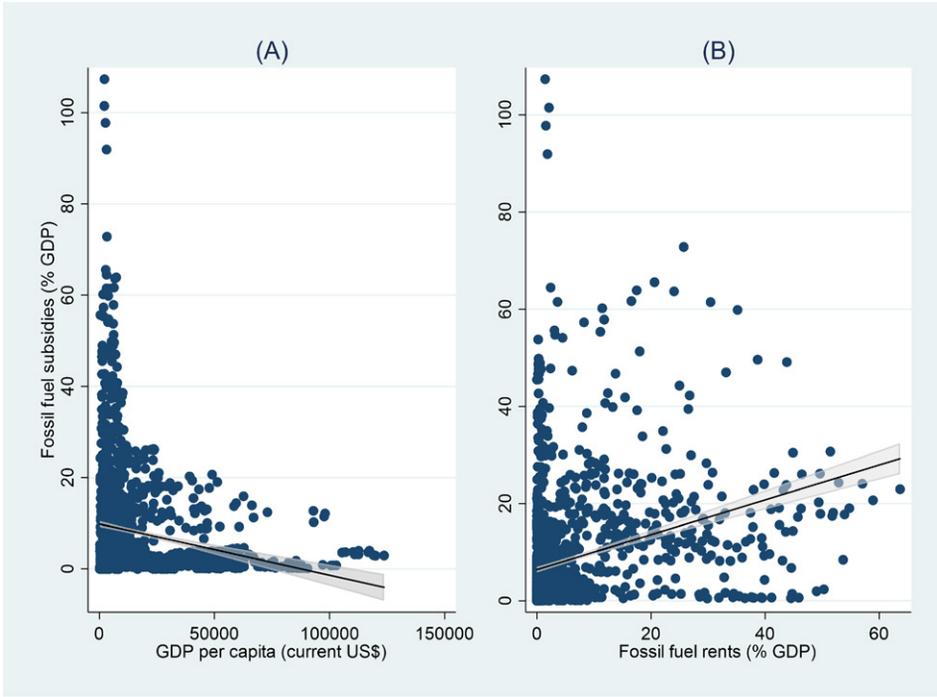
Source: (Parry et al., 2021). Note: The decline in FS in 2020 shows a temporary dip due to restrictions on economic activity over the COVID-19 pandemic.



In general, wealthier countries tend to spend a lower share of GDP on FS compared to poorer countries, as indicated by the downward sloping line (fig. 2A). In addition, countries that depend on fossil fuels for a large share of national income tend to spend more on FS compared to countries that obtain most of their income from non-fossil sources and activities (Figure 2B).⁷ The positive relationship between fossil rents (the share of national income derived from fossil fuel activity) and FS spending holds across different stages of economic development as low, medium and high-income countries consistently tend to spend a larger share of national income on FS when they depend on fossil fuel rents for a large share of GDP (see Figure A1, appendix).

⁷ Pairwise correlation tests reported in Table A1 in the appendix show that these relationships are highly significant (P<0.0001).

Figure 2: Fossil fuel subsidy spending (GDP share) as a function of (A) economic development (per capita GDP) and (B) fossil fuel rent (GDP share). Black lines show best fit and shaded regions 95% confidence intervals.



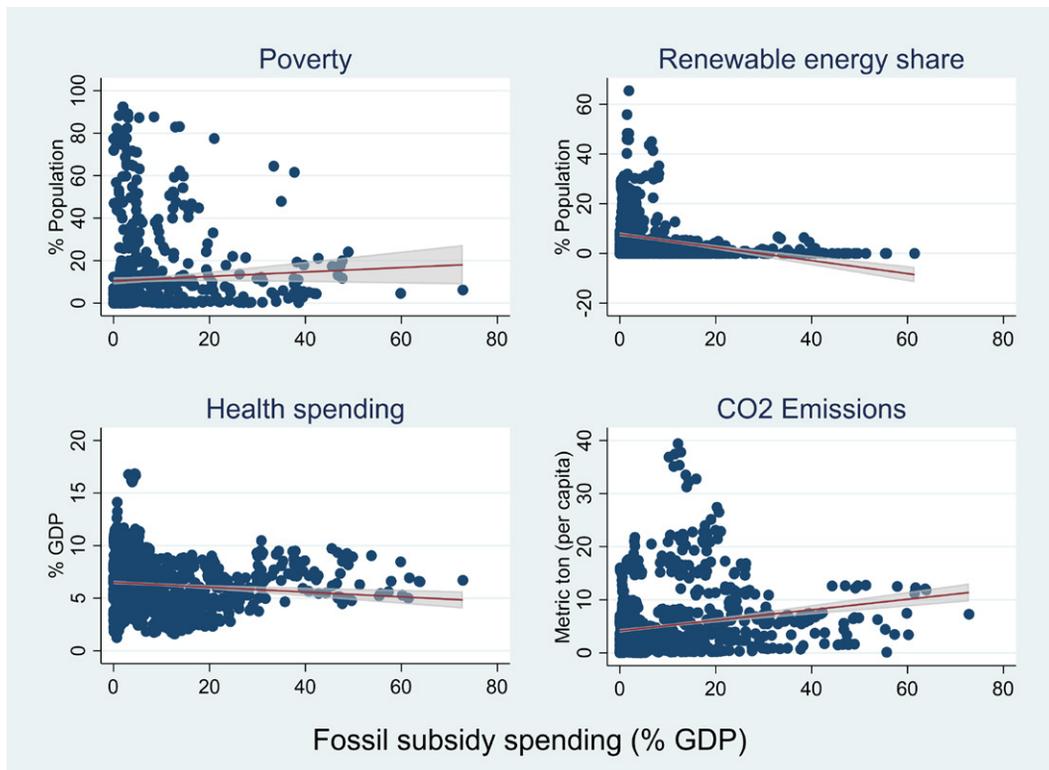
Why should education unions care?

Why do we need to end fossil fuel subsidies?

It is widely agreed that FS undermine our ability to meet several sustainable development goals (SDGs) including poverty eradication (SDG1), global health (SDG3), gender equality (SDG5) and transition to affordable, reliable energy (SDG7) and sustainable consumption and production (SDG12) (UN Environment Programme, 2019; Work of the Statistical Commission Pertaining to the 2030 Agenda for Sustainable Development, 2017). On the one hand, FS redirect limited resources away from initiatives that could be used to support economic development (Solarin, 2022; Vandeninden et al., 2022) and provide basic health care and sanitation (Jakob et al., 2015), particularly in some regions such as Africa, where FS spending is equal to the amount spent on health care (Couharde & Mouhoud, 2020). On the other hand, by supporting fossil activity, FS can increase the prevalence of certain health problems that are associated with high levels of air pollution (Burg & Whitley, 2016a) or exacerbate gender inequalities by supporting fossil activities that are disproportionately carried out by women such as, for example, the use of liquified petroleum gas (LPG) for cooking (Kusumawardhani et al., 2017). Experience shows that subsidy removal often results in more equitable access to electricity (and vital services that require electricity) (Ouyang & Lin, 2014; Rentschler, Bazilian, et al., 2017), greenhouse gas emissions reduction (Bridle et al., 2018; Coady et al., 2017; Skovgaard & van Asselt, 2019) and increased use of low carbon energy sources such as renewables (Monasterolo & Raberto, 2019; Schmidt et al., 2017a).

Figure 3 illustrates how different indicators of human development vary when countries spend negligible (left) to substantial (right) shares of national income on FS. The slope of the line of best fit illustrates the direction of the relationship between FS spending (x-axis) and dimension of human development (y-axis). The upward sloping poverty and CO₂ emissions lines show that countries tend to have higher poverty rates and per capita CO₂ emissions levels when they spend a larger share of GDP on FS compared to when the share of FS funding is lower. Furthermore, the downward sloping renewable energy and health expenditure lines suggest that higher shares of FS spending tend to be associated with lower shares of renewable energy generation and investment in healthcare. Collectively, associations in our dataset suggest that FS spending is inhibitory to multiple goals of sustainable development.

Figure 3: Poverty ratio (% general population), renewable energy share (% total energy generation), health spending (%GDP) and per capita CO2 emissions (metric tonnes) as a function of fossil subsidy spending (% GDP).



Note: Red lines are lines of best fit and shaded regions 95% confidence intervals. Points are country-year observations from dataset.

Comparison of education and fossil fuel spending

Why are fossil fuel subsidies bad for education?

While countries that spend highly on FS tend to rank poorly in socio-economic development in general (including education, health, sanitation and basic infrastructure) (Black et al., 2005; Gylfason et al., 1999; Michieka & Gearhart, 2018; Stijns, 2006), there are several reasons why FS are particularly detrimental to education. Most obviously, FS spending uses up resources that could be directed to support educational institutions, widen access to educational opportunities and improve performance (Cheon et al., 2013; Lindebjerg et al., 2015; Solarin, 2022). Yet the negative relationship does not arise only from limited resources: when political power is based on fossil rents rather than earned state income, governments have little incentive to invest in other – including more productive – industries, which is why resource wealth is often linked to economic stagnation (Ross, 1999). Furthermore, in fossil rich countries, fossil based activities tend to attract higher profits and wages, which encourages private sector interests to

compete for a share of fossil rents rather than explore opportunities in more skilled industries (Bjorvatn et al., 2012). The lack of impetus for public and private sector investment in new skills development is a key mechanism through which fossil fuels (and FS) obstruct education (Arezki et al., 2011; Douglas & Walker, 2017).

Figure 4 shows the relationships between FS spending and (A) education spending and rates of completion of (B) primary, (C) secondary, (D) tertiary, (E) Bachelors and (F) Masters education in our dataset. The lines of best fit consistently slope downwards, indicating that countries that spend more of their national income on FS tend to spend less on education (relative to GDP) and have lower rates of primary, secondary, tertiary and university education completion compared to countries that spend lower shares of national income on FS.

Figure 4: Educational spending, primary, secondary, tertiary, Bachelor's and Master's education completion rates as a function of fossil subsidy spending. Black lines are lines of best fit and shaded regions are 95% confidence intervals. Pearson's correlation coefficients (reported in Table A3) show that globally, FS spending is inversely correlations with educational investment and higher education attainment, although the direction, strength and significance of correlations with different educational indicators varies across different countries depending on their level of energy imports and economic development.

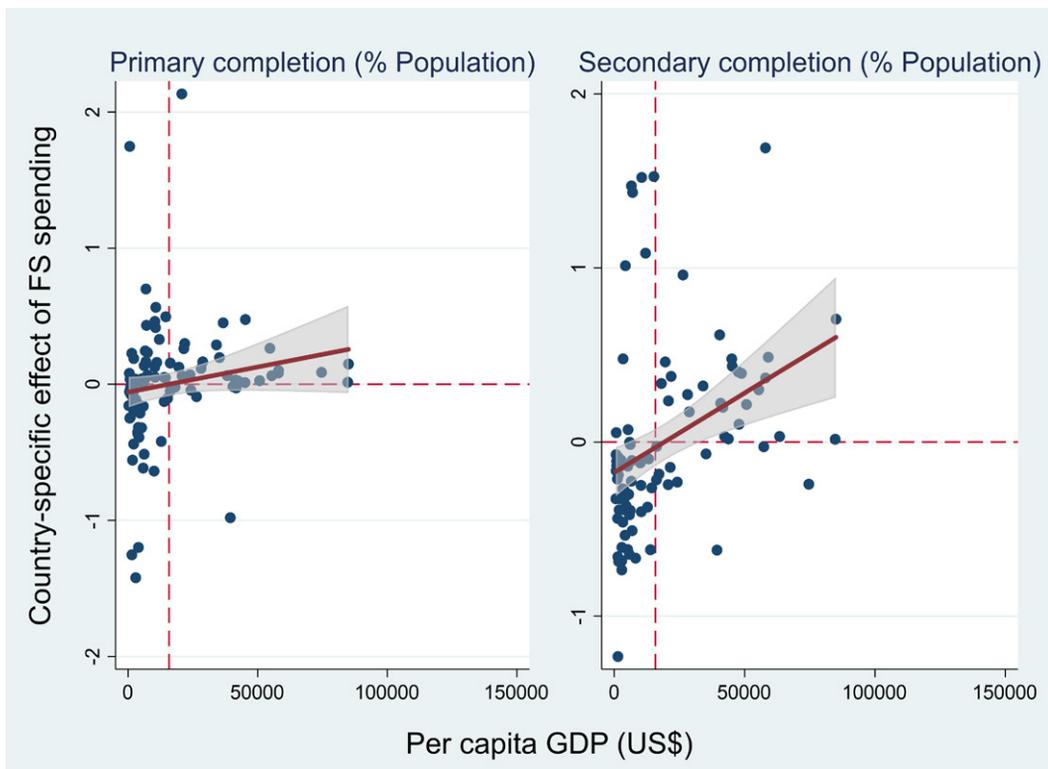


When we hold constant other potential drivers of education (namely: population, per capita GDP and fossil rent shares of GDP) and look within the same country, we find that the educational implications of FS spending vary widely across different countries (see the appendix for complete details of the research design). Specifically, the high significance ($P < 0.0001$) of the random FS spending estimates is a strong indicator that

FS spending: (a) significantly influences educational investment and primary and secondary education completion rates; and (b) has different educational implications for different countries (see main results reported in Table A4).⁸

Figure 5 shows how the educational implications of FS spending vary across countries at different stages of economic development (as measured by per capita GDP).⁹ Each point represents the effect of FS spending (as a share of GDP) on primary and secondary school completion rates within a given country. The upward slope of the best fit lines show that FS spending is generally most detrimental to primary and secondary education attainment in low-income countries on the left: in these countries, increases in FS spending are associated with reductions in the share of population to have completed primary and secondary education. By contrast, in wealthy countries on the right of the figure, increasing FS spending tends to be associated with increases in primary and secondary school completion rates. The relatively steeper slope of the secondary completion line suggests that the detrimental effects of FS on poor countries are stronger for secondary than primary education.

Figure 5: Random country-specific effects of fossil fuel subsidy spending (percentage of GDP) on primary and secondary school completion rates (percentage share of population aged 25 years and above) across countries at different levels of economic development (as measured by per capita GDP, US\$).



Note: Each point represents a country-specific effect. Dashed vertical lines show global mean per capita GDP. Figures are based on the results and posterior estimates of random coefficient models reported in Table 2. Lines of best fit (red) show typical variation in FS effects across different levels of economic development (as measured by per capita GDP). Shaded areas are 95% confidence intervals.

8 Moreover, as discussed below, the country-specific effects of FS often contradict and sometimes even offset the positive FS-primary/secondary school effects captured by the fixed effects in columns B and C, Table A4.
9 The effect of FS spending on education investment appears to be autonomous of economic development (see Figure A4).

Table 2 shows the typical (mean) effect of FS spending on educational investment and primary and secondary school attainment in low, medium and high-income countries. On average, and while keeping other factors constant, a one percent increase in the share of GDP spent on FS is associated with a 0.24% decline in primary and 1.12 % decline in secondary school completion rates in low-income countries. As shown in figure 5, the detrimental effect of FS spending on educational attainment becomes weaker with economic development: in medium-income countries, a one percent increase in share of GDP spending on FS is associated with a 0.1 percentage point decrease in primary school completion rates, although this negative effect does not significantly affect secondary education attainment in these countries. By contrast, in high-income countries, a one percent increase in FS spending is associated with 0.16 and 0.81 percentage point increase in primary and secondary school completion rates respectively.¹⁰ Similar trends are observed for higher education completion; a one-point increase in the share of GDP spent on FS is associated with 0.15 and 0.01 percentage point decline in undergraduate completion rates in low and medium-income countries respectively, and, by contrast, a 0.07 percentage point increase in high-income countries (see Table A5).

Table 2: Mean effects of fossil subsidy spending on primary and secondary education attainment rates in low, medium and high-income countries.

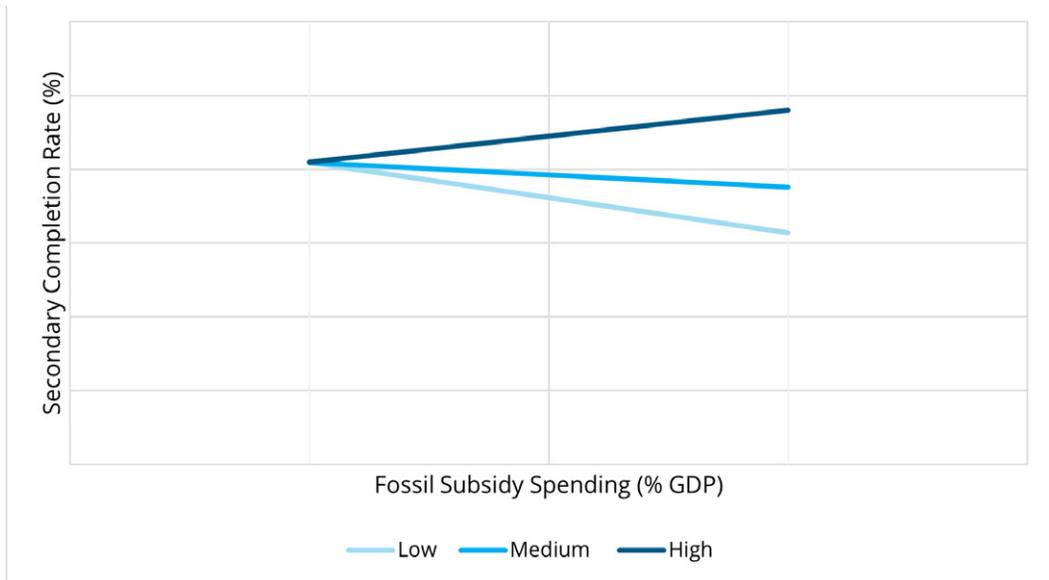
Education indicator	Low-income	Medium-income	High-income
Primary completion	-0.24***	-0.10**	0.16**
Secondary completion	-1.12***	0.17	0.81***

Note: Entries are mean country-specific FS spending effects. Low-income = per capita GDP of 30th percentile and below, medium-income = 31st to 69th percentile, high-income = 70th percentile and above. Percentage point estimates and standard errors are presented in Table A5.

Figure 6 shows the predicted rates of secondary education attainment in low, medium and high-income countries. In line with the preceding discussion, the sharp downward slope of the (light grey) low-income line indicates that rising FS spending rates are associated with the largest decreases in the poorest countries. While the downward trend of the medium-income (dark grey) line indicates that FS are still detrimental, the flatter slope suggests that the effect is not as obstructive as in lowest income countries. By contrast, the ascending (black) high-income line suggests that FS spending tends to be conducive to secondary school completion in the wealthiest countries.

¹⁰ In high-income countries, a one percent increase in share of GDP spent on FS is associated with a 0.21 percent decrease in share of national income invested in education, although no similar effects were found for lower income countries (see Table A5).

Figure 6: Predicted secondary education attainment rates among adult population associated with fossil subsidy spending (as a percentage share of GDP) in low (light blue line), medium (medium blue line) and high-income (dark blue line) countries.

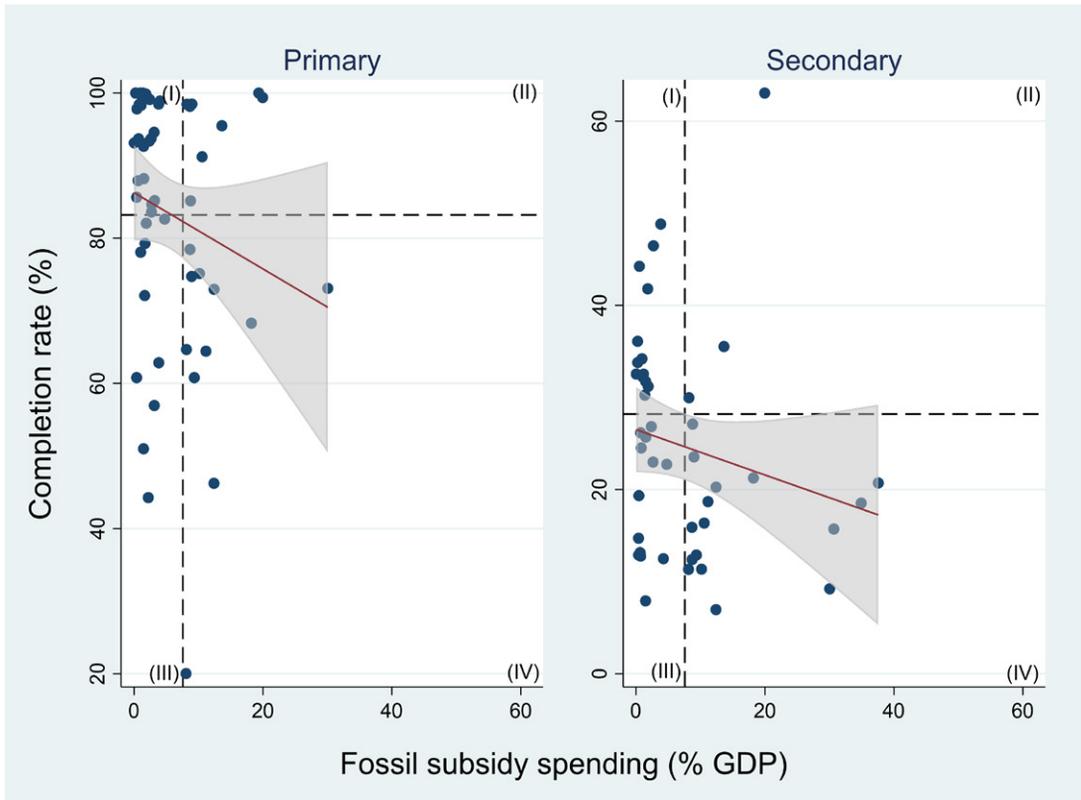


Note: Values are posterior estimates predicted by the regression results presented in Column 4, Table A4. Low-income = per capita GDP of 30th percentile and below, medium-income = 31st to 69th percentile, high-income = 70th percentile and above.

Case studies

Figure 6 shows the mean percentage shares of GDP that countries spent on FS and primary and secondary school completion rates over 2010 to 2020. In general, subsidies are inversely related to educational outcomes: countries that spend below (world) average shares of GDP on FS tend to have above (world) average rates of primary and secondary school completion (Quadrant I) whereas countries that spend above average on FS tend to exhibit below average primary and secondary completion rates (Quadrant IV). An important number of countries exhibit below average levels of educational attainment despite spending below average on FS (Quadrant III), suggesting that, for these countries, educational performance is primarily inhibited by factors other than FS. Only a minority of (mainly large energy-exporting) countries exhibit both above average rates of educational attainment and FS spending (Quadrant II).

Figure 7: Primary and secondary education completion rates and fossil subsidy spending.



Note: Solid lines are lines of best fit. Dashed lines show world average levels of educational attainment and FS spending. Shaded areas are 95% confidence intervals. Points denote country mean FS spending and educational attainment from 2010 to 2020. The complete list of countries that fall under each quadrant is provided in the Appendix. Norway and Indonesia are located in quadrant I and India and South Africa quadrant IV. Summary statistics of case study countries are provided in Table A4

Yet global trends conceal the wide breadth of national conditions and factors that determine the share of income that countries ultimately decide to spend on FS, as well as drivers that facilitate their continuation or removal. Here we focus on four key countries at different stages of economic development from opposite quadrants listed in table 3:

Table 3: Mean FS spending and educational performance in case study countries.

Country	Quadrant	FS spending (US\$ billions)	FS spending (% GDP)	Primary education (%)	Secondary education (%)	Education spending (% GDP)
Norway	I	4.90	1.16	99.88	37.87	6.52
Indonesia	I	113.23	8.10	78.21	48.00	3.08
South Africa	IV	48.92	12.84	82.21	18.16	5.77
India	IV	322.49	15.73	57.46	11.49	3.08

Norway

With abundant gas and oil reserves, Norway relies on fossil fuels for around a seventh of its national income, which has created longstanding incentives for Norwegian policymakers to support fossil-intensive sectors. Yet the country has also invested heavily in electric vehicle (EV) subsidies, resulting in the highest EV penetration in the world. In the multilateral climate negotiations, Norway was a longstanding member of the Umbrella Group, which, along with other fossil-rich advanced economies such as the US, Australia and Canada, opposed the setting of stringent emissions targets (Depledge, 2006). Over the last 15 years, however, the country has aligned with the more ambitious climate goals adopted by the EU, for example, by updating its Nationally Determined Contribution to the global climate regime in line with the EU's 'Fit for 55' package. Actual funding for FS has been relatively low (around a ninth of world average levels), although FS spending has gradually increased from 0.92 to 1.58 percent of GDP from 2010 to 2020. Owing to its mature democracy and high economic ranking (second in terms of per capita GDP), the country has been able to avoid the 'resource curse', whereby fossil endowments typically result in poor socio-economic performance (Ross, 1999). In relation to education, it is notable that spending and primary and secondary school completion rates are significantly higher than world average levels (quadrant I, figure 7).

As with many other countries, global impetus to meet increasingly ambitious decarbonisation targets has been a key driver of FS reform in Norway. For example, environmental NGOs such as GreenPeace and WWF Norway allied with international partners in the Paris negotiations to learn about the potential risks of income dependence on petrol extraction. By pushing to reframe oil as an object of risk, environmental interests influenced the government to involve climate risk commissions in investment decisions of the petroleum industry and increased justification for diverting public funding from fossil fuels to renewable energy (Bang & Lahn, 2019). Relatedly, concerns from domestic actors over the association between government funds and unsustainable industries successfully catalysed the government into setting criteria for excluding some companies from the Norwegian Government Pension Fund Global based on their conformity with limited degrees of greenhouse gas emissions (Norges Bank Investment Management, 2022). Moreover, unlike many other fossil-rich countries, Norway maintained high taxes on petrol and did not subsidise domestic consumption, allowing it to build up one of the world's largest sovereign wealth funds. In this sense, Norway is an unusual case of an advanced economy with a strong fossil fuel industry and unique combination of domestic and international pressures for energy transition that have resulted in relatively modest levels of FS spending for a fossil-rich country.



Indonesia

Indonesia is one of the few developing countries to have made considerable progress in reducing FS. While, on average, revenues from fossil fuel accounted for a relatively small share (2.4%) of the country's GDP from 2010-2020, the government spent around a sixth of the state budget subsidising fossil fuels. The Asian financial crisis in 1998 ushered in a series of government attempts to phase-out FS to reduce the deficit in the state budget, though the road to phase-out has been plagued by various obstacles (Pradiptyo et al., 2015a). Since poor households spend large fractions of income on basic commodities, consumer subsidy programs have traditionally provided the main form of social protection in Indonesia, which has created a longstanding belief that FS reform would increase poverty, despite the existence of numerous contradictory analyses (Agustina et al., 2012; International Renewable Energy Agency, 2022; Whitley & Van Der Burg, 2015). Notably, the first major attempt to reduce FS immediately after the Asian crisis was met with widespread protest and culminated in President Soeharto's resignation in 1998. Yet the experience prompted subsequent reformers to address potential sources of social unrest, which ultimately resulted in the country making important progress in FS reform. In 2014, for example, President Joko Widodo took measures to inform voters about the financial strain of FS and used the revenue savings from ending gasoline subsidies to enable more poor people to access health, education and welfare programs. In COP 27, Indonesia signed the Just Energy Transition Partnership (JETP) on climate finance, which is expected to bring forward the country's power sector peak date by seven years – potentially resulting in a cumulative reduction of more than 300 megatons in greenhouse gas emissions by 2030 (The White House, 2022).

Unlike many other developing countries that have struggled with FS reform, Indonesia's success has been facilitated by several important factors: Notably, even though governments have changed, there has been remarkable unity around the need for FS reform and the role of targeted social welfare programs to alleviate the potential adverse effects of phase-out on the poor (Kyle, 2018). This has been augmented by public information campaigns about the size of the state budget allocated to FS and concentration of FS benefits among the wealthy and fossil fuel industries (Pradiptyo et al., 2015a). Furthermore, unlike many other developing economies, most of the local institutions that were responsible for ensuring that reform benefits reached poor households were highly trusted by local communities due to relatively low levels of corruption and advanced administrative capabilities (Kyle, 2018). While the existence of these conducive circumstances suggests that Indonesia will continue with phase-out in the future, strategies such as building trust and administrative capacity in local authorities and disseminating accessible information about the potential benefits of reform will be critical for shaping beliefs that further bouts of FS reform will deliver significant socio-economic and environmental benefits to the wider public.

South Africa

As an emerging economy with abundant coal reserves, South Africa is one of the most challenging countries for FS reform. While fossil rents accounted for 2.3% of GDP from 2010-2020, the drive for rapid growth has resulted in high (90%) dependence on low-cost electricity from domestic coal. Eskom, the publicly owned electric utility, dominates the electricity sector and has, thus far at least, been largely successful at resisting competition from alternative energy producers. Part of its success is due to its close links with political elites, which has facilitated its longstanding involvement in energy policymaking (Schmidt et al., 2017b). Since the 1960s, the fossil industry has been the recipient of substantial subsidies (averaging 13% of GDP from 2010 to 2020), which, at its peak in 1998, accounted for 73% of total FS in Africa and the Middle East combined (Bridle et al., 2022). Generous tax exemptions for the energy sector have resulted in some of the lowest electricity prices in the world and a coal-intensive economy dependent on cheap power. While a lack of transparency makes it difficult to quantify the scale of FS in South Africa, it is widely agreed that the social costs of FS, in terms of health, education, environmental pollution and energy access – which is plagued by regular nationwide daily blackouts - far exceed their benefits (Burton et al., 2018). Educational performance is notably low; despite ranking as the 31st largest economy¹¹, average rates of primary and secondary school completion from 2010 to 2020 were 82 and 18 percent respectively.

Yet recent developments such as the growing investment in renewable energy over the last decade and depletion of cheap domestic coal reserves have begun to undermine the economic rationale for the country's reliance on subsidized coal power generation (Schmidt et al., 2017b). Like Indonesia, South Africa recently signed the JETP, which set out an investment plan to mobilise an initial \$8.5 billion to accelerate coal transition and upscale renewable energy in the country (UK Government, 2022). At this critical moment, there are various measures that policymakers could take to increase the prospect for FS reform: Increasing fossil taxes could raise revenues to fund investment and stimulate jobs creation in sustainable sectors such as renewable energy, which would facilitate access to alternative reliable energy for powering rapid economic growth. As is the case for other developing economies, targeted programmes for poor rural households to access new connections would be particularly helpful (Sharma et al., 2019). This could be complemented by improving transparency and subsidy reporting, which would help ensure that policymakers are accountable for FS reform (Burton et al., 2018).

11 World Bank Development Indicators (2021), available from: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?most_recent_value_desc=true&year_high_desc=true

India

As a rapidly emerging economy with an average annual growth rate above 6% (International Monetary Fund, 2022), India, like many developing countries, has relied heavily on FS for facilitating stakeholders to access (largely coal-based) cheap energy. With energy access rates expected to double by 2030 alongside rapid economic and population growth (Sharma et al., 2019), India's continued reliance on FS would be significantly determinantal to global emissions trends as well as a major drain on the Indian treasury. India spent an average of 14.4% of GDP on funding FS over the past decade, with 75% of subsidies devoted to agricultural and 20% to domestic residential consumers (Aggarwal et al., 2020). This level of FS strongly inhibits multiple dimensions of human development/ SDGs such as universal access to sanitation, energy, healthcare and education (Jakob et al., 2015). Educational performance is notably poor, with only 57.5% and 11.5% of the general population having completed primary and secondary education respectively.

Vulnerability to international price fluctuations arising from high (around 80%) reliance on petroleum imports prompted the Indian government to take measures to deregulate prices of petroleum products and transform cooking gas subsidies into a direct benefit transfer since 2010 (Acharya & Sadath, 2017). However, significant discrepancies between the number of households to have reported LPG as their main source of cooking fuel and estimates from national wide surveys highlights the need for major improvements in transparency and reporting (Atansah et al., 2017). Fundamentally, successful reform in India would need to balance the need for increasing access to reliable energy for human development and powering the country's rapid growth with the reduction in real incomes that is likely to affect poor households and energy-intensive firms who rely most on FS. Removing subsidies that do not contribute to energy access and investing savings from FS removal in key infrastructure to compensate for the higher energy costs would alter the balance between households that support and oppose reform (Jakob et al., 2015). In relation to the latter, recent attempts to engage with industrial and commercial firms suggests that private stakeholders regard new coping mechanisms such as rebates on rooftop solar (Moerenhout et al., 2019) and greater transparency in fuel pricing (Aggarwal et al., 2020) as key measures that could greatly improve the ability of private sector interests to cope with higher fuel prices arising from FS reform.

Accessibility of information on fossil fuel subsidies and the role that climate change education can play in educating young citizens about fossil fuel subsidies and alternatives

Although most existing information on FS is publicly available, widespread lack of awareness among stakeholders means that actual interest in accessing available information is generally low. This is changing, however, as stakeholders have grown increasingly interested exploring the potential for FS reform to help meet decarbonisation and net zero targets. Yet even when awareness is high and stakeholders interested, the difficulty of defining and measuring FS - particularly for smaller countries that possess limited resources - has meant that comprehensive, high-quality information is not readily available (Burg & Whitley, 2016b; Kojima & Koplow, 2015). While recent efforts to capture a broader range of fossil-supportive measures over a wider (global) geographical terrain such as the IMF FS index have made important improvements to data availability, accounting problems and definitional gaps persist, leaving many externalities unaccounted for. Information access is also impeded by a lack of transparency in government reporting, particularly in relation to the share of GDP spent on FS and the negative consequences of subsidisation (Burg & Whitley, 2016b).

Experts largely agree that more transparent information about the size and multifaceted (socio-economic, ethical and environmental) implications of FS and reform is vital for incentivising governments to remove FS and ensuring that private sector interests, civil society and general publics formulate well-formed opinions (Pradiptyo et al., 2015a; van Asselt & Kulovesi, 2017). The experiences of many countries that have successfully phased out FS show that public information campaigns often play a critical role in eliciting widespread support for reform (Beaton & Lonton, 2010; Breisinger et al., 2019; Pradiptyo et al., 2015a). There are important reasons for targeting young people in particular: First, younger generations will bear more of the long-term outcomes of FS policies for longer, making it imperative that they have access to reliable information about FS (Fairbrother et al., 2019), which would help future publics develop well-informed opinions about the level and type of support that should be given to fossil fuel industries going forward (Rousell & Cutter-Mackenzie-Knowles, 2019). Educating young people is also critical for building key skills for just transition such as, for example, training future engineers and energy operators in low carbon energy technologies that will replace fossil fuel plants and understanding and managing the socio-economic, environmental and ethical challenges that will accompany energy transition (Kowalska et al., 2022; Kwauk & Casey, 2022).

What can be done?

What are the alternatives to subsidising fossil fuels?

Given the strong linkages between FS and a multitude of adverse social, economic and environmental outcomes, it is hardly surprising that international organisations, NGOs, academics and national governments have grown increasingly supportive of subsidy reform. Yet, in practice, reform attempts have almost always proven politically contentious. Around the world, both in industrialising nations (e.g. Nigeria, Indonesia, Sudan and Jordan) and some of the world's strongest economies (e.g. the US and Canada), FS reform has been diluted or even aborted entirely in response to strong opposition from segments of the general public and, sometimes, within the government.

Political economists offer valuable insights about the conflicts and complexities that shape the staggered paths of FS reform. Fundamentally, FS are difficult to phase out because they allow political rulers to meet certain goals at relatively low (political) costs and become entrenched over time as their long-term existence makes other strategies politically infeasible. Initially, FS originate as a relatively easy-to-implement mechanism to foster economic development by promoting access to cheap energy to power industrialisation. Yet this results in externalities, inefficiencies, and inequalities, which crowd-out investments in more (socio-economically and environmentally) sustainable industries (Schmidt et al., 2017b). Over time, political elites come to rely on support from (generally influential) fossil interests, who become accustomed to the provision of subsidies (Harring et al., 2023). Lock-in effects are particularly strong in fossil-rich countries, where fossil fuel-based activities account for a significant share of national income and employment (Jakob et al., 2015; Timperley, 2021). In these cases, FS are often accompanied by narratives about citizens' entitlements to revenue streams from national resources or perceptions that subsidy reform is a threat to national security (Corral-Montoya et al., 2022).

In general, government reluctance to phase out FS reflects an effort to pre-empt strong opposition from potential losers of subsidy reform – notably: consumers (especially poor households) who stand to pay higher prices for foods and commodities as a result of higher fuel prices (Atansah et al., 2017; Corral-Montoya et al., 2022; Lockwood, 2015; Pradiptyo et al., 2015b; Timperley, 2021) and firms that derive a significant profit from fossil fuels or incur large production costs from energy (Erickson et al., 2020; Rentschler, Kornejew, et al., 2017; Supran & Oreskes, 2017; Victor, 2009). In

general, lower subsidies would curtail demand for and, therefore, profit from fossil-based products – including fossil-based energy. While this would be detrimental for energy producers (and producers of other fossil-intensive goods), reduced energy access caused by higher fossil fuel prices would pose a major challenge for developing economies which are already struggling to supply reliable power because of deficient power infrastructure (Bazilian & Onyeji, 2012). Therefore, while FS emerge and become entrenched because of strong political incentives, it is important to recognise how disincentives against reform are more deeply embedded in the national infrastructure.

Over the past two decades, the rising impetus for global decarbonisation and net zero has galvanised many national governments into phasing-out FS. At the time of writing, 48 countries had signed up to the World Trade Organization’s fossil fuel subsidy reform initiative to eradicate inefficient subsidies (World Trade Organization, 2023).¹² Successful reform attempts demonstrate that governments can use different mechanisms to meet their political goals while avoiding the socio-economic and environmental costs that are associated with FS (Victor, 2009). The mixed empirical track-record of FS reform attempts shows reforms are more likely to succeed when effective measures are in place to compensate key stakeholders who stand to lose. When compensatory measures are lacking, however, reforms tend to prove politically unpalatable. There are various examples of initiatives that can be used to redistribute revenues from foregone FS to consumers affected by higher energy prices such as investing in education, health care and providing cash transfers to poor households. Multi-country studies show that public attitudes towards different redistributive measures vary widely across countries, suggesting that reformers can maximise support for phase-out by adopting measures and strategies that are most acceptable to their own publics (Harring et al., 2023). While less interest has been paid to redistributive measures for firms, it is increasingly recognised that policymakers need to support the ability of private sector actors - including those outside the energy sector that would be affected by indirect processes - to respond to energy price shocks by providing technical assistance, information programmes, infrastructural investment and financial support and access to non-fossil energy to counteract losses in competitiveness (Breisinger et al., 2019; Rentschler, Kornejew, et al., 2017). Some experts propose the notion of subsidy phase-out bonds, which would be issued by international financial institutions such as the World Bank to allow countries to access funds for overcoming political barriers by investing in measures to assist the worst affected industries (Hale & Ogden, 2014). Other strategies can also play an important role in overcoming political opposition to the removal of FS. National experiences suggest that institutional capacity for monitoring, reporting, and regulating reform (and affected socio-economic systems) is a facilitating factor for ensuring that FS can be removed in a socio-economically and environmentally

12 Namely: Albania; Austria; Belgium; Bulgaria; Chile; Colombia; Costa Rica; Croatia; Cyprus; Czech Republic; Denmark; Estonia; European Union; Fiji; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Latvia; Liechtenstein; Lithuania; Luxembourg; Mali; Moldova; Republic of; Montenegro; Netherlands; New Zealand; North Macedonia; Norway; Panama; Paraguay; Poland; Portugal; Romania; Samoa; Slovak Republic; Slovenia; Spain; Sweden; Switzerland; Tonga; United Kingdom; Uruguay and Vanuatu.



sustainable manner. In this regard, experts are increasingly calling for international institutions such as the UNFCCC or WTO to take the lead in setting and regulating national strategies for recycling FS revenues as part of global efforts to meet net zero (Johannes Urpelainen & Elisha George, 2021; Wold et al., 2011).

Recommendations for education unions

With strong links to local agents for new skills development and knowledge transfer, education unions are well placed to support the phase-out of inefficient FS around the world. In particular, there are five key contributions that unions could play in helping policymakers identify and utilise the most effective, socially appropriate and sustainable reform measures.

Education and green skills development: History shows that successful FS reforms tend to be supported by extensive education campaigns to teach key stakeholders about FS – as well as the varied trade-offs that sustain them - and the potential benefits of and challenges to reform (Pradiptyo et al., 2015a; Whitley & Van Der Burg, 2015). Yet beyond this, several stakeholders including young people, engineers, natural scientists, energy providers, policymakers and, at some level, publics at large, will need to develop a range of key ‘green skills’ for understanding, navigating, deliberating, implementing, monitoring and governing energy transition. Energy companies and employees are often more supportive of FS phase-out if subsidies are provided to generate alternative economic opportunities in low carbon energy sectors. Therefore, education and training in low carbon energy technologies such as renewables is a key strategy for building support for subsidy reform from potential losers of phase-out such as the fossil fuel industry and energy intensive sectors in general (Presha Ramsarup & Mike Ward, 2017; Vona et al., 2018). More broadly, as future cohorts of energy stakeholders, engineers and national publics, young people in national education comprise an obvious focus for such education initiatives (Eaton & Day, 2019; Tannock, 2020).

Trust-building: By helping stakeholders to understand the multiple trade-offs, concerns, opportunities and challenges associated with different reform options, education unions could also support actors to formulate well-informed opinions on FS (and energy) policy. Presumably, well-informed stakeholders would be more engaged and willing to participate in policymaking, making it more likely that these concerns are addressed by policy reform, and that the reform process itself is perceived as just and socially feasible. Indeed, education campaigns have often proven critical in reframing reform in a positive light, particularly in fossil-rich countries where publics often feel that FS are the only way for them to share the revenue streams from national resources (Schmidt et al., 2017b). Education unions could also help build trust in FS reform by improving transparency by disseminating accessible information relating to countries’ performance on FS phase-out (Aldy, 2017).

Organise reform beneficiaries: History shows that reform attempts usually fail when groups in favour of phase-out are disorganised. In this regard, FS beneficiaries tend to be in a relatively advantageous position as they mainly consist of well organised groups that are in receipt of tangible subsidy benefits such as fossil fuel lobbies and recipients of consumer subsidies. By contrast, reform proponents such as renewable energy, environmentalists, education and health services and poor segments tend to be more widely dispersed across time and space (Skovgaard & van Asselt, 2019; van Asselt & Skovgaard, 2021). Education unions could draw on their strong links to local and national educators and institutions to access valuable contextual knowledge and connections for uniting potential beneficiaries of phase-out. One of the major obstacles facing potential reformers is that some beneficiaries are not aware that they stand to gain, or which types of gains they could make if FS are phased out. Therefore, a first step for education unions would be to work with educators and more organised proponents to inform less aware groups of potential gains and synergies. In addition, educators should also work with organised proponents of reform such as policymakers and low carbon energy industries to build confidence among potential losers that that they would be given effective support access to promising opportunities in other sectors.

Pick low-hanging fruit: Part of the reform challenge is that FS reform entails significant changes across the economy and society. As such, proponents need to make critical decisions about which sector(s) to target first, the level of ambition (i.e. is the goal to eradicate FS completely or reduce to a certain level?), choice of compensatory measures and priority beneficiaries of reform. Experience suggests that a good strategy is to begin by implementing reforms that can break long-term fossil lock-in. This was the case, for example, in India, where universal subsidies were increasingly replaced by targeted subsidies which gradually reduced support for new gas and oil fields that would need to remain active for decades to pay off the initial investment (van Asselt & Skovgaard, 2021). Ultimately, reforms would need to reflect national conditions and therefore require a good understanding of which measures are likely to be most effective in different countries and regions. Education unions could use their connections to local educators and NGOs to access ground-knowledge for informing political economy analyses and developing recommendations to assist policymakers to design effective strategies to suit the unique reform conditions within their country. A tailored approach would go a long way towards overcoming the multifaceted and, often, entrenched barriers to reform in countries where phase-out is particularly challenging. For example, decreasing energy intensive production poses significant challenges for fossil-rich countries that rely on fossil activity for a large share of national income (Inchauste & Victor, 2017; Victor, 2009). By contrast, the potential environmental benefits of reform do not speak to the major challenges in developing economies, which require significant investment in energy infrastructure in order to maintain even current (deficient) levels of power supply (Bazilian & Onyeji, 2012). In

these latter countries, governments should start by removing subsidies that are not important for energy access and subsidising measures that establish new connections, particularly from the rural poor (Sharma et al., 2019). Education unions could play a vital role in cultivating ground knowledge for identifying the most effective measures for overcoming the unique (immediate and longer term) challenges that accompany FS reform in different countries.

Tap into international fora: The drive for global decarbonisation and net-zero has spawned growing interest from national governments, multinational corporations and international organisations in FS reform. During last year's COP-27, UN members committed to rationalising inefficient FS and adopted SDG indicator 12.c.1 to track the global size of FS. To support transparency and monitoring, the UNEP, OECD and IISD developed a methodology to guide governments in collecting and sharing FS data, though few have submitted data (International Institute for Sustainable Development, 2022). Other complementary international developments include the World Trade Organization's fossil fuel subsidy reform initiative (WTO 2023), OECD and IISD's Fossil Fuel Subsidy Tracker¹³ and the inclusion of FS data in the IEA's annual World Energy Outlook database as of 2016.¹⁴ Yet recent events such as the COVID pandemic and Ukraine War have driven many governments to adopt new subsidies to shield their economies from rising energy prices and supply shortages. At this critical moment of increased impetus for FS reform, on the one hand, and contradictory disincentives against fossil phase-out, on the other, education unions could help tip the scale in favour of reform by progressing transparency.¹⁵ A first step would be to collaborate with relevant international organisations to develop materials for raising awareness among national stakeholders about the costs and benefits of FS and phase-out and data requirements for effective reporting. With links to worldwide NGOs and educators, education unions are well placed to act as an interlocuter for disseminating emerging international norms surrounding fossil phase-out as well as global data needs. Indeed, such exchanges between international fora and local agents of reform have often been a determining factor for reform success (Bang & Lahn, 2019). This would provide a channel for local stakeholders to contribute valuable ground knowledge about the specific challenges to reporting and transparency in their own country, which could help shape international mechanisms for funding improvements in national reporting capacities (Benninghof, 2013; Johannes Urpelainen & Elisha George, 2021).

13 <https://fossilfuelsubsidytracker.org/>

14 <https://www.iea.org/reports/world-energy-outlook-2016>

15 It is worth noting that transparency and reporting are not exclusively problems for developing economies, fossil-rich countries or closed political regimes. On the contrary, FS reform is significantly obstructed by unclear timelines, national policies and reporting practices for monitoring and incentivising phase-out even in some of the strongest economies, fossil-poor countries and oldest democracies, (Gençsü et al., 2020; Nowag et al., 2021).

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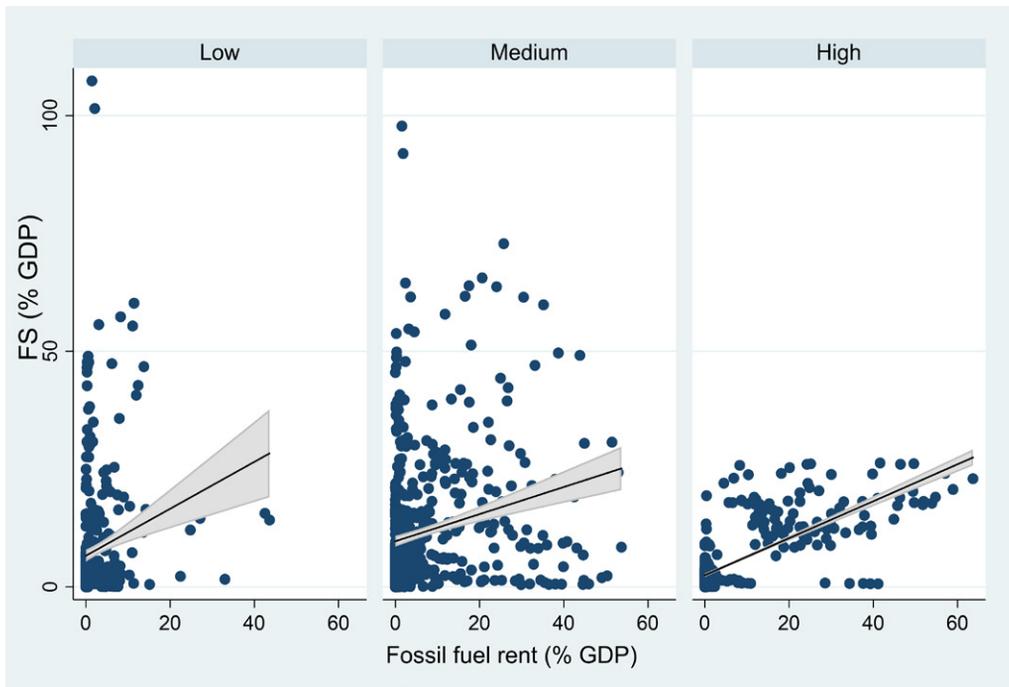
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Appendix

Fossil fuel subsidies spending as a function of fossil rents in low, medium and high income countries

Figure A1: Fossil fuel subsidy spending (% share GDP) as a function of fossil fuel rent (% share GDP) across low, medium and high-income countries. Lines are lines of best fit and shaded regions 95% confidence intervals.



Note: Low = incomes that fall <30th, medium = 30th to 70th and high = >70th percentile world average per capita GDP for that year. A complete list of country-year classifications of low, medium and high income countries is given in the Appendix.

Interestingly, the narrowing of the confidence intervals with economic development (towards the right of the figure) suggests that the positive relationship is strongest in advanced economies. This coheres with claims that fossil dependency has long-term economic effects that 'lock-in' fossil-intensive activity even after industrialisation and advanced levels of development have been attained (Erickson et al., 2015; Healy & Barry, 2017).

Correlation coefficients between fossil fuel subsidies spending, economic development and fossil rent shares

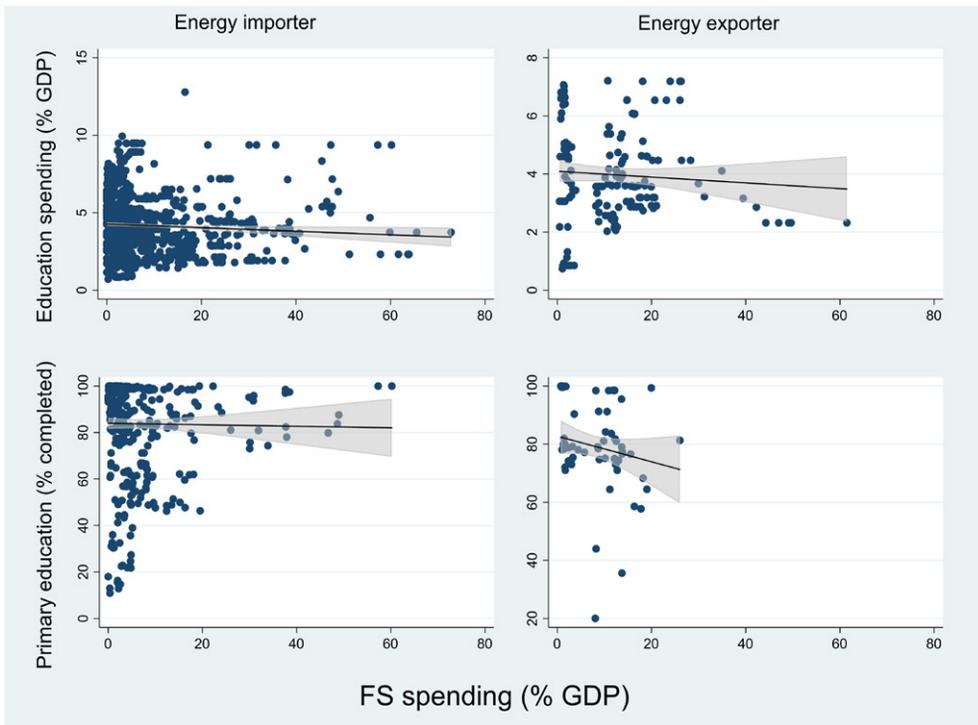
Table A1: Pairwise correlation matrix of FS spending, economic development and fossil rent dependency.

Factor	Correlation coefficient
FS spending and:	
Economic development	-0.20***
Fossil rent share	0.31***
Economic development & fossil rent share	0.60

Note: Entries are Pearson's correlation coefficients for FS spending as a share of GDP, per capita GDP and percentage share of fossil rents of GDP. *** denotes $p < 0.001$, ** $p < 0.01$ and * $p < 0.05$.

Educational spending and primary school completion rates in energy importers and exporters

Figure A2: FS spending as a function of education spending and percentage of population aged 25 years and over that has completed primary school education to in energy importer and exporter countries.



The steeper best fit lines in exporter countries depict stronger negative relationships between FS spending, education spending and primary education completion in energy exporters compared to energy importers.

Table A2: Mean levels of selected educational outputs and outcomes across the world, energy importers and exporters and significance of difference tests. The unequal t-test statistic and associated p-value (shown in brackets) in the far right column indicates that differences in means are statistically significant in all cases except completion rates of secondary education.

Indicator	World		Importers		Exporters		T-test statistic (p-value)
	Mean	SD	Mean	SD	Mean	SD	
Outputs							
Education spending (% GDP)	4.20	0.04	4.20	0.05	3.97	0.12	45.075 (0.000)
Education spending (% total public spending)	91.19	0.23	91.45	0.23	89.41	1.08	38.43 (0.000)
Outcomes							
Primary school enrolment (% primary school aged children)	92.89	0.32	92.51	0.37	95.08	0.53	-62.23 (0.000)
Completed primary school (% aged 25 years+)	83.19	0.90	83.78	0.99	80.37	2.14	19.40 (0.0000)
Completed secondary school (% aged 25 years+)	28.22	0.72	28.23	0.78	28.40	2.06	-0.98 (0.326)
Completed tertiary school (% aged 25 years+)	23.58	0.54	23.69	0.59	23.60	1.74	0.76 (0.444)
Bach degree (% aged 25 years+)	18.65	0.48	19.06	0.52	15.96	1.47	27.45 (0.000)
Masters degree (% aged 25 years+)	6.48	0.33	6.90	0.36	3.20	0.47	52.35 (0.000)
Doctorate (% aged 25 years+)	0.62	0.03	0.63	0.04	0.45	0.09	17.10 (0.000)

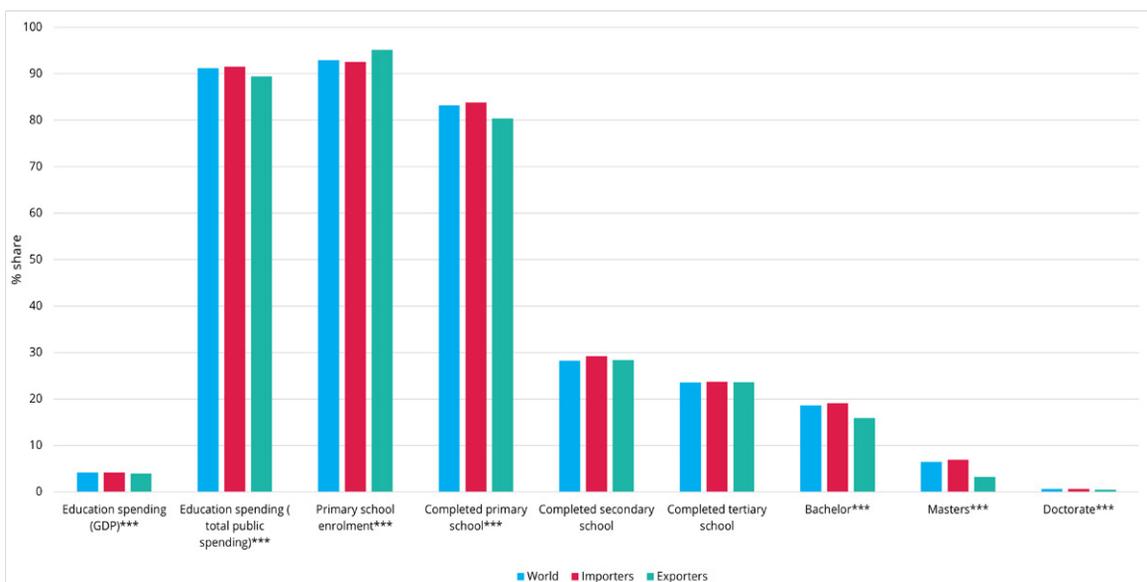
Table A3: Pearson's correlation coefficients between FS spending and selected educational outputs and outcomes across key country groupings. Note: *** denotes $p < 0.001$, ** $p < 0.01$ and * $p < 0.05$ and T $p < 0.10$.

Indicator	Country sample						
	All	(Net) energy import level			Income level		
		Importers	Exporters	Top exporters	Low	Medium	High
Education spending (% GDP)	-0.04T	-0.07*	-0.07	-0.12	0.30***	-0.12**	-0.21***
Education spending (% total public spending)	0.05	0.06	-0.02	-0.11	0.02	0.17**	-0.31***
Primary school enrolment (% primary school aged children)	0.12***	0.11**	0.11	0.03	0.35***	0.20***	0.04
Completed primary school (% aged 25 years+)	-0.03	-0.01	-0.24T	-0.32*	0.70***	0.25***	-0.57***
Completed lower secondary school (% aged 25 years+)	0.08T	0.11*	-0.09*	-0.24T	0.83***	0.41***	-0.25***
Completed secondary school (% aged 25 years+)	-0.06	-0.03	-0.40*	-0.56***	0.91***	-0.01	-0.06
Completed tertiary school (% aged 25 years+)	-0.02	-0.01	-0.16	-0.35*	0.81***	0.12	-0.02
Bach degree (% aged 25 years+)	-0.14**	-0.14**	0.03	-0.29T	0.67***	0.06	-0.12T
Masters degree (% aged 25 years+)	-0.32***	-0.31***	-0.43*	0.70***	0.01	-0.11	-0.41***
Doctorate (% aged 25 years+)	-0.25***	-0.24***	-0.46	-0.87**	0.12	0.29*	-0.20**

Globally, a one percent increase in the share of GDP spending on FS is correlated with a 0.4 percentage point decrease in the share of GDP invested in education and 0.14, 0.32 and 0.25 percentage point decrease in bachelors, masters and doctorate degree attainment rates respectively (Table A3). Yet FS spending is not negatively correlated with multiple other key measures of education including the percentage of total public expenditure on education, primary school, lower secondary school, upper secondary school and tertiary education completion rates (Table A3). More detailed analyses show that the correlations between FS spending and different measures of educational outputs and outcomes vary widely across countries depending on their level of energy exports and economic development (Table A3).

The correlation between FS spending and education varies widely across countries depending on their level of energy exports and economic development. Energy exporters¹⁶ tend to spend significantly more on FS and less on education and have lower completion rates of primary, secondary, tertiary school and university education (figure A3) than energy importers (Figure 5 and Table A2). Moreover, FS also are significantly more inhibitory to educational investment and primary education attainment in energy exporters (Figure A2). In general, energy importers that spend above average on FS tend to spend below average levels of GDP on education and have lower undergraduate and postgraduate degree completion rates, but have higher levels of primary school completion (though this is not carried through to secondary school). For energy exporters, on the other hand, FS spending is negatively associated with multiple key markers of educational attainment – namely: rates of primary, lower secondary, upper secondary, tertiary and university education completion, but not educational investment.

Figure A3: Average levels of selected educational outputs and outcomes across the world, energy importers and exporters. * denotes differences between energy importers and exporters are statistically significant at P<0.0001 (complete results of t-test statistics are reported in Table A2).**



¹⁶ We define energy exporters as countries that export the equivalent of a third or more of domestic energy consumption after deducting energy imports.

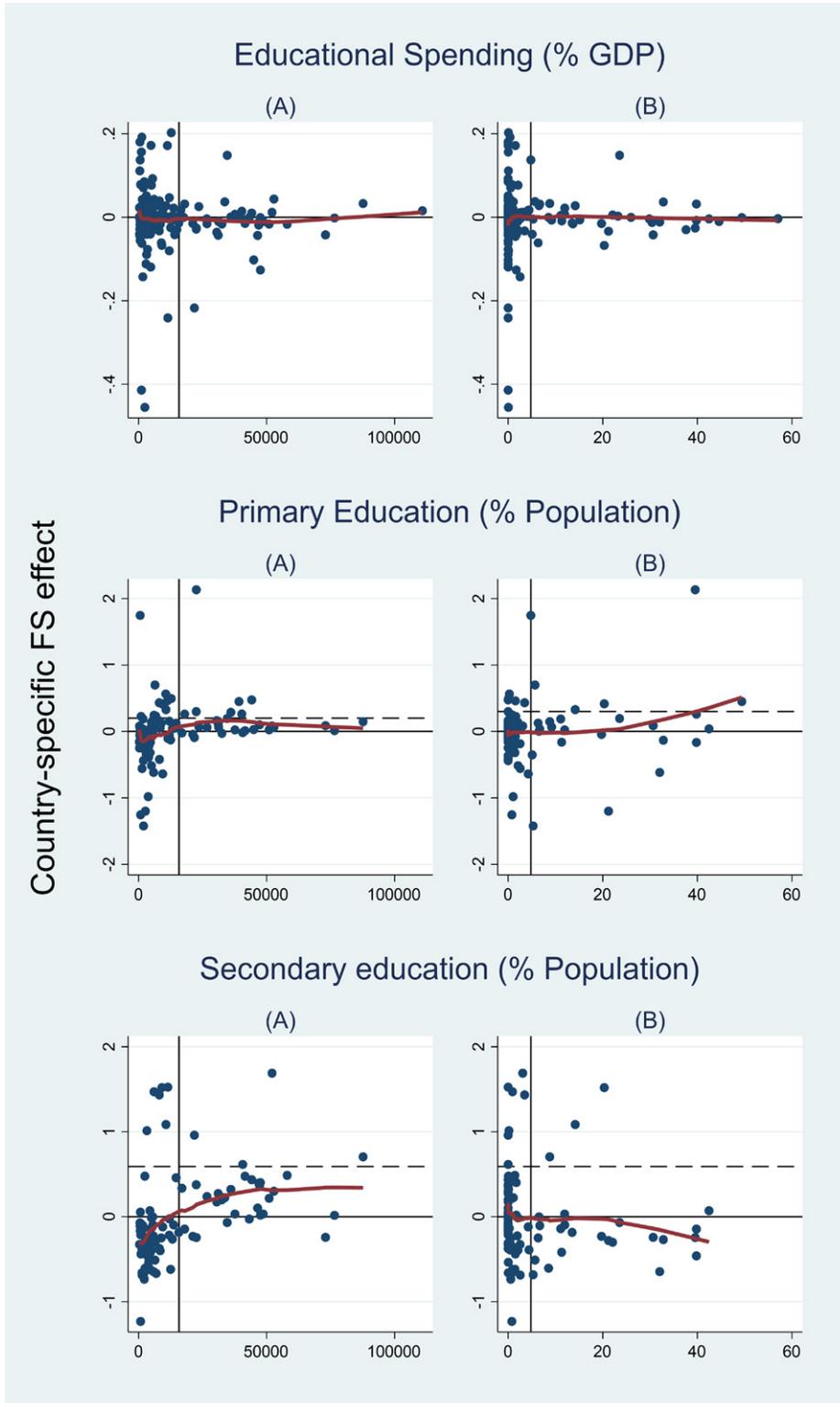
Table A4: Potential drivers of educational spending and rates of primary and secondary school completion (as a percentage share of the population).

Parameter	(A) Education investment	(B) Primary school completion	(C) Secondary school completion
Fixed effects			
FS spending	2.94E-3	0.30*	0.59**
Population	-1.90E-9*	2.18E-8T	-5.96E-9
Per capita GDP	-3.60E-6	1.67E-4***	2.11E-4***
Fossil rents	4.78E-3	-0.53***	-0.31***
Random effects			
FS spending (% GDP)	0.01***	0.62***	0.89***
Country variance	2.92***	600.62***	186.63***
Country-year variance	0.14***	5.61***	8.18***
LR test OLS	3667.75***	1268.07***	757.67***
N	1607	485	487

Note: Entries are maximum likelihood estimates. *Significant at 5% ($p < 0.05$). **Significant at 1% ($p < 0.01$). ***Significant at 0.01% ($p < 0.001$).

Table A4 presents the main results of our core regression model. The fixed effect FS values estimate the typical effect of a one percent increase in the share of GDP spent on FS on (A) educational investment, (B) primary school completion and (C) secondary school completion rates among the population aged 25 years and above. On average, a one-percent increase in the share of GDP spent on fossil fuels is associated with a 0.3 and 0.6 percentage point increase in primary and secondary school completion rates respectively, while the insignificant FS estimates in columns A suggests no clear association between FS spending and educational investment. If the story was to end here, the positive sign of the column C and D estimates and lack of significance of column A estimates would negate the claim that FS is detrimental to education.

Figure A4: Random country-specific effects of fossil fuel subsidy spending (percentage of GDP) on educational investment (percentage share of GDP), primary and secondary school completion rates (percentage share of population aged 25 years and above) across country mean levels of (A) economic development (per capita GDP, US\$) and (B) fossil rent dependency (percentage of GDP).



While FS spending tends to be compatible with primary school attainment in fossil-rich countries and detrimental in fossil-poor countries, this relationship is inverted at higher levels of education, where FS spending tends to be associated with diminishing rates of secondary education completion in FS-rich countries, while being positively associated with secondary school completion in fossil-poor countries (Figure 6B). By contrast, the effect of FS spending on educational investment is largely autonomous of a country's level of economic development and reliance on fossil rents.

Table A5: Mean educational effects of fossil subsidy spending in low, medium and high-income countries.

Education indicator	Low-income	Medium-income	High-income
Education spending	2.00E-3	-0.01*	-0.21*
Primary completion	-0.24***	-0.10**	0.16**
Secondary completion	-1.12***	0.17	0.81***
Undergraduate degree completion	-0.15***	-0.01***	0.07***

Note: Entries are mean country-specific FS spending effects with standard errors in parentheses. Low-income = per capita GDP of 30th percentile and below, medium-income = 31st to 69th percentile, high-income = 70th percentile and above. Percentage point estimates and standard errors are presented in Table A5.

Research design

The variables, data sources and coding strategy used to conduct the quantitative analysis in this policy brief are summarised below.

Table A7: Variables, coding strategy and sources.

Variable	Coding strategy	Source
Fossil subsidy spending	Percentage share of total GDP spent on FS in a given country per year. Includes spending on both implicit and explicit subsidies.	IMF Fossil Fuel Subsidies database
Population	Population in a country year in a given year	World Bank World Development Indicators
Per capital GDP	Per capita GDP (\$) in a country per year	World Bank World Development Indicators
Fossil rents	Percentage share of GDP derived from coal, gas or oil in a country-year	World Bank World Development Indicators
Poverty	Poverty headcount ratio – percentage of population at £3.65 per day (2017 purchasing power parity) in a country-year	World Bank World Development Indicators
Renewable energy share	Percentage of electricity generation from renewable energy sources (excluding hydro energy) in a country-year	World Bank World Development Indicators
Health spending	Percentage of GDP spent on public health care in a country-year	World Bank World Development Indicators

CO2 emissions	Per capita metric tonnes of CO2 emissions in a country-year	World Bank World Development Indicators
Educational investment	Percentage of GDP spent on education in a country-year	World Bank World Development Indicators
Primary school enrolment	Percentage of primary school aged children enrolled in primary education in a country-year	World Bank World Development Indicators
Primary school completion	Percentage of the population aged 25 years and above to have completed primary school in a country-year	World Bank World Development Indicators
Secondary school completion	Percentage of the population aged 25 years and above to have completed secondary school in a country-year	World Bank World Development Indicators
Tertiary education completion	Percentage of the population aged 25 years and above to have completed tertiary education or equivalent in a country-year	World Bank World Development Indicators
Bachelors degree	Percentage of the population aged 25 years and above with a Bachelors degree or equivalent in a country-year	World Bank World Development Indicators
Masters degree	Percentage of the population aged 25 years and above with a Masters degree or equivalent in a country-year	World Bank World Development Indicators

Preliminary tests consisting of null variance models showed that the majority (around 90% of total variation) of variation in educational performance occurs at the country-year level (i.e. observations of educational indicators are more likely to be similar to each other if they belong to the same country).¹⁷ Therefore, this study accounts for country-level clustering by using a hierarchical model consisting of country-years nested in countries, which holds constant country-level confounding factors (including ones not explicitly included as control variables in the core regression) to ensure that observed associations between FS and education are indeed attributable to FS rather than other country-level conditions. The core specification is:

A two-level random coefficient model consisting of country years nested in countries is used to model the hierarchical data structure and allow the random effect of FS to vary between countries.¹⁸ The core specification is as follows:

$$Education_{ij} = \beta_0 + \beta_1 FS_{ij} + \beta_2 POP_{ij} + \beta_3 GDP_{ij} + \beta_4 FOSSIL_RENTS_j + u_1 FS_j + u_j + e_{ij}$$

Where $Education_{ij}$ is the educational indicator in year i in country j , β_0 is the overall mean education indicator level for all observations across all countries and $\beta_0 + u_j$ is the mean education indicator level for all observations from country j . $u_1 FS_j$ is the random country effect of FS spending on the specified educational indicator in country j .

¹⁷ These results are available from the author on request.

¹⁸ All models described in this article were fitted using Stata's `xtmixed` command.





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Fossil Fuel Subsidies

A Briefing for Education Unions

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November 2023



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Published by Education International - Nov. 2023

ISBN: 978-92-9276-004-5 (PDF)

Cover design: Education International



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