FAQ

RESULTS

What is the interpretation of results?

We simulate a carbon price, which increases the cost of emitting carbon emissions, thus making products more expensive. We assume that these additional costs are passed on 1:1 to the consumer. Absolute additional costs express how much additional budget a household (or a group of households) would need to maintain their previous consumption level. Relative additional costs express these absolute additional costs in comparison to the total available household budget, e.g. household expenditures increase by 2% of total budget. This allows comparison across households with different levels of affluence.

Our results should not be interpreted as a loss in income or consumption. Our results do not include demand responses by households, i.e. adjustments of consumption behavior to changing prices. Instead, our results express first-order effects.

Our results likely overestimate actual costs because industries may partially absorb increasing costs of carbon emissions through the adoption of cleaner technologies.

Which interpretation of results is not warranted?

Our results do not include changes in wages, wealth or investment requirements, which may follow from carbon pricing. Our results do not include co-benefits (e.g. outdoor air quality, if individual road transportation decreases) or co-costs (e.g. indoor air quality, if households shift to cooking with biomass) of carbon pricing.

How robust are the results?

Our results combine two distinct data sources: Multi-regional input-output data and household budget survey data.

Multi-regional input-output data is often aggregated at the sectoral level. With the help of this data it is possible to express between-sector differences in carbon intensity of production or consumption for 160 countries and 65 sectors. Conditional on data quality we are confident to claim that our simulation of carbon intensities at the country- and sector-level captures national and international between-sector trade relationships and thus differences between sectors within countries.

Household budget survey data provides information on household-level expenditures on different consumption items and household characteristics. Conditional on data quality we are confident to claim that the distribution of calculated households' expenditure shares reflect households' preferences for more and less carbon-intensive goods and services.

Combining multi-regional input-output data and household budget survey data allows for investigating households' expenditure shares, weighted by sectoral carbon intensities. Our results provide a good approximation of the within-country distribution of additional costs, subject to aforementioned quality of underlying datasets.

Our results provide a rough approximation of (absolute or relative) *levels* of additional costs. It is subject to some assumptions and should be interpreted with more caution compared to the *distribution* of costs.

Do results capture dynamic effects?

No. Our results assume a full pass-through of increasing costs for carbon emissions from producers to consumers, i.e. no dynamic effects on the supply-side. Moreover, they display the first-order costs to consumers in absence of adjusted consumer behavior, i.e. without dynamic effects on the demand-side.

Are displayed impacts comparable to real-world impacts?

Real-world distributional impacts of carbon pricings reforms may differ from impacts displayed in CPIC. Our results are first-order approximations of additional costs, leveraging sectoral differences in carbon intensities of production and household-level differences in sectoral expenditure shares. Including dynamic effects, such as behavioral adjustments, substitution effects and technological improvements will *lower* additional costs. Moreover, our data reflects carbon intensities from 2017 and household expenditure shares from surveys conducted between 2010 and 2019. Future carbon prices may have differing impacts, conditional on fuel prices, available mitigation technology and supplementary policies that are not included in our results.

Some countries have already implemented a carbon price. How to interpret your results under such circumstances?

Our results can be interpreted as the impacts of a policy instrument increasing consumption costs in equivalence to embedded carbon emissions. Such results do not include recent climate policies or policies that have been implemented after the household budget surveys have been conducted.

Some countries have implemented sector-specific carbon pricing policies, such as the European Emissions Trading Scheme covering emissions from many industries including electricity. In such countries, results for a "national carbon price" would nevertheless indicate additional costs of a policy intervention increasing the costs for nationally released CO_2-emissions across all sectors, i.e. irrespective of existing climate policies.

Results reflect sectoral carbon intensities for the year 2017 and sectoral expenditure shares for respective survey years of household budget surveys. Changes in climate policies since then and their effects on industries and households are not explicitly addressed in CPIC. Moreover, CPIC does not account for recent changes in fossil fuel prices.

What does `additional costs` mean?

'Additional costs' refers to simulated first-order costs that households would have to pay when a) a carbon price is introduced and when b) purchasing the same amount of goods and services than prior to the carbon price introduction. Absolute additional costs express such costs in US$. Relative additional costs express such costs in comparison to total household expenditures. Relative additional costs are expressed in %, e.g. household expenditures increase by 2% of total household budget.

Comparing relative additional costs helps address the concern that the impact of the same absolute additional costs may be felt differently among different households. For instance, poorer households will find it more difficult to cope with additional costs of US$ 100 per year compared to richer households.

I am interested in absolute additional costs in a different currency. How can I change the currency from US$ to a different currency?

Expenditure survey data is usually collected in local currencies. We use exchange rates for 2017 from IMF to convert local currencies to USD to facilitate combining household expenditure data and multi-regional input-output data, which is expressed in USD.

In this version of CPIC, it is not possible to display results in a different currency. Note, however, that relative additional costs are equal for local currencies and USD.

Currently, it is also not possible to express the carbon price per tCO_2 in a different currency than USD.

I am interested in relative additional costs compared to household income. Why do you use household expenditures instead of income?

We collect information on household expenditure shares from surveys that have a focus on tracking household expenditure behavior. Information about household income is often lacking in such surveys, and also prone to inaccuracies. For example, income may fluctuate seasonally or households may not report

income from informal activities. Therefore, researchers often use total household expenditures, which is considered a more accurate proxy for lifetime income.

Using total household expenditures instead of household income affects the interpretation of results for richer households, because such households may save a fraction of income instead of spending it for consumption, i.e. relative additional costs (compared to households' income) may be overestimated for richer households.

Note that CPIC does not include impacts of carbon pricing on households' income, e.g. from labor or capital.

Can results differ from analyses published in peer-reviewed publications?

Yes. While our method is acknowledged and widely used, other researchers may have access to different datasets. Such datasets may differ with respect to data quality, resolution or time. Analyses sketched in CPIC may therefore differ from previously published analyses.

Can results differ from analyses distributed through other models?

Yes. Similar tools exist to calculate the effects of carbon pricing reforms on households, but such tools differ with respect to underlying data and simulation methods. Each method rests on different assumptions, which can influence the (interpretation of) results. Users should acknowledge that CPIC includes some important assumptions as described in the section 'Methodology'.

Is CPIC suitable to compare two countries with each other?

Comparing the distributional impact of carbon pricing across countries is not the primary purpose of CPIC. One reason is that energy systems, industries and households' consumption behavior differ between countries, which could lead to misleading interpretations of cross-country comparisons. Furthermore, household expenditure data comes from national surveys with differing survey designs. Not all countries include information about all household characteristics, impeding cross-country comparisons.

METHODOLOGY

What are advantages and disadvantages of using multi-regional input-output data for policy simulation?

Multi-regional input-output (MRIO) data have advantages because it provides an opportunity to reflect input-output-relationships and thus indirect CO_2-emissions embodied in final output. Such data ensures consistency across countries, i.e. all country- and sector-specific carbon intensities come from the same dataset and modelling approach. In particular, the GTAP-database covers a range of lower-income countries. Disadvantages include that MRIO-data are not able to capture within-sector heterogeneity. In addition, our data reflect industrial input-output-relationships in 2017.

What do sectoral carbon-intensities express?

Sectoral carbon intensities express the amount of carbon emissions that can be attributed to the production of output from one particular sector in one particular country. We compute average sectoral carbon-intensities, thereby ignoring within-sector heterogeneity - i.e. some steel products may be less carbon-intensive than others, but this is not captured with our approach. Instead, our approach reflects differences in carbon intensities between sectors.

How does the method address carbon emissions that are embodied in imported goods?

Carbon emissions embodied in imported goods are included in the calculation of costs of a "Global carbon price". It can best be thought of as an additional import levy in equivalence to the carbon intensity of imported goods. The simulation of a "National carbon price" assumes the absence of such instruments, effectively accounting only for CO_2-emissions emitted in national jurisdictions.

Has this method been subject to peer-review?

Combining multi-regional input-output data with household expenditure survey data is common in the peer-reviewed literature. The approach we are using has been formally described in many publications (See *Downloads*). Our tool itself has been subject to internal review, but not to external peer-review. A detailed description of the database feeding into CPIC is in preparation and can be requested through cpic@mcc-berlin.net.

DATA

Which expenditure items do you extract from the household budget surveys?

We extract all expenditure items from household budget surveys that are included. Usually, such items comprise expenditures for various durable and non-durable goods and services. Importantly, such items may differ from survey to survey. Where necessary, we delete items that indicate aggregate consumption categories to avoid double counting. We remove items indicating taxes (e.g. 'property tax') because such tax payments are not included in each country and because inclusion would introduce errors in calculating expenditure shares. We remove outliers (i.e. the 100th item-level expenditure percentile) and duplicates (i.e. if two or more households spend the same amount on all expenditure items).

Are your results nationally representative?

Data included in this investigation come from household budget surveys with nationally representative samples. Data cleaning may selectively skew the distribution in our sample, but it is unlikely that this leads to overrepresentation of some population groups.

How were survey participants recruited? How large is the sample size?

Survey participants were recruited through respective statistical authorities. Authors of CPIC were not included in conducting such surveys. We document the sample size for each household budget survey dataset used in CPIC (*see Methodology > Downloads*).

Can I trust the underlying survey data?

Household budget surveys are prone to several shortcomings. Households may not correctly recall their expenses. Consumption behavior may be subject to seasonal patterns. Households may not need to pay for consumption, for example through farming activities or as remuneration for labor. Our approach builds on the assumption that such data, nevertheless, reflects heterogeneity in household-level expenditure shares. Data collection may include measurement error. Several data cleaning steps, which are identical across countries, should help to minimize exaggerated expenditures.

What is the source of household budget surveys?

Microdata from household budget surveys can be obtained through respective statistical authorities. We provide an overview of all household budget survey datasets used in CPIC (*see Methodology > Downloads*).

Can I trust the underlying multi-regional input-output data?

Multi-regional input-output data as provided through GTAP (Global Trade Analysis Project) consists of sectoral and nationally aggregated data, thereby neglecting within-sector heterogeneity. While more detailed information about the GTAP data quality can be found at the GTAP website, it is reasonable to assume that GTAP conducts several quality checks to ensure consistency across the dataset. Transformation of trade-data from GTAP to input-output tables follows the procedure introduced in this study.

What is the source of multi-regional input-output data?

Multi-regional input-output data and accounts of CO_2-emissions come from the Global Trade Analysis Project (GTAP). More information can be found at the GTAP website.

Why does CPIC not include all countries worldwide?

We have screened the availability of detailed and nationally representative expenditure survey data for most countries worldwide. For countries missing in our dataset, we were unable to find or obtain such data. Detailed expenditure data is, however, a necessary requirement for inclusion in CPIC. If you are aware of household expenditure survey data for countries not included in this dataset, please send an e-mail to cpic@mcc-berlin.net.

Is it possible to access the entire dataset?

No. Unfortunately, we are not allowed to distribute the entire dataset because of confidentiality restrictions by the issuing organizations. We provide extensive information on data sources and link to issuing organizations, where raw data can be obtained. We are also happy to share code for simulation exercises and compiling the final dataset.

HOUSEHOLD CHARACTERISTICS

Does the order of selected household characteristics matter?

The order of selected household characteristics matters for the visualization of results, but not for the computation of household groups. For example, selecting "Five income groups" first and "Gender of household head" second will result in two panels (for "Gender of household head") and five groups (e.g. bars for "Five income groups"). This sequence features the comparison across income groups. Instead, selecting "Gender of household head" first and "Five income groups" second will result in five panels (for "Five income groups") and two groups (e.g. bars for "Gender of household head"). This sequence features the comparison across genders. Importantly, this approach would not lead to calculation of five equally sized income groups for households, conditional on gender of household head. Information about households' income groups always reflects the income group across the entire sample.

Is it possible to choose two household characteristics excluding income groups?

Yes, that is possible. Note that the order of selected household characteristics matters for the arrangement of graphs (see question above). To change the order first unselect all characteristics and then reselect.

Why is it not possible to select more than two household characteristics?

Selecting more than two household characteristics would result in many figures, which would complicate visual representation and interpretation. Please get in touch through cpic@mcc-berlin.net in case you would be interested in analyses combining more than two household characteristics.

What is the difference between urban and rural area?

We follow the definition for "urban" and "rural" proposed by statistical authority collecting household expenditure survey data. Such definitions may differ between countries, but are consistent within countries. Suburban areas are commonly classified as urban areas. Please feel encouraged to replicate our analyses with more detailed, spatially explicit data.

Why are some household characteristics available in some countries but not in others?

The availability of household characteristics depends on underlying household budget survey data. If such data does not include a characteristic, we are unable to include it in CPIC. We refrain from imputing such information because we find this methodologically challenging.

What is a "household head"?

A "household head" is the reference person for each household. This person usually contributes the largest share of household income or is responsible for many economic decisions including consumption. Statistical authorities, which have conducted household budget surveys, often follow consistent guidelines to identify such reference persons. We use sociodemographic information about the household head to

investigate differences between households with differing characteristics for household heads, but acknowledge that comparing information from household heads may be an imperfect proxy for comparing households.

What is the source for the description of household characteristics?

We use the household characteristics found in respective household budget surveys. We homogenize such information for major cooking, lighting and heating fuels or household heads' education to facilitate interpretation. For information about provinces and socio-demographic characteristics (gender, religion, ethnicity, language, nationality) we use descriptions as provided, refraining from claiming that such information accurately reflects how groups describe themselves. For more detailed information, please visit supplementary information about respective household budget surveys.

CARBON PRICING

What is the default assumption for a carbon price when starting to work with CPIC?

The default option is a carbon price of USD 40/tCO_2 on all nationally released CO_2-emissions from all sectors. We choose USD 40/tCO_2 because this is usually considered to be at the lower bound of carbon prices consistent with the Paris Agreement.

What is the difference between a global and a national carbon price?

A national carbon price represents a carbon price on all nationally released CO_2-emissions from all sectors. A global carbon price represents a carbon price on all CO_2-emissions from all sectors and all countries. Our simulation of a global carbon price thus considers international trade-flows and that some CO_2-emissions contribute to the production of exported goods and services. Additional costs of a global carbon price can be interpreted as a national carbon price in combination with border carbon adjustment.

Why does CPIC not include an option for international carbon prices in the electricity or transport sector?

CPIC predominantly serves the purpose of evaluating the impact of national policies. Such national policies could entail border carbon adjustment (which would be comparable to the 'Global carbon price'), but not necessarily the regulation of foreign electricity or transport sectors. Therefore, we choose to not include sectorally differentiated international carbon prices to improve clarity.

What is your understanding of "carbon pricing" in CPIC?

In CPIC, we understand carbon pricing as a policy intervention that increases the cost of emitting CO_2-emissions for emitting industries and households, leading to increased costs for goods and services in equivalence to attributable CO_2-emissions. Households that spend more on CO_2-intensive goods and services can expect larger absolute additional costs from carbon pricing. Households that spend a larger share of their expenditures on CO_2-intensive goods and services can expect larger relative additional costs from carbon pricing. We explicitly account for indirect CO_2-emissions of goods and services, which is equivalent to an upstream carbon price.

Which other climate policies exist?

CPIC serves the purpose of exploring the distributional impacts of carbon pricing, but other policies are conceivable that could lead to reducing CO_2-emissions. One option is reducing subsidies for fossil fuels. In this case, results from CPIC could be helpful, because the impact of a decreasing subsidy can be compared to the impact of an increasing emissions price.

Other policy options include technology standards, technology mandates, subsidies for less CO_2-intensive technologies and behavioral interventions. For such instruments, distributional impacts are determined by the distribution of less carbon-intensive technologies among the population, which is difficult to observe with the data available for CPIC.

Results from CPIC are ignorant towards the specific design of carbon pricing, i.e. through a carbon tax or emissions trading scheme.

Why is it not possible to set carbon prices higher than USD 100 /tCO2?

It is not possible to set carbon prices higher than USD 100/tCO_2 because CPIC should predominantly serve the purpose of informing about distributional impacts in the absence of carbon prices. It is unlikely that carbon prices are introduced at levels higher than USD 100/tCO_2. Note that the distribution of additional costs would not change with higher carbon prices. Higher carbon prices would affect the level of relative and additional costs, but changes would be linear.

Why is not possible to simulate other sectoral carbon pricing policies, for example on gas or agriculture?

We have currently employed version 1.0 of CPIC. In the future, we are happy to include policy options with greater sectoral resolution or regulation of non-CO_2 greenhouse gases, such as CH_4, N_2O or F-gases. Please do not hesitate to get in touch in case of interest to include further policies via cpic@mcc-berlin.net.

COMPENSATION POLICIES

I would like to see further compensation options. Why is CPIC restricted to five fixed compensation options?

We have currently employed version 1.0 of CPIC. In the future, we are happy to simulate further compensation options, tailored to specific country-contexts. Please get in touch via cpic@mcc-berlin.net in case you have suggestions for additional compensation options.

How can other tax and fiscal policies be represented?

Our results for carbon pricing without compensation can be combined with external investigations of distributional impacts of other tax and fiscal policies that are not included in CPIC. Note that we are not allowed to share household-level microdata, which might be necessary for such an exercise.

What is the interpretation of results if revenues are only partially redistributed?

One advantage of carbon pricing is that governments can generate revenues that can be used for redistribution. We nevertheless refrain from imposing that revenues from carbon pricing must be used for redistribution and allow users to simulate compensations by using revenues only partially. In CPIC, total revenues are calculated as the sum of additional costs from carbon pricing to households, but CPIC does not serve the purpose of calculating possible revenues of carbon pricing.

Can revenues also be used for other purposes than compensation?

Yes. All compensation options included in CPIC are stylized options to reimburse households for increasing costs. We include compensation options that are frequently proposed in the academic literature or in the public debate. They may also provide efforts to compensate households with comparably little administrative effort. Nevertheless, this list is not comprehensive and should serve the purpose of exploring different options to compensate households and associated distributional implications.

ACCESS AND CONTRIBUTION

How can I contribute to better results?

We are constantly seeking to improve our analyses and to provide results that are more meaningful to everybody. If you encounter a novel dataset on household budget surveys, if you have suggestions for

alternative compensation options or if you are aware of household budget survey data for countries not yet included in CPIC, please send an email to cpic@mcc-berlin.net. Any other feedback is welcome as well!

Is it possible to access and use data and figures from CPIC?

Yes. It is possible to download all figures generated through CPIC. ZIP-folders also include the data necessary to produce each figure such that it is possible to reproduce our figures according to specific needs.

Unfortunately, we are not allowed to share the comprehensive dataset, because household expenditure data is often subject to confidential access. Nevertheless, microdata may be obtained through individual statistical organizations as listed in our sources. We are happy to distribute code for cleaning such data and for simulating carbon pricing policies.