Carbon Tax Design Architectures for Developing Countries

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OUTLINE

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- Carbon tax design from different perspectives
  - Economic
  - Distributional (equity)
  - CO2 mitigation
- Carbon tax rate design
- Carbon tax for co-benefits (environmental & fiscal)
- Conclusions

Disclaimer

The views expressed in this presentation are those of the speaker only and do not represent his employer or any other organizations

Results related to Ethiopia country study included in this presentation are preliminary

What is a carbon tax and how does it work?

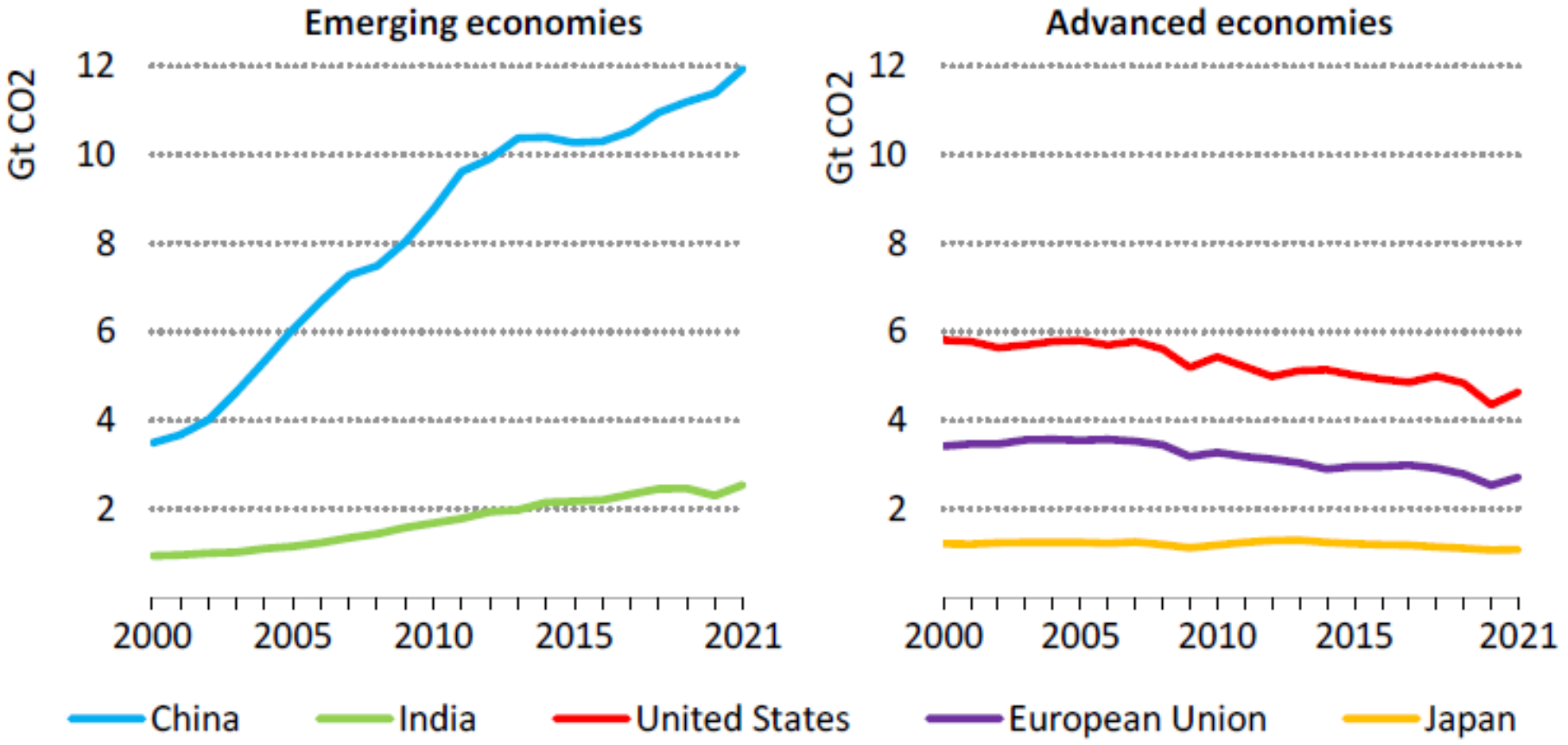
- A levy imposed on sources of CO_2 in proportion to their carbon intensity, following polluter pay principle
  - Taxes on fossil fuels in proportion to CO_2 for the same amount of energy output (e.g., GJ)
  - Taxes on outputs in proportion to their CO_2 intensities for the same monetary value of outputs
- It works, through:
  - Fuel price channel – Reduced demand due to increased price
  - Fuel substitution channel – Substitution of fossil fuels
  - Product price channel – Reduced demand for carbon-intensive products
  - Product substitution – Substitution of carbon intensive products
  - Behavior change – Reducing wasteful consumption of energy
  - Technological improvement – Low emission technologies throughout the energy chain (production to end-use consumption)

Why are we talking about carbon pricing for developing countries? (1/4)

- A brief background:
  - UNFCCC (1992) – to stabilize atmospheric concentrations of GHGs at a level that avoid dangerous interference with the climate system
  - Common but differential responsibilities
  - Kyoto Protocol (1997) – a binding obligation to developed countries and economies in transition for 5% (on average) reduction of their emissions during 2008-2012 from 1990 levels (ratified by 177 countries)
  - Doha Amendment of the Kyoto Protocol: Extension of the Kyoto Protocol until 2020 with a target of achieving 18% emission reduction during 2013-20 from 1990 level
  - Change in recent emissions trends: not possible to achieve UNFCCC objective without developing countries participation

Why are we talking about carbon pricing for developing countries? (2/4)

Figure 5 CO2 emissions in selected emerging and advanced economies, 2000-2021

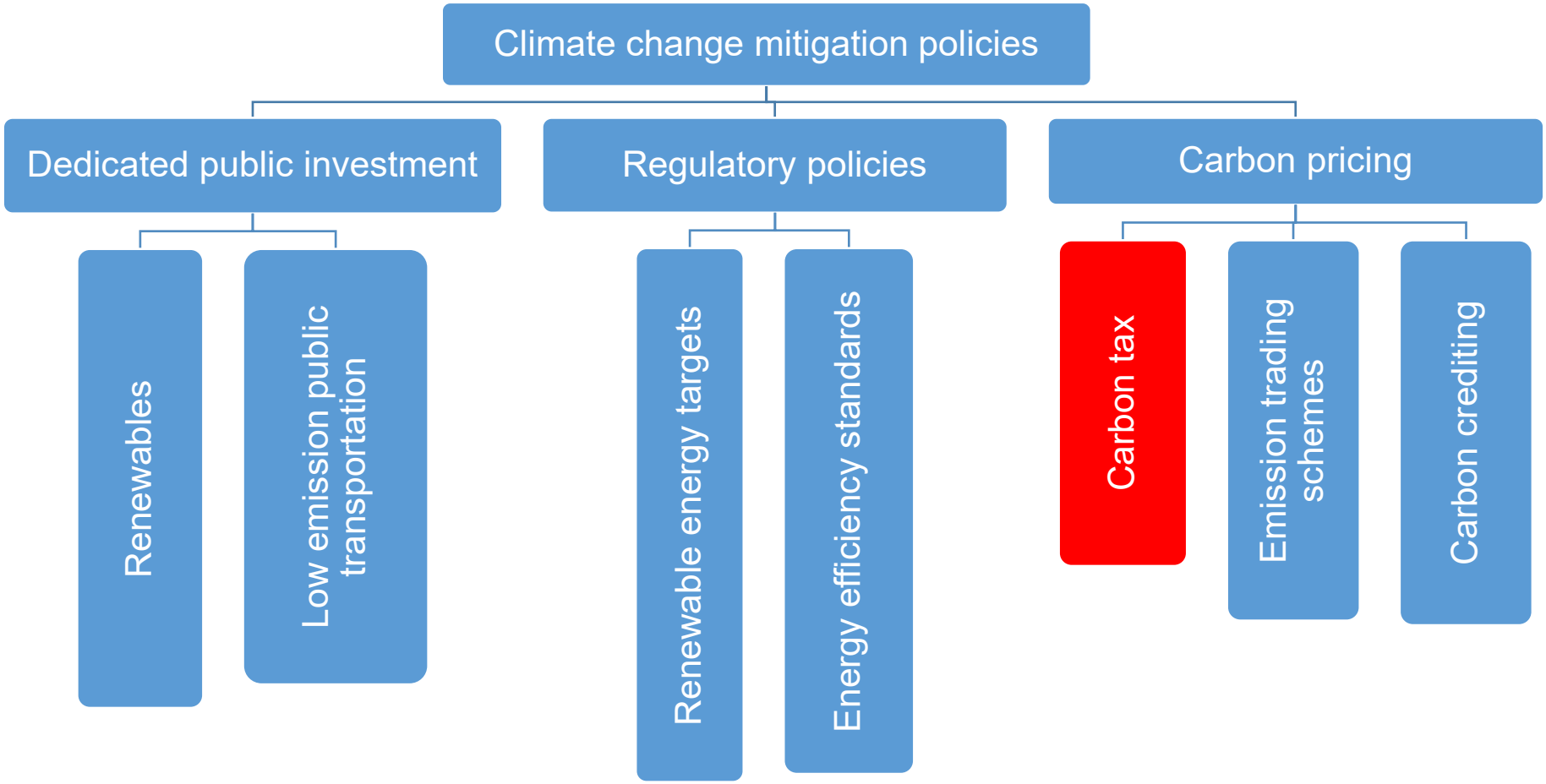


Why are we talking about carbon pricing for developing countries? (3/4)

- Paris climate agreement (2015) (21st COP to UNFCCC)
  - Agreed, for the first time, to limit GHG emissions to control the global warming at 2^0 C by the end of the century while pursuing to achieve 1.5^0 C
  - A voluntary agreement
  - Allowed the countries to commit their emission mitigation based on their capacity – Nationally determined contribution (NDC)
  - Pledged a wide range of targets by 2030 (some islands countries plan to achieve 100% reduction through renewables)
  - Signed by 196 countries, 189 countries already adopted by now
  - Carbon pricing is included in NDC packages of many developing countries

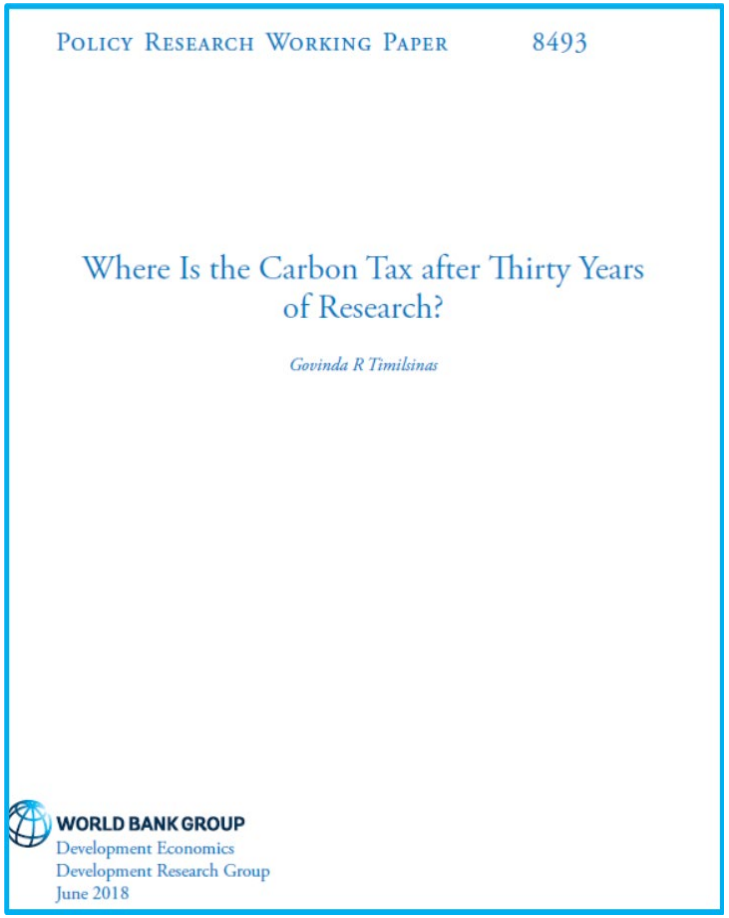
Why are we talking about carbon pricing for developing countries? (4/4)

Policies & measures included in NDCs?



Carbon Tax Research

- William Nordhaus, perhaps the first economist to initiate the discussion on carbon tax (Nordhaus, 1977)
- Carbon tax took attention to researchers only after 1990, when international initiatives on climate change started with the formation of IPCC and UNFCCC
- Around the same time, Scandinavians countries (Denmark, Norway, Finland, Sweden) introduced carbon tax
- Hundreds of studies have been carried out since then covering various issues related to carbon tax



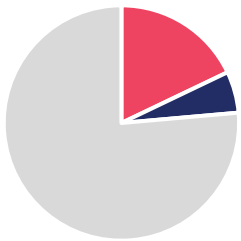
- After the Paris Agreement, interest on carbon tax has increased substantially including developing countries and corporate world

Key issues with carbon pricing

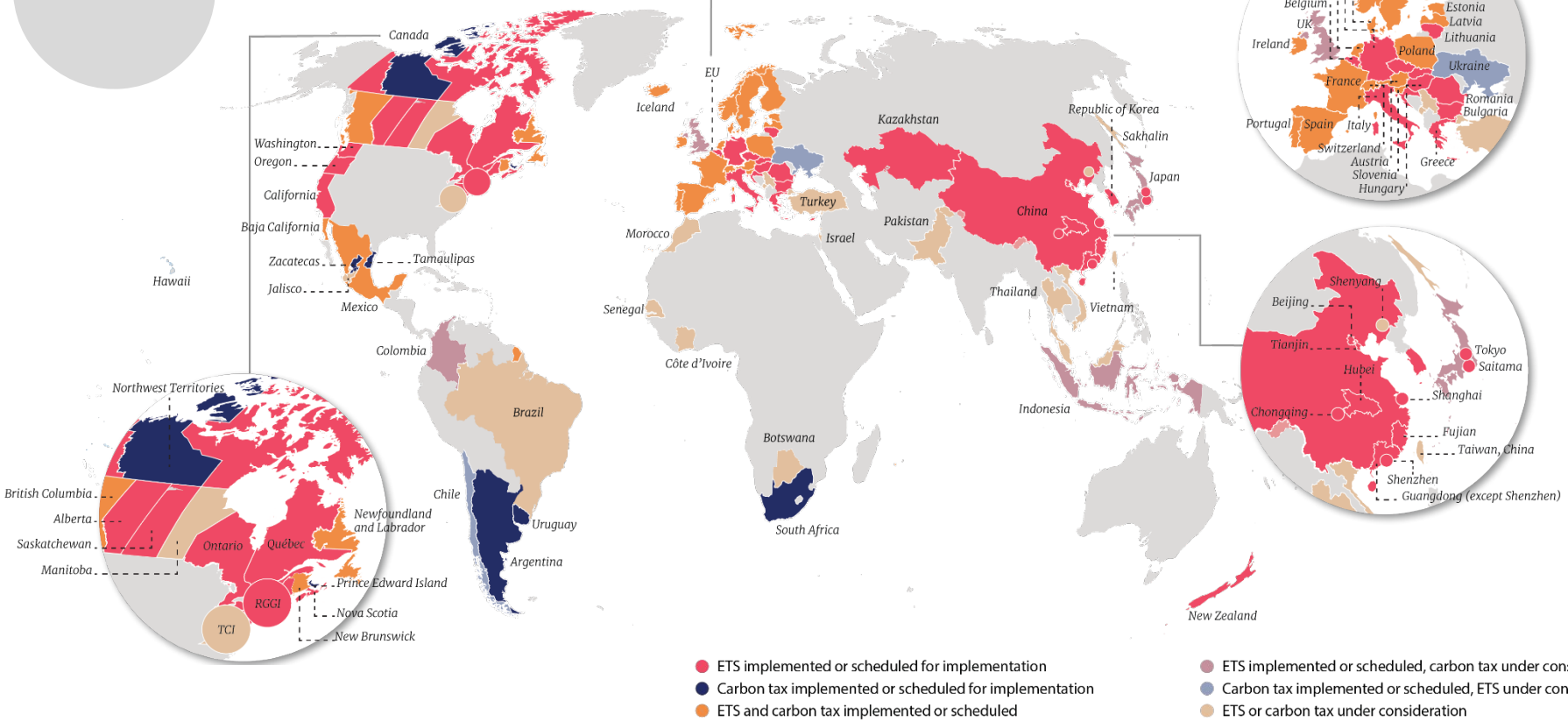
- Carbon pricing, perhaps, is the richest in environmental economics literature

- Based on the review of literature, key issues discussed on carbon tax, are:
  - Design architecture
  - Economic impacts
  - Distributional effects
  - Revenue recycling schemes
  - Competitiveness and emission leakage
  - Carbon border adjustment mechanisms
  - Specific issues related to carbon taxation

Where has carbon tax been introduced?



23% of global GHG emissions covered

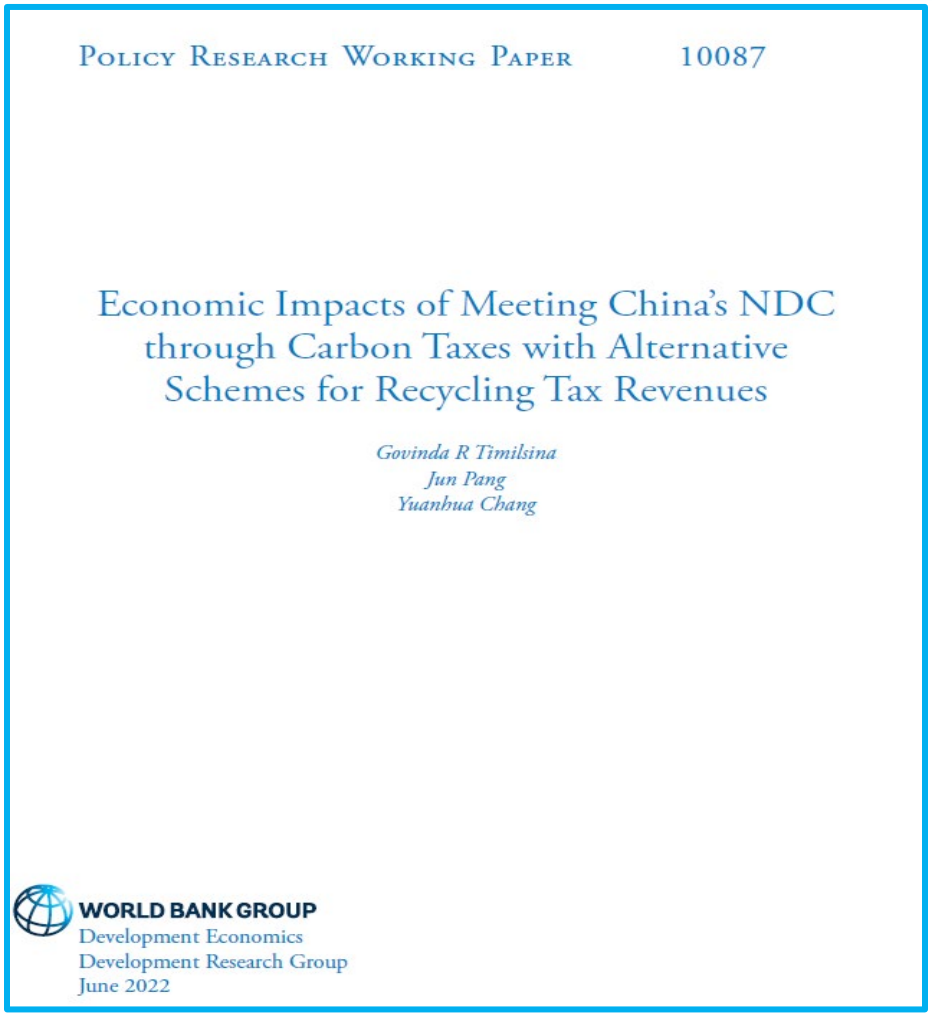


- 68 taxes and emissions trading systems are operating
  - New CPIs in Uruguay and North America—Oregon, New Brunswick, and Ontario
  - CPIs scheduled in Indonesia, Austria, and Washington State
- But other developments, including cross-border approaches to carbon pricing

Source: World Bank (2021)

Designing a carbon tax from an economic efficiency perspective

Source of Presentation

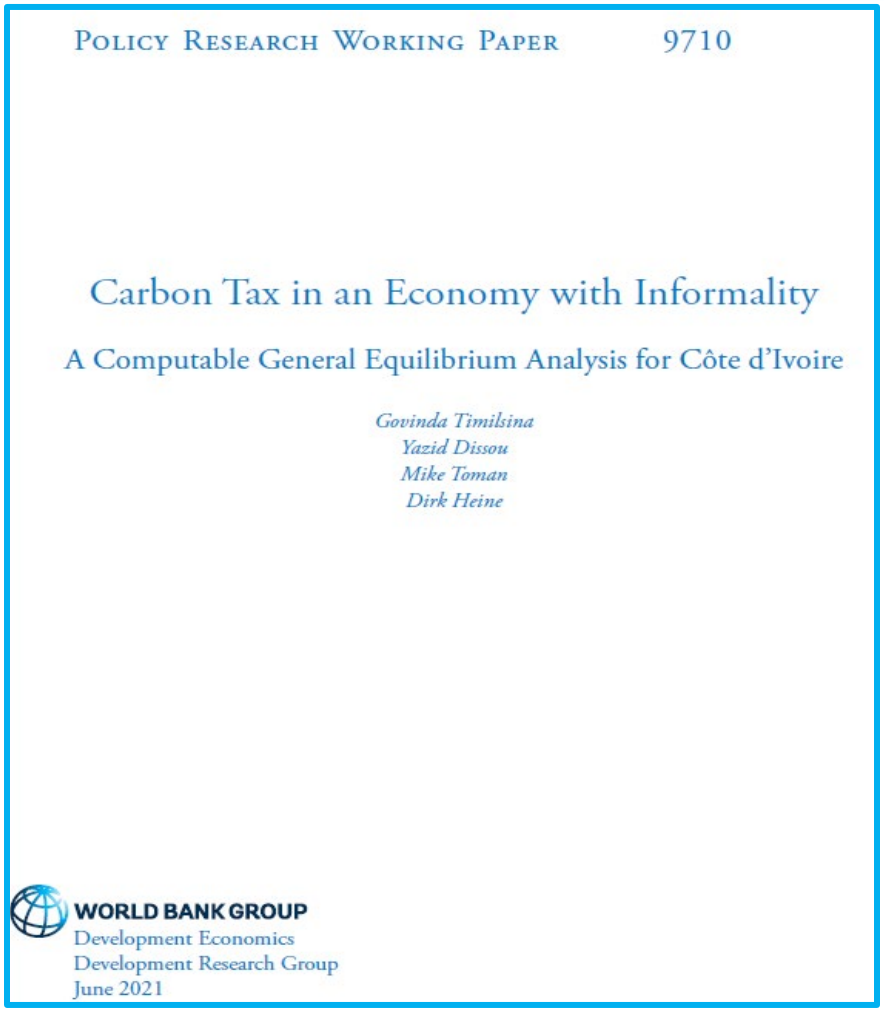


POLICY RESEARCH WORKING PAPER 10087

Economic Impacts of Meeting China's NDC through Carbon Taxes with Alternative Schemes for Recycling Tax Revenues

Govinda R Timilsina
Jun Pang
Yuanhua Chang

WORLD BANK GROUP
Development Economics
Development Research Group
June 2022



POLICY RESEARCH WORKING PAPER 9710

Carbon Tax in an Economy with Informality

A Computable General Equilibrium Analysis for Côte d'Ivoire

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Mike Toman
Dirk Heine

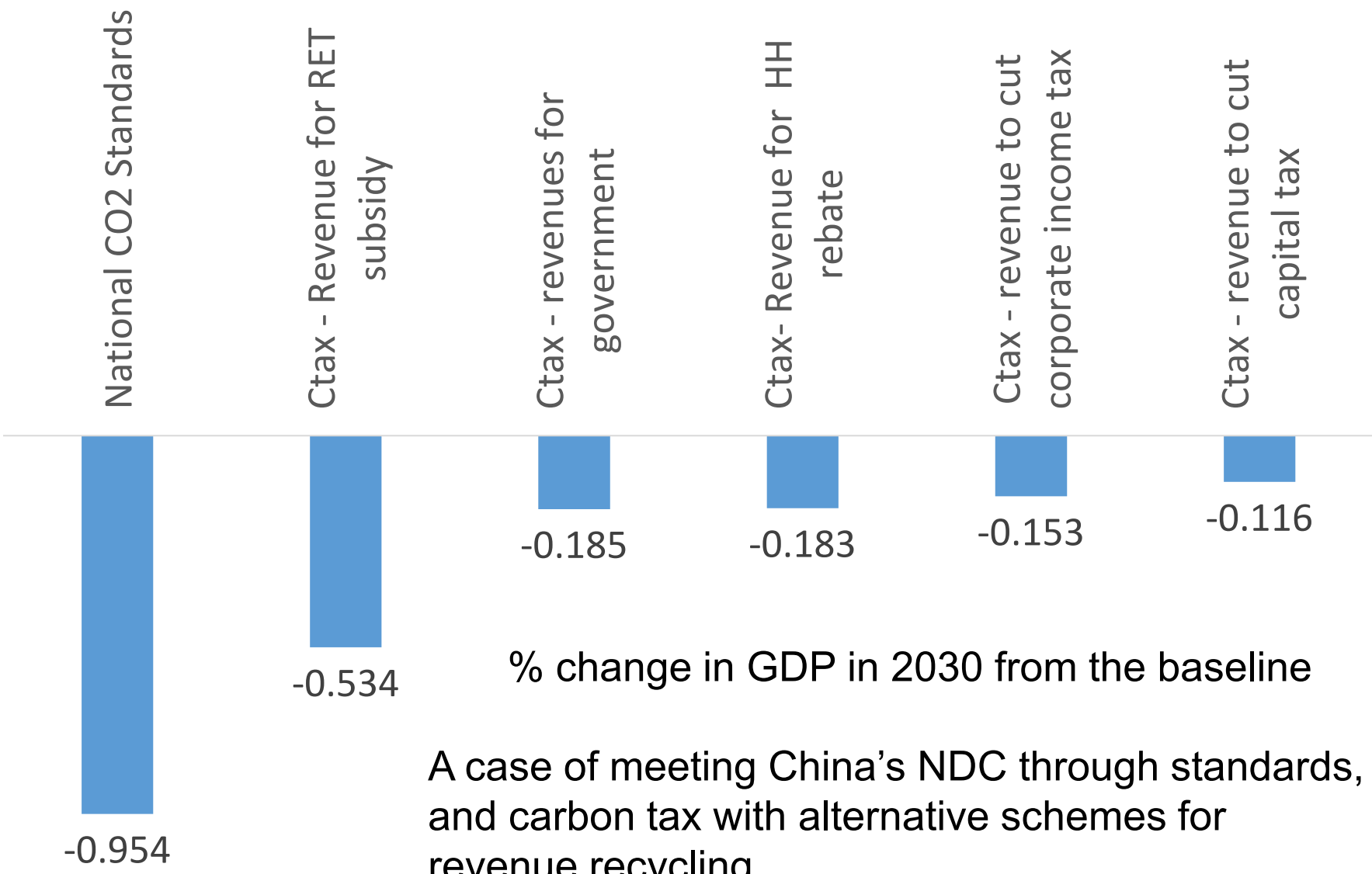
WORLD BANK GROUP
Development Economics
Development Research Group
June 2021

- Timilsina Govinda & Samuel Sebsibie. Carbon Tax with Alternative Tax-Design Schemes for Ethiopia: A General Equilibrium Analysis (to be completed, preliminary results)

The Three Country Case Studies

- China: A national CO_2 standard and a carbon tax with alternative revenue recycling schemes to meet China's NDC target in 2030
- Cote d' Ivoire: A \$22/tCO_2 carbon tax with an explicit representation of the informal production activities
- Ethiopia: A \$20/tCO_2 carbon tax with multiple households by income
- CGE modeling framework used for all three case studies

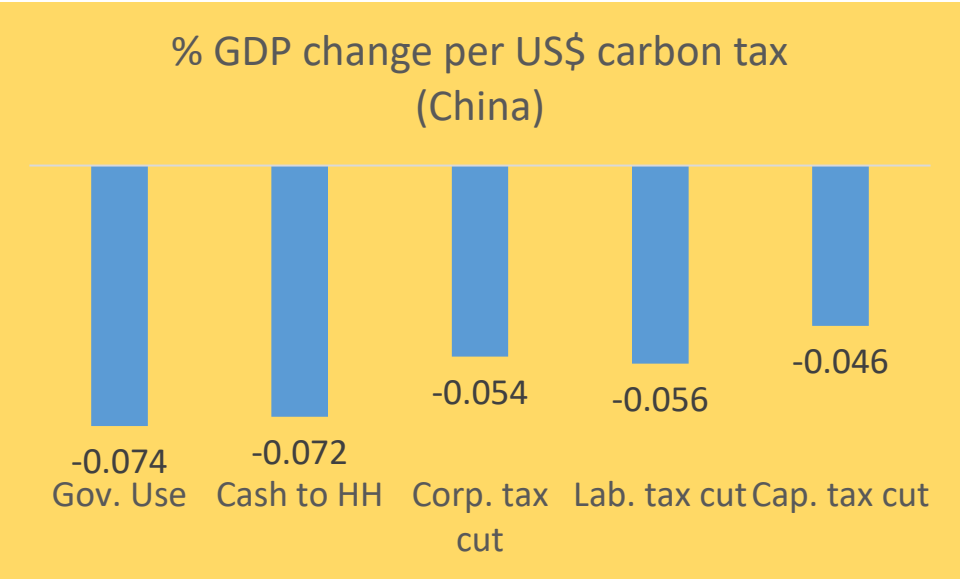
How do revenue recycling schemes affect economics of a carbon tax?

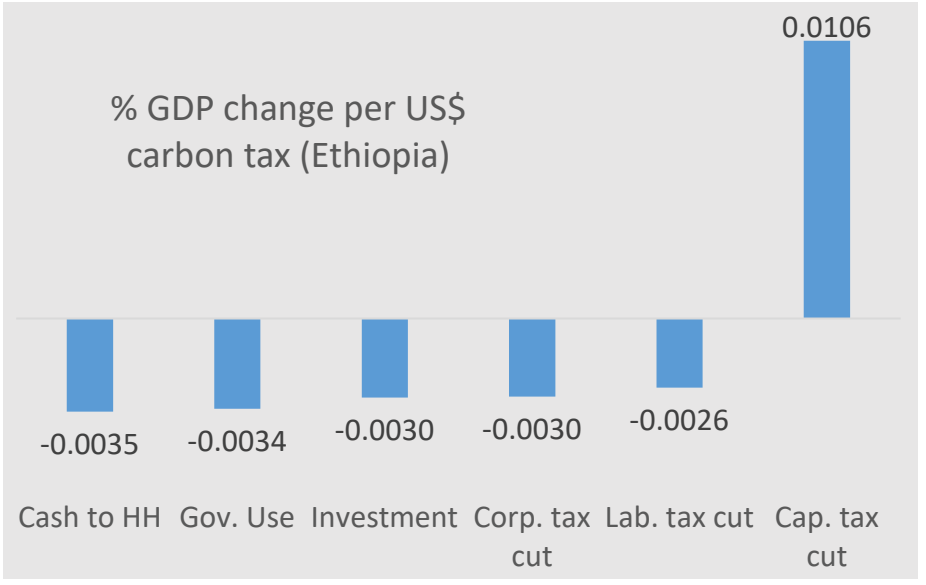


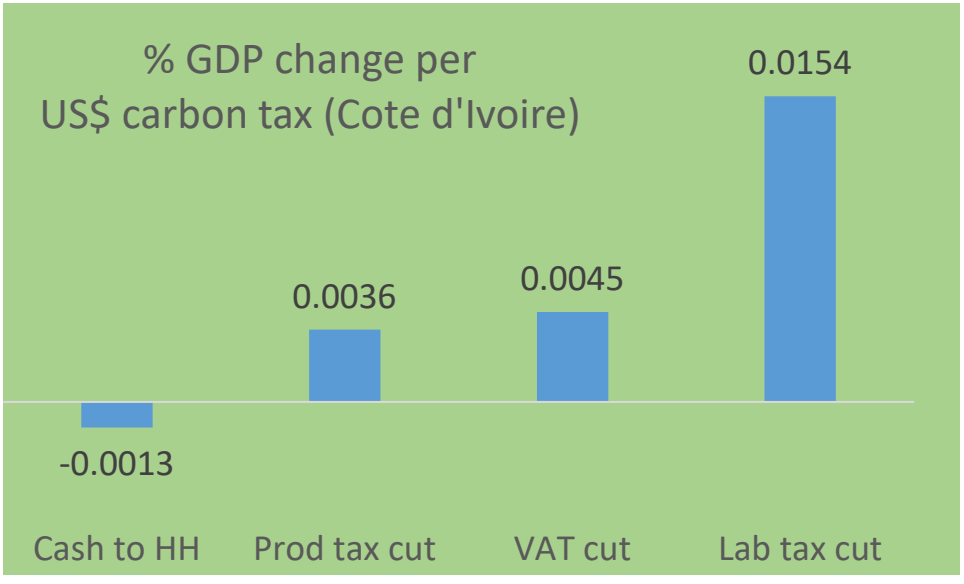
% change in GDP in 2030 from the baseline

A case of meeting China's NDC through standards, and carbon tax with alternative schemes for revenue recycling

How do carbon tax impacts differ across countries under similar schemes for revenue recycling?

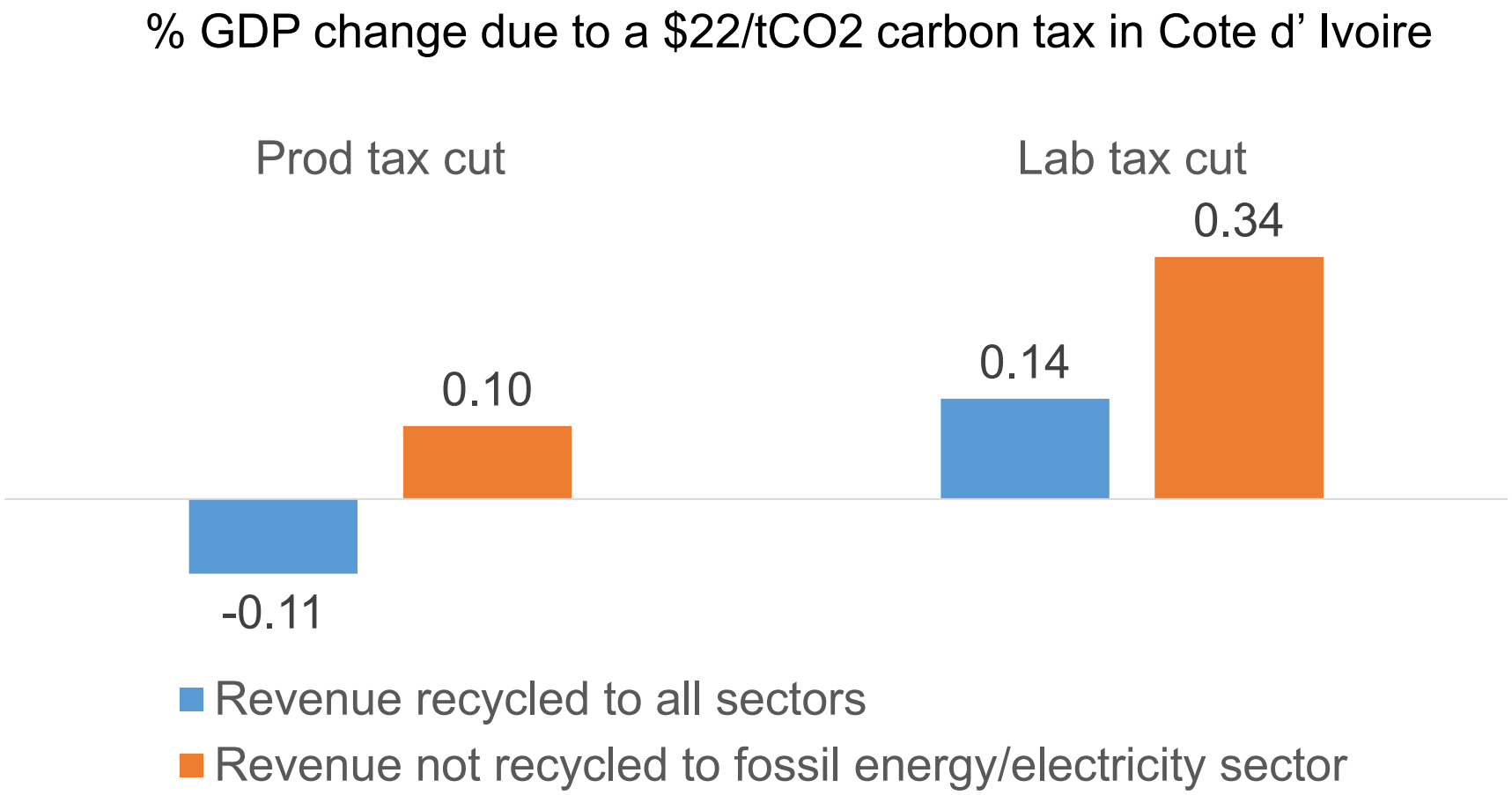






- Two key messages:
- Economic costs are significantly different across countries not only in magnitude but also in direction
- Many factors are responsible – energy supply systems, economic structure, import substitution (imported fossil fuels with domestic hydro in Cote d' Ivoire and Ethiopia)

Should fossil energy sectors be excluded from revenue recycling?



- Excluding energy sector from recycling revenues improves the economics of carbon tax

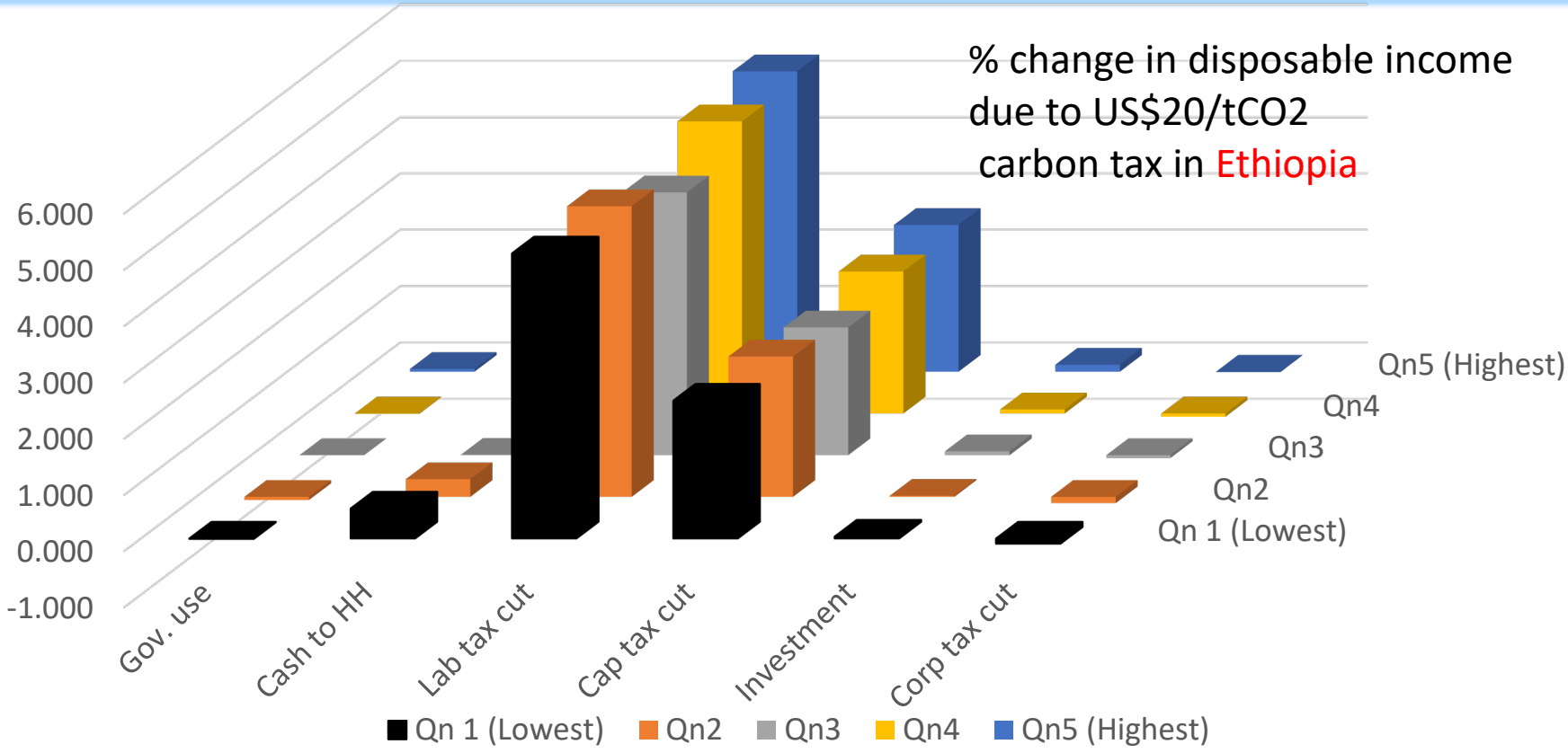
Do the criteria to reallocate carbon tax for a given revenue recycling scheme matter?

% change in GDP in 2030 due to a carbon tax to meet China's NDC when the tax revenue is recycled to cut the corporate income tax using **alternative criteria**

- Since China's economy is relatively more export oriented, a carbon tax favorable to export-oriented industries cause lower economic loss

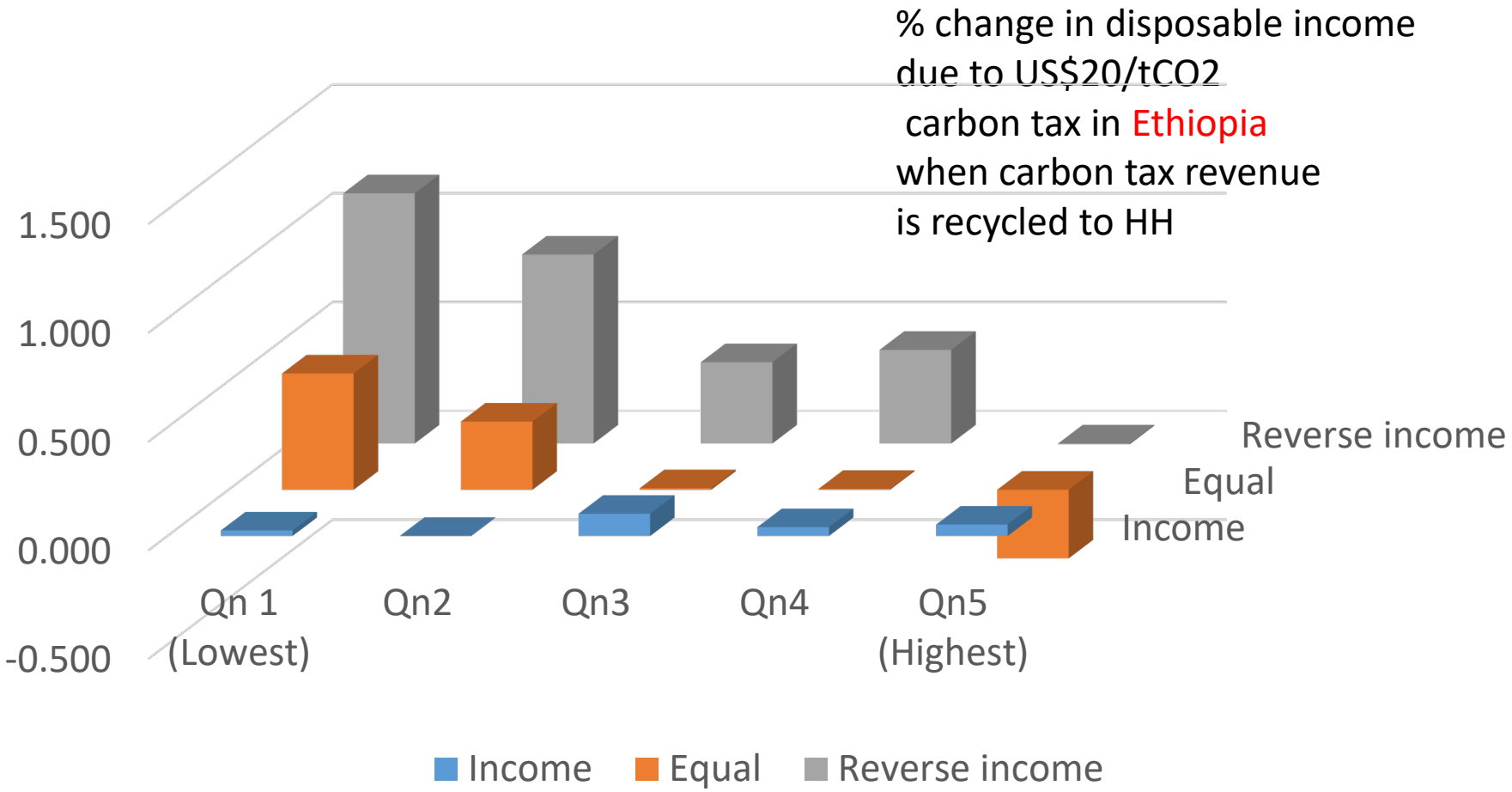
Designing a carbon tax from a distributional (equity) perspective

How does carbon tax affect households by income group?



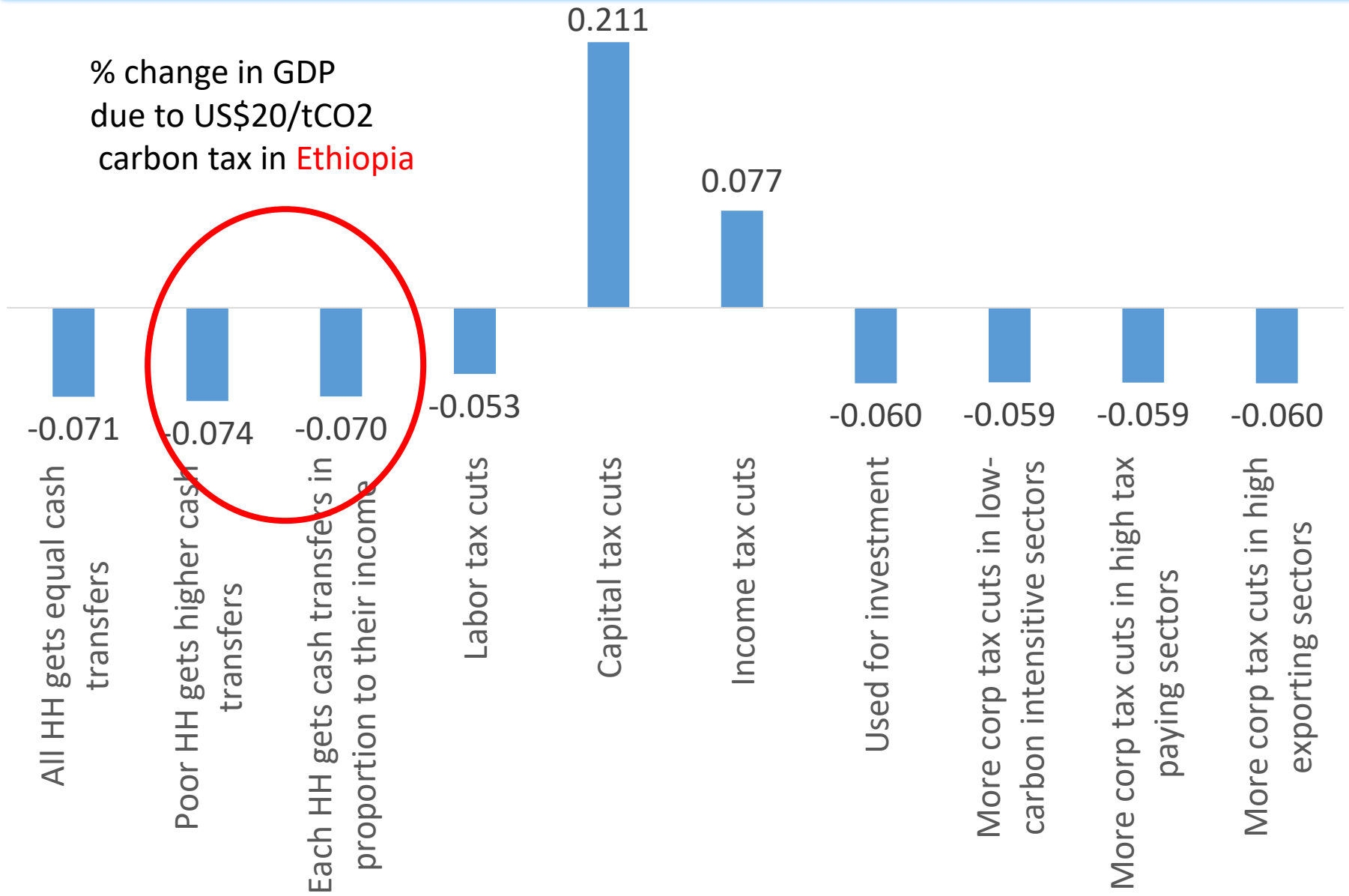
- Using carbon tax revenues to cut labor and capital tax would be more beneficial to all HH than other schemes of revenue recycling
- But scheme is regressive (low-income HH benefit less than high-income HH)

How can a carbon tax be made progressive?



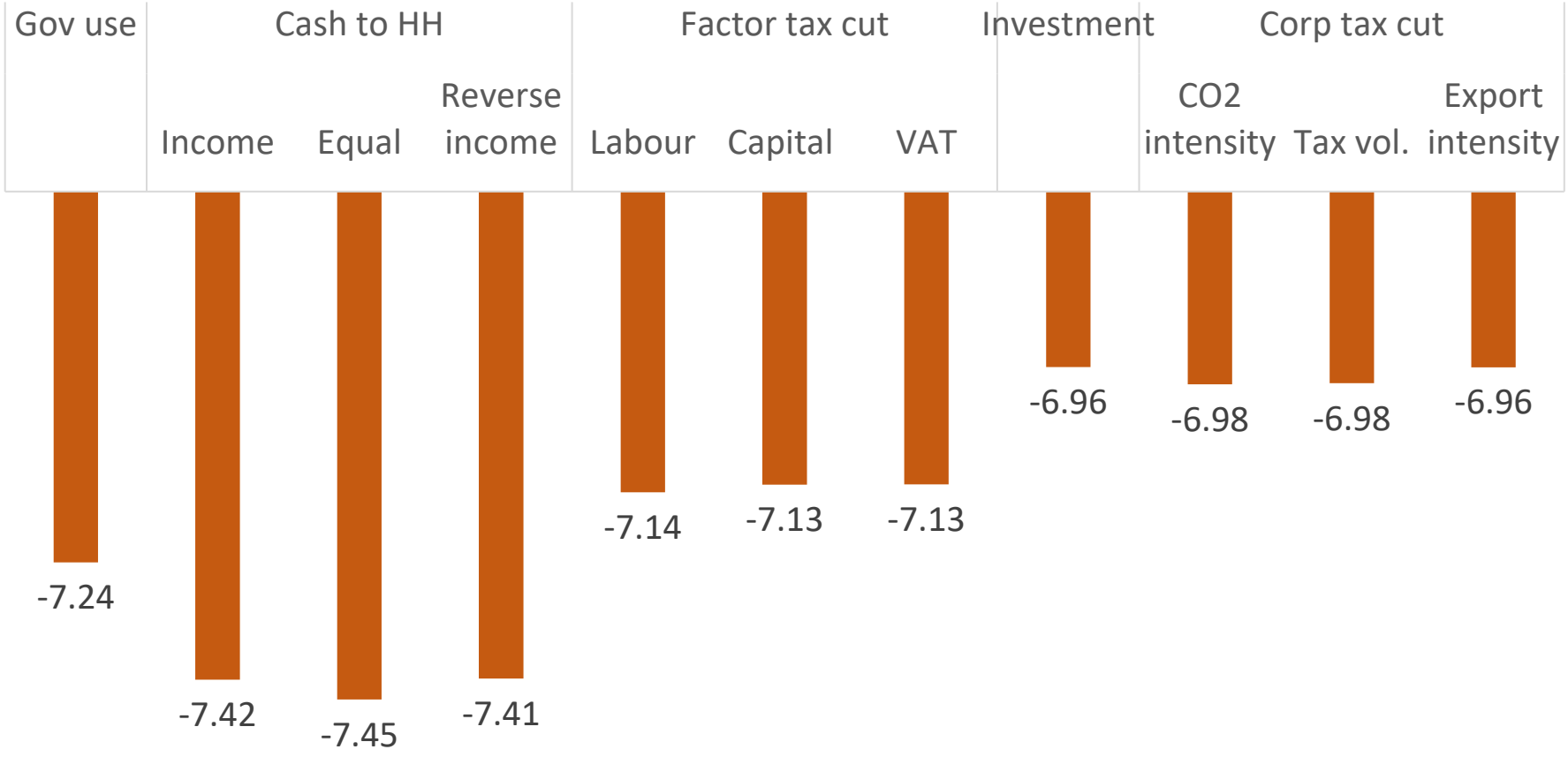
- Proportional recycling (households receives the rebate in proportion to their income in the baseline) benefits more the high-income HH (regressive)
- Equal and reverse order recycling (low-income HH receives higher rebate) are progressive

Is a progressive carbon tax economically efficient?



Designing a carbon tax from a purely CO2 mitigation perspective

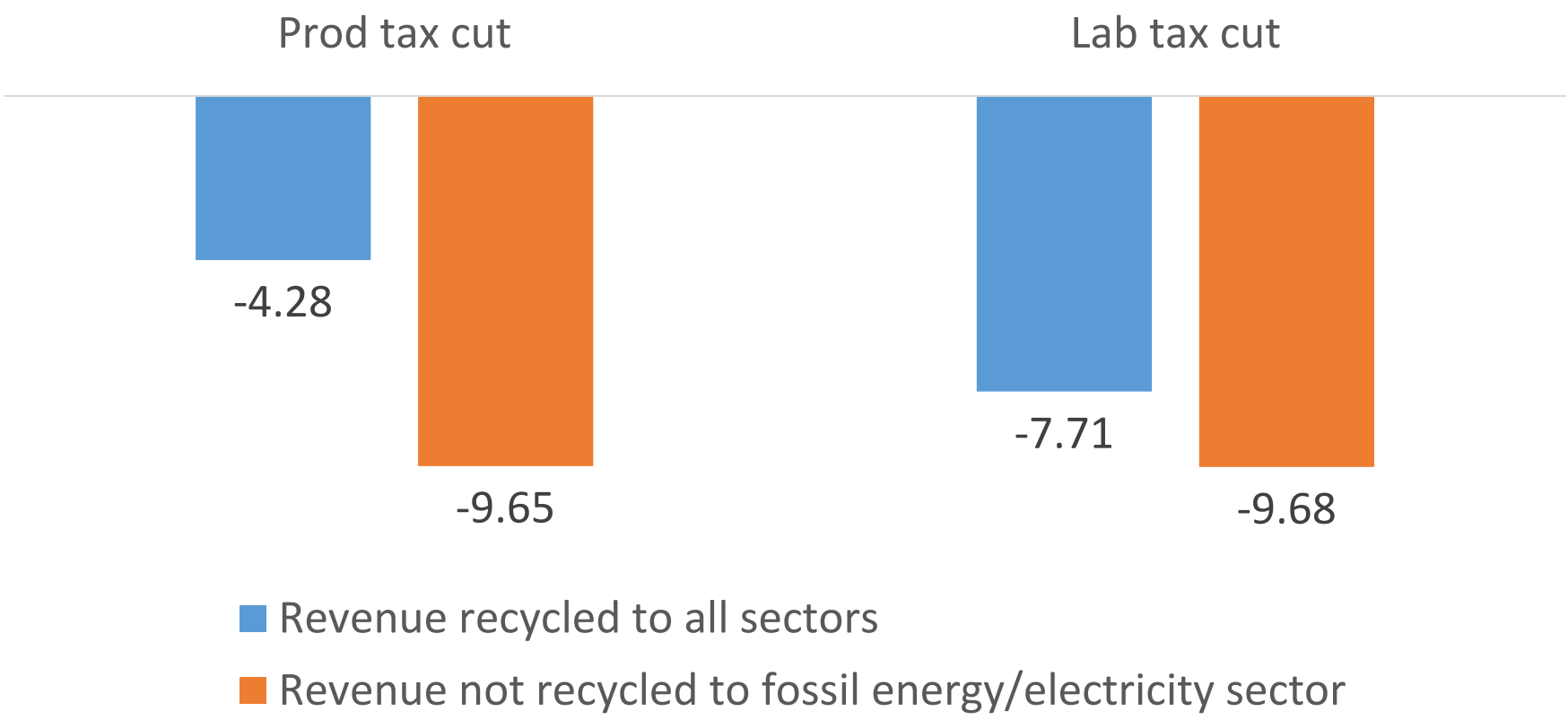
Do emission reductions from a carbon tax change under different revenue recycling schemes?



CO2 reductions due to a US$20/CO2 carbon tax in Ethiopia under the alternative revenue recycling schemes (% change from the base case)

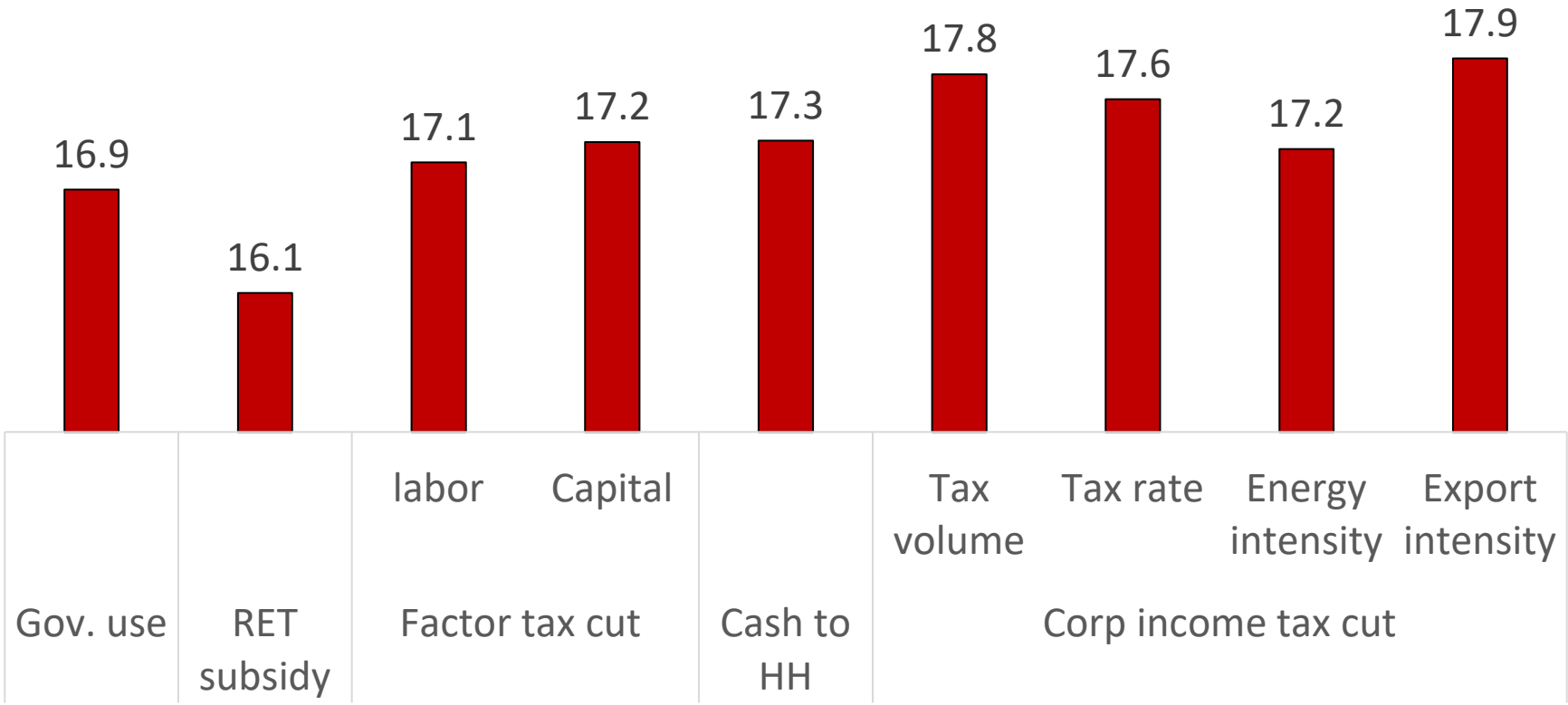
Should fossil energy sectors be excluded from receiving carbon tax revenues -- CO2 mitigation perspective?

% change in CO2 emissions due to a US$22/tCO2 carbon tax in Cote d' Ivoire



- Recycling carbon tax revenue significantly lowers emission reduction due to rebound effects

Does carbon tax rate alter across revenue recycling schemes?



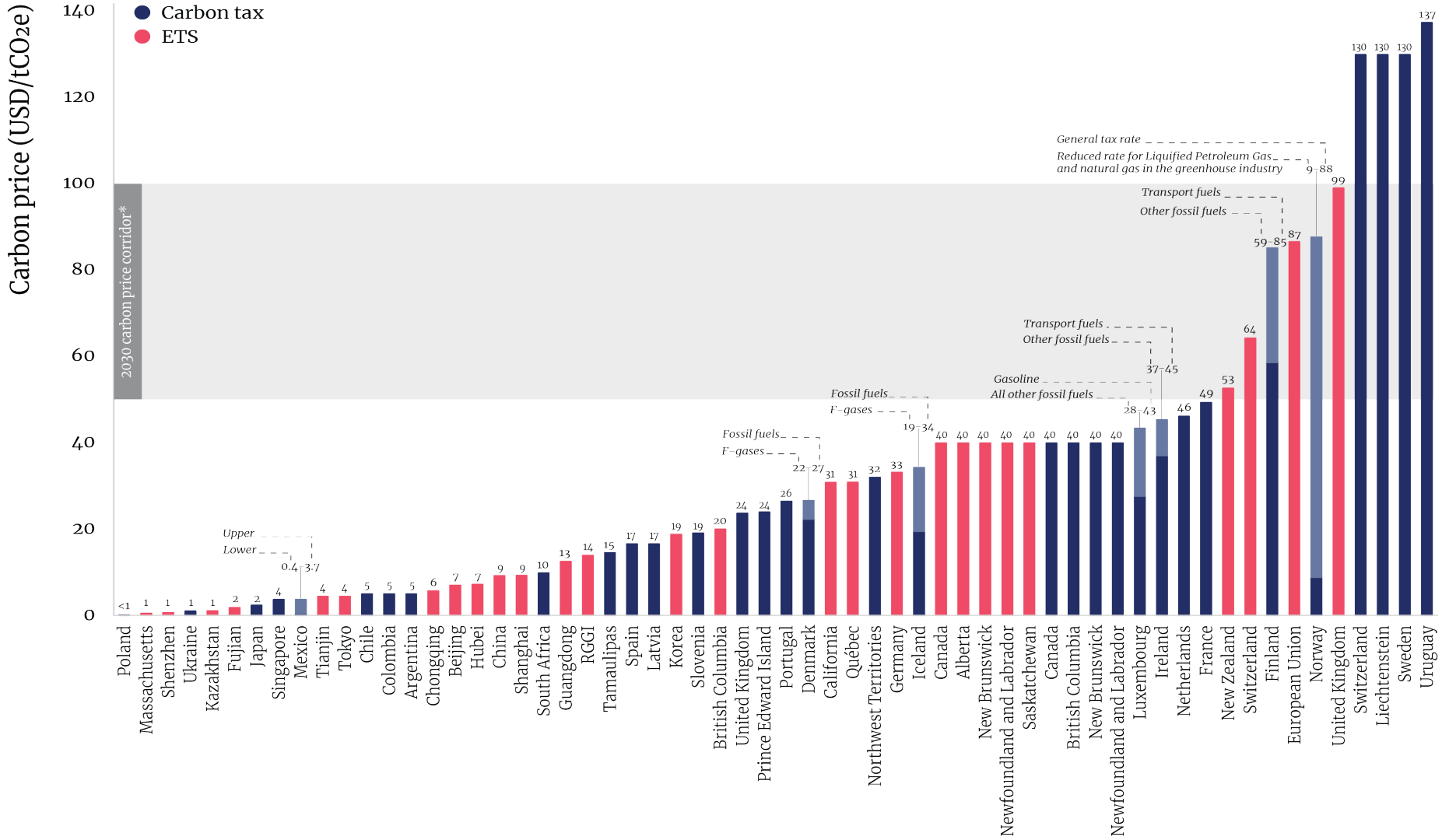
Carbon tax rate (2017 US$/tCO2) in for meeting its NDC target in 2030

(% reduction of emissions from the baseline is ~10.5%)

What should be the rate of a carbon tax?

- Economic theory: optimal carbon tax rate = marginal cost of abatement = marginal damage (social cost of carbon)
- For 1.5°C target, Dietz et al. (2018): $85/tCO2 (2020), $145/tCO2 (2030) and US$4,550/tCO2 (2100) in 2005 price
- Nordhaus (2017) using SCC approach: $31/tCO2 (2015) and $103/tCO2 (2050) in 2010 price.
- The Report of the High-Level Commission on Carbon Prices (Stiglitz et al. 2017) indicates $50-100/tCO2e carbon tax by 2030 to achieve the 2°C target.
- For NDC of large emitters, $35/tCO2 (2017 price) would be sufficient (IMF, 2019)

What are carbon tax rates in practice?



Should the real rate of carbon tax be flat or increasing?

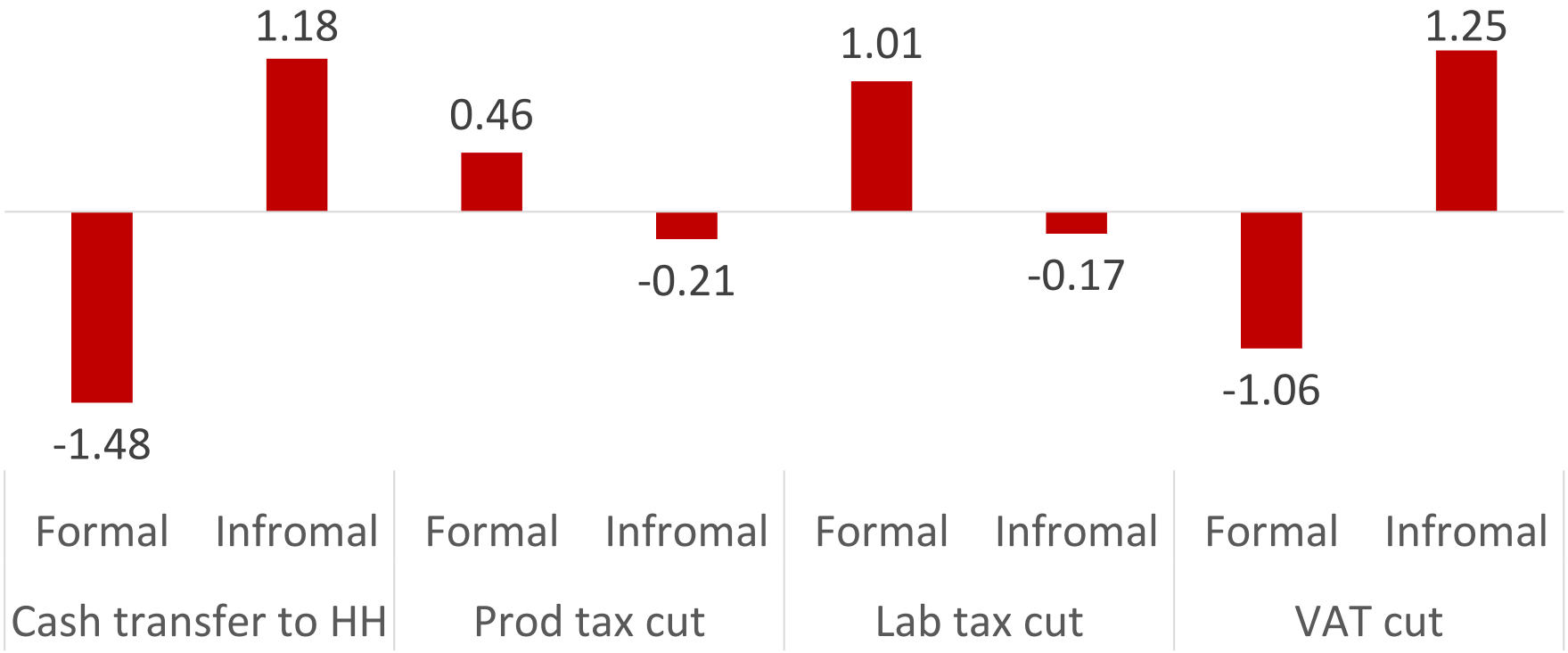
- Based on a study for China, a gradually increasing rate would be efficient (i.e., lower economic costs) than a flat or fixed tax rate to meet the target set for a future year (Timilsina et al. (2018)).
- To meet China's NDC (65% emission intensity reduction from 2005 level), a carbon tax introduced at ¥9.8/tCO2 in 2015 and gradually increased to ¥157/tCO2 in 2030 causes 0.4% GDP loss; for meeting the same target, a flat tax of ¥82/tCO2 (2015-2030) causes a 0.5% GDP loss.
- Based on a study for US, a fixed rate of $43-45/tCO2 (introduced in 2019) would be enough to reduce US emissions 28% in 2025 below its 2005 level (Chen and Hafstead (2019).
- In the case of fixed rate, duration matters. If the duration decreases by 2 years (i.e., carbon tax starts in 2021 instead of 2019) in Chen and Hafstead case, the tax rate increases by 9%, and if the duration decreases by 4 years the required tax rate increases by 23%.

How large other environmental benefits of a carbon tax could be?

- Li et al. (2018) show that a US$72/tCO2 carbon tax that reduces 24% of CO2 emissions in China by 2030, also reduces SO2 by 25% and NOx by 19% and PM2.5 by 12%.
- The reduction of PM would avoid 94,000 premature deaths, the corresponding health benefits are 3.7 times larger than the cost of the carbon tax.
- Woollacott et al. (2018) show that a US$25/tCO2 carbon tax introduced in the U.S. in 2020 and increased 5% annually until 2040 would produce US$71-162 billion health benefits by reducing PM 2.5 and avoiding 8,559 to 19,329 deaths. If the carbon tax is doubled (US$50/tCO2), the corresponding health benefits will increase by 35%.
- Parry et al. (2015) show that countries that can receive highest health benefits from a carbon tax are Saudi Arabia, Iran, Russia, China, and Poland.
- Shakya et al. (2012) find that a carbon tax in Nepal (gradually increases from $13/tCO2 in 2015 to $200/tCO2 by 2050) that reduces 12% of cumulative CO2 emissions, would reduce SO2 by 12%, NO2 by 7% in 2050 from the baseline.
- Pradhan et al. (2020) estimate, a carbon tax that reduces 58% CO2 emissions in Nepal in 2030, would reduce 50% SO_2 emissions and 15% NO_x emissions in the same year.

Does a carbon tax reduce economic informality?

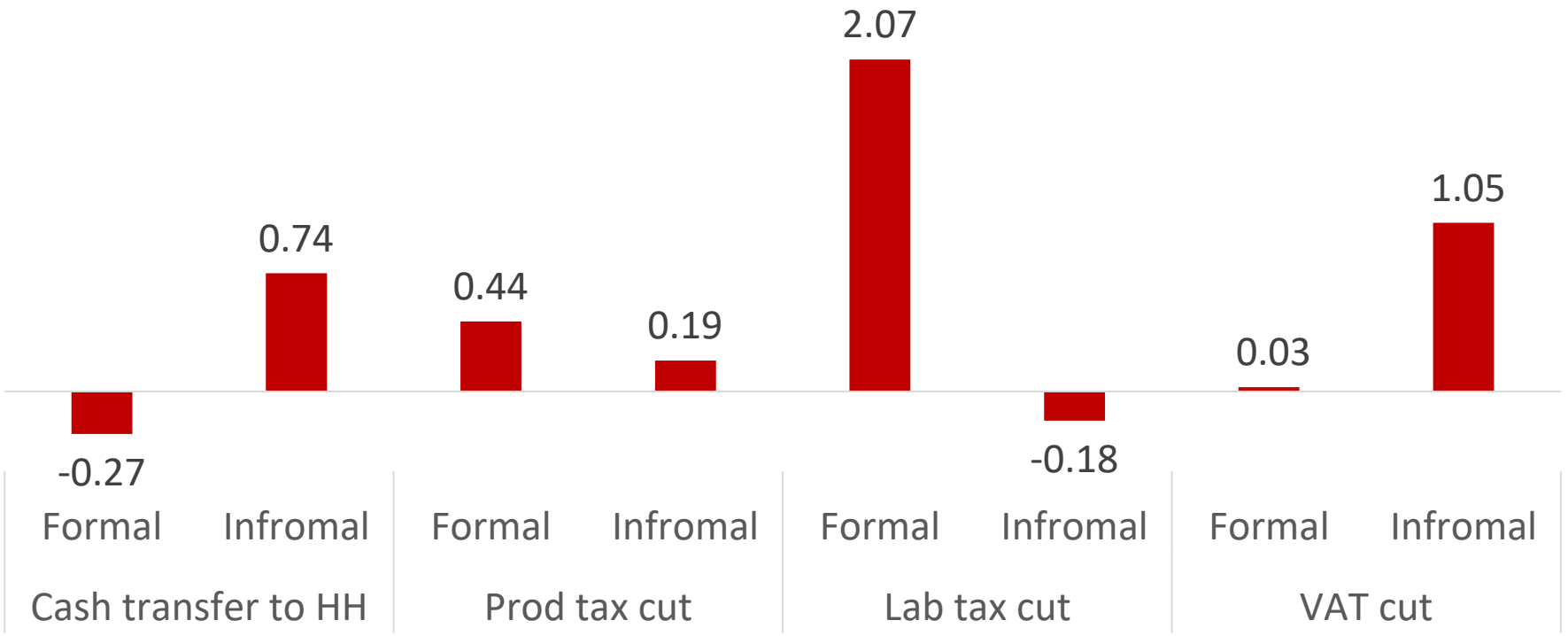
(% change in sectoral outputs from the baseline due to a US$22/tCO2 carbon tax in Cote d' Ivoire



- A carbon tax can reduce economic informality if the carbon tax revenue is targeted to the formal sector only
- Cash transfer to households and reduction of VAT may not help reduce economic informality because households and consumption goods can not be differentiated as formal and informal

Does a carbon tax incentivize labor to move from informal to formal sector?

% labor supply change from the baseline due to a US$22/tCO2 carbon tax in Cote d' Ivoire



- A carbon tax can provide incentives to labor force to move from informal production activities to formal production activities when carbon tax revenue is recycled to cut labor tax in the formal sector

Conclusion: Can a Carbon Tax be Appropriate for Developing Countries?

❖ **It can be, if:**

- The carbon tax is designed in a way it benefits the country even without accounting for co-benefits (Cote d' Ivoire)
- The economic loss of carbon tax is smaller than that in other policies to achieve the same mitigation target (China)
- The health/environmental benefits of a carbon tax offset its costs (e.g., China) or the reduction of local air pollution is as high as the reduction of CO2 emissions (e.g., Nepal and many other countries)
- Helps reduce economic informality and leakage of existing taxes, such as VAT (Cote d' Ivoire)
- Preferred from distributional perspective (socially and politically favorable)

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