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Andersson, Fredrik N G

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Fredrik N. G. Andersson

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Fredrik N.G. Andersson
Department of Economics, Lund University, Sweden
P.O. Box 7082
220 07 Lund
Sweden
Tel: +46 46 222 46 44
Email: fredrik_n_g.andersson@nek.lu.se

Abstract
This paper considers the potential inflation effects of a global carbon price on consumer prices, investment prices, export prices. and import prices. We estimate the effects under three different scenarios. The results clearly indicate that the inflation effects in developed countries of a 100 USD/ton carbon price are small. For developing countries, the inflation effect is larger and potentially too large for it to be politically feasible to introduce a global carbon price. However, a simple adjustment of the price based on the price level in each country equalizes the inflation effects across all countries, whereby a global carbon price is more likely to be implemented.

Key-words: carbon price; inflation; consumer prices; export prices; imports prices; investment prices; monetary policy

JEL-codes: E31; E52; Q54; Q58

1. Introduction

Combating global climate change is a key policy challenge. From a theoretical economic point of view, a carbon price is one of the most efficient and important policy tools available to reduce emissions. The price should be applied uniformly across all economic sectors and all countries for it to be as effective as possible (Weitzman, 2014). Either a national or a regional carbon price, rather than a global price, may lead to outsourcing of carbon-intensive production to locations with either no or a low carbon price and thus have little effect on global emissions (Cole, 2004; Andersson, 2018).

Although carbon pricing has become increasingly popular across regions (Lo, 2012; Newell et al., 2013) and countries (see e.g., Fedor, 2016 for a review), there is still no agreement among countries on a global price. Developing countries, in particular, are concerned that they will be disproportionally negatively affected by it, because their economies tend to be relatively less carbon-efficient compared to more developed economies. China, for example, emits up to seven times more carbon dioxide (CO_2) per unit of GDP compared to the European Union (EU) (World Development Indicators, 2017).[1]

Another concern shared also by developed countries is that, in the short term, both consumers' and firms' ability to change their behavior to reduce their carbon footprint is limited, and consequently the carbon price's effect is likely to reduce economic welfare in the short run. Over the long-term, the economic welfare effects of the carbon price are uncertain. Depending on factors, such as the development of new technology and the impact of behavioral changes (Aldy et al., 2012; Pearce, 1991), the long term effects could be both positive or negative.

[1] http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators

Politically, a carbon price that has a large negative short-run effect on economic welfare is difficult to implement politically, also in the case when the carbon price's long-term effects are positive. The introduction and abolishment of the Australian carbon tax is an example where the design and implementation of the tax caused such a high level of resistance that it was eventually abolished (Crowley, 2017).

One way of modeling the possible short run welfare effects is by studying how prices of final consumption will change. A large increase in prices reduces economic welfare. In this study, we explore the aggregate price level effects of a global carbon price on consumer prices, investment prices, import, and export prices as well as to discuss the political feasibility of a global carbon price based on the size of the inflation effects. Included in our study are the United States (US), the EU, other developed countries, and two rapidly growing emerging economies China and India.

Previous studies have focused on effects on prices in individual markets, such as prices for cement or steel (see e.g., Smale et al., 2006). The aggregate effects are also important from a policy perspective. Aggregate price level changes will have economic welfare effects. In addition, many countries have adopted inflation targets whereby the central bank aims to limit the inflation rate. If the carbon price leads to temporarily high inflation, the central banks may wish to ignore this effect to avoid rising interest rates and depressing the economy due to the introduction of the carbon price.

How a global carbon price affects prices depends on the response by consumers and firms. It is likely that both consumers and firms will change their behavior to reduce their carbon footprint. Exactly how agents will change their behavior is uncertain and is likely to depend on the time scale studied. From a modeling approach, one technique to deal with this uncertainty is to use scenarios (Farber et al., 2007). By altering the assumptions as to how agents in the economy respond to the carbon price, we can map the different possible outcomes of the policy and draw policy conclusions from it. Thus, we study the inflation effects under three different scenarios linked to different assumptions as to how agents respond to the carbon price. From our analysis we can draw inference on i) to what degree technological change alone is sufficient to limit the inflation effects of the carbon price, ii) how large changes in consumer behavior are necessary, and iii) how different countries are affected.

The rest of the paper is organized as follows. In section 2, we present our method and data. In section 3, we present the empirical results, and Section 4 concludes the paper.

2. Method to estimating the inflation effect of a global carbon price

2.1 Different model approaches

A global carbon price constitutes a major change in policy. How firms and consumers respond to the policy determine which effect it will have on emissions and economic welfare. It is likely that the price will trigger changes in the economy that reduce the use of fossil fuels, but the exact change in behavior and technology is uncertain. There are, broadly speaking, two approaches to model the effects: one is to use models to predict the behavior of consumers and firms and, from those predictions, estimate the effects on, e.g., consumer prices, investment prices etc. The other approach is to use scenarios with different assumptions as to how consumers and firms will behave to map various potential outcomes based on assumed behavior.

The model approach to predict the behavior is based either on a pure economic model or an integrated energy-economic model that also includes the energy system. Broadly speaking, there are three types of integrated models: bottom-up models, top down-models, and models that combine the two approaches (for a review, see Hourcade and Jaccard, 2006; Böhringer and Rutherford, 2008; Hardt and O'Neill, 2017). Bottom-up models focus primarily on the energy system and potential energy carriers and contain fewer details on the economy. Top-down models, on the other hand, have a greater focus on the economy and on how agents in the economy react to various climate policies and contain fewer details on the energy system. Bottom-up models tend to use too-simplified assumptions in relation to the economy, and top-down models tend to use too-simplified assumptions in relation to technology and the energy-system. The third category of models, hybrid-models, combines the bottom-up and the top-down approaches to make the models more realistic.

The response of consumers and firms is modeled using a general equilibrium model. To yield predictions of the future, the models are parametrized using historical outcomes (i.e., estimates of past behavior). The accuracy of the predictions depends both on how realistic the model is and to what degree past behavior is a useful guide for future behavior.

An often overlooked factor that also affects the accuracy of the models' predictions is "radical uncertainty" about the future (King, 2016). There will be future events that are impossible to forecast in advance and that will have profound effects on the economic outcome. Some of these unforeseeable events will be random, while others will be potentially triggered by a major change in policy. Large policy changes commonly lead to unpredictable changes in behavior, which makes past behavior a poor guide to the future (see, e.g., Lucas, 1976; Lubik and Surico, 2010).[2]

One approach to deal with radical uncertainty is to use scenarios. The purpose of scenarios is not to try and predict the actual outcome of the economy, as such predictions are difficult to make, given the uncertainty over how firms and consumers will behave. The purpose of

[2] Great effort has gone into improving the model to overcome this problem, including improving the model's microeconomic foundations. However, this approach has not solved the instability problem arising from changes in behavior (Oliner et al., 1996; Callabero, 2010; Hurtado, 2014)

scenarios is to explore contrasting outcomes using different sets of assumptions (Peterson et al., 2003). In other words, the aim of the scenarios is not to predict the actual outcome or to paint an exact picture of the future. Instead, scenarios aim to map as many realistic outcomes as possible (Faber et al., 2007, van Vuuren et al., 2011).

Scenarios are, thus, widely used to model possible future economic outcomes under radical uncertainty. In climate economics, scenarios are used to deal with, for example, uncertainty over how the climate will respond to various levels of CO_2 concentrations, how a rise in temperature affects economic activity, and which technologies which will become available in the future (see, e.g., Moss et al., 2010, van Vuuren et al., 2011). It is less common to use scenarios to alter the effect of how consumers and firms will change their behavior (see, e.g., Carpos et al., 2014).

Given the high level of uncertainty regarding households' and firms' responses to a carbon price, we will rely on scenarios to map possible responses of agents to the global carbon price, rather than use a model trying to predict such responses based on past behavior. Consequently, we do not employ a model to predict behavior. Instead, we map possible outcomes by assuming alternative possible changes in behavior due to the carbon price. Our study is, thus, a complement, not a supplement, to studies based on integrated economic–energy models.

2.2 Assumptions and scenarios

We consider three different scenarios. In each scenario, we vary one assumption, which allows us to map the possible responses of the economy to the carbon price.[3] In one of the scenarios

[3] Whether the price is imposed through a price or an emissions' trading system has no effect on our results. What matters is the price level, not how the price is imposed.

we alter the assumption on technology, and in another scenario we alter the implementation of the price. We do not consider a specific scenario including changes in consumption patterns. However, we do discuss how consumption patterns may change and their potential effects on the inflation effects of the carbon price based on our results.

We consider the inflation effect on consumer prices, government prices, investment prices, export prices, and import prices. For consumer prices we also consider the inflation effect on various groups of consumption goods and services. This decomposition allows us to study the potential distributional effects of a carbon price among consumers within a country, as low-income households generally have higher shares of spending on items such as food and clothing and lower shares of spending on services. The distributional effects are important, though often forgotten in the analysis (Denning et al., 2015). Here, we can also study the potential effects of a lower pass-through rate in certain sectors.

The three scenarios are:

Scenario 1: a global carbon price of 100 USD/ton is introduced world-wide. Countries that already have a put a price on carbon, either through a carbon price or a trading system, are assumed to increase the present price level by 100 USD/ton. This assumption implies that countries that are already leading other countries in terms of pricing carbon continue to have a more ambitious climate policy.

Scenario 2: Developing countries are often less productive compared to developed countries. This is one of the reasons why the price level is lower in developing countries than in developed countries (Balassa, 1964; Samuelson, 1964; Ravallion, 2013). Thus, 100 USD has greater purchasing power in China and India compared to either the US or the EU. And a common global carbon price would be a greater economic burden in developing countries compared to developed countries due to the lower price level. Thus, in the second scenario, we adjust the carbon price to the price level. In developed countries, the price is 100 USD.

According to the OECD,[4] in 2008, the Chinese price level was 45% of the US price level, and the Indian price level was 28% of the US price level. Thus, the carbon price is set to 45 USD/ton in China and 28 USD/ton in India.

Scenario 3: One effect of a carbon price is that it increases the incentives to adopt the latest already existing and most carbon-efficient technology. Developing countries, in particular, have a lot to gain by shifting to more carbon-efficient means of production. In scenario 3, we assume that all countries become as carbon-efficient as the US.[5] In other words, we assume that countries shift to already existing technologies. We are not assuming that there is any improvement compared to the levels that already exist today. For some countries, the shift to US levels of carbon-efficiency implies a worsening and not an improvement of the carbon-efficiency of the economy. This is true for some smaller developed countries. However, for simplicity, we use the US as the benchmark in these calculations.

In all scenarios, the estimated price effect depends partly on the pass-through rate, i.e., how much of the increase in cost is pushed on to the consumers in terms of higher prices. De Buyn et al. (2015) found that the pass-through rates onto the consumers after the EU Emissions Trading Scheme was introduced were close to 100 percent in the most carbon-intensive sectors. [6] The pass-through rate was particularly high in carbon-intensive industries such as the utilities and metals industries, which are characterized by relatively large actors and limited competition. Similarly, Fabra and Reguant (2014) found that emission costs were almost fully

[4] https://stats.oecd.org/Index.aspx?DataSetCode=SNA_TABLE4

[5] Some countries are more carbon-efficient than the US but we use the US as a benchmark.

[6] Using a theoretical model, Smale et al. (2006) finds that a carbon price would lead to a close to 100 percent pass-through rate in carbon-intensive industries.

passed on to consumers in the electricity sector in the US, a result confirmed for Australia by Nazifi (2016).

Given the high pass-through rate of emission costs, especially in carbon-intensive industries, we assume, for simplicity, that the rate is 100 percent in our calculations. When we discuss the inflation effects on individual consumption goods we also discuss the effect of a potentially lower pass-through rate in sectors with greater competition.

2.3 Data

To estimate the inflation effect of a carbon price, we must first estimate how much CO_2 each unit of consumption contains. We do so by using input–output tables from the World Input Output Database (WIOD).[7] WIOD is one of the largest input–output databases available that also includes environmental accounts. It includes harmonized data covering 35 industrial sectors from 40 major economies (see Appendix A for a list of sectors and countries). All other countries (mostly developing countries) are combined into one component: "The rest of the world". Final consumption comes from three main groups; households, the government, and investments in fixed capital (i.e., machinery and buildings). It is also possible to estimate exports and imports for a country.

WIOD contains annual data from 1995 to 2009. In our estimations, we primarily use data from 2008 to estimate the inflation effects because 2009 is affected by the international financial crisis. Most countries observed large declines in output and trade in 2009 as a result of the crisis, which may bias our results. Consequently, we use the most recent year that is not affected by the crisis. To explore how changes in technology and consumption patterns over time impacts

[7] See (Boitier, 2012), Timmer et al. (2015) and Andersson (2018) for a detailed description of the database.

our estimates, we also briefly discuss what the inflation effects would have been based on data from 1995 and 2002.

2.4 Estimating the price effects of a global carbon price

We estimate the inflation effect of a carbon price in two steps: First, we calculate the amount of CO_2 that is contained in each unit of consumption, investments, exports and imports using the input–output tables. In the second step, we apply the carbon price to the amount of CO_2 emitted to produce each unit of consumption. We thereby obtain an estimate of how much the cost of consumption increases with the carbon price.

The CO_2 content in each unit of final consumption is obtained as follows (see Boitier, 2012 and Andersson, 2015, for the full details). Let x_m be a vector with total output from country m=1,…,N. The economy is made up of 35 industries, and each element in x_m represents the output from one specific industry. The output is used either for final consumption or as an intermediary good in the production of a final good. The final consumption can be private consumption, investments, or government consumption.

Let $f_{v,m,k}$ represent the final consumption in country m that is produced in country v=1,…,N and consumed by consumer $k=\{consumer, investments, government\}$. Final consumption can either be private consumption, government consumption, or investments. The total output is equal to

$$\begin{pmatrix} x_1 \\ \vdots \\ x_m \\ \vdots \\ x_N \end{pmatrix} = \begin{pmatrix} A_{11} & \cdots & A_{1v} & \cdots & A_{1N} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ A_{M1} & \cdots & A_{mv} & \cdots & A_{mN} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ A_{N1} & \cdots & A_{Nv} & \cdots & A_{NN} \end{pmatrix} \begin{pmatrix} x_1 \\ \vdots \\ x_m \\ \vdots \\ x_N \end{pmatrix} + \sum_{m=1}^{N} \begin{pmatrix} f_{1,m,k} \\ \vdots \\ f_{v,m,k} \\ \vdots \\ f_{N,m,k} \end{pmatrix} \quad (1)$$

where $A_{m,v}$ is the inter-industrial matrix showing how many intermediate goods country v imports from country m to produce one unit of output. This matrix captures the trade links among countries and allows for estimation of how much CO_2 each unit of final consumption contains and the country it was emitted from.

Thus, (1) can be written as

$$x = Ax + \sum_m f_m. \quad (2)$$

The output required to produce one unit of final consumption is given by,

$$x = \sum_m (1 - A)^{-1} f_m = \sum_m y_m. \quad (3)$$

Let e_m be a vector of the CO_2 emissions in tons per unit of output in country m. The amount of emissions in country m to produce one unit of consumption in country v is given by

$$E_{m,v,k} = e_m y_{m,v,k}, \quad (5)$$

where $y_{m,v,k} = \left(1 - A_{m,v}\right)^{-1} f_{m,v,k}$.

Having obtained the emission content in each unit of final consumption, we multiply the emission by the carbon price to obtain the cost of the carbon. We then divide this cost by the value of the final consumption. This gives us an estimate of the inflation effect:

$$PE_{k,v} = \frac{\sum_{m=1}^{41} PC_m \times E_{m,v,k}}{\sum_{m=1}^{41} f_{m,v,k}}, \quad (6)$$

where PC_m is the carbon price in country m, i.e., the country where the emissions originated.

3 Empirical results

The estimated inflation effects for Scenario 1 are shown in Table 1. The inflation effects are modest, despite assuming that there is no change in either behavior or technology. For developed countries, consumer, government and investment inflation is limited to between 1 and 3.5 percent. Central banks, such as the Federal Reserve and the European Central Banks, have inflation targets of 2 percent. Thus, our estimates correspond to one year of normal price increases.

For developing countries, the inflation effect is double in size, or even three times as high compared to developed countries. Consumer prices in both China and India would increase by approximately 8 percent. Investment prices would see double digit increases of between 11 and 13 percent.

Foreign trade in all countries, developed and developing, would be relatively heavily affected by a global carbon price. Foreign trade is still dominated by trade in goods, and not by trade in services, whereby the export and import prices are more affected than are consumer, government, and investment prices: they are between 9 and 16 percent for all economic regions, except for the EU, where export inflation is limited to 3.9 percent. The lower export inflation for the EU is explained by below-average carbon intensities and a relatively high share of service exports.

The conclusion for Scenario 1 is that inflation effects of a global carbon price are small in developed countries, even under highly unrealistic assumptions that are likely to lead to an overestimate of the inflation effect. If the price is phased in over two or three years, any potentially negative welfare effect is likely to be very small, even in the short run. Moreover, the need for consumers and firms to adjust their consumption patterns and technology to limit the inflation effect is limited, which is likely to make a global carbon price politically feasible.

A clear concern, however, is the change in trade patterns that the carbon price may cause, as exports from China and India, in particular, will rise by far more than will those from developed countries. Also, the relatively high domestic inflation rate in developed countries is a likely concern. The purpose of the carbon price is, of course, to penalize countries with carbon-intensive production methods, but the ability to reduce emissions in the short-run is likely to be limited, whereby it is unlikely that these countries will agree to a common carbon price. A simple method to accommodate such concerns in the short-run is to temporarily reduce the carbon price for developing countries in the short-run, which leads us to the second scenario.

[TABLE 1]

In Scenario 2, we weight the carbon price by the price level in each country, such that the carbon price is equal across countries in purchasing power terms. Unsurprisingly, adjusting the global carbon price to these differences in the price level lowers the price and inflation effect paid by China and India (see bottom half of Table 1). In China, the consumer price inflation effect is reduced from 8.2 percent to 3.9 percent, the government consumption inflation effect is reduced from 7.3 percent to 3.4 percent, and the effect on investment prices is reduced from 13.3 percent to 6.3 percent. For India, the corresponding inflation reductions are 7.9 to 2.4 (consumer), 6.3 to 1.9 (government), and 11.4 to 3.7 (investments). Overall, the inflation effects are thus reduced to a level similar to the one observed in developed countries. As part of the differences in price levels is caused by differences in productivity, it is unsurprising that the inflation effects are more or less equalized when the price is adjusted for differences in price levels. Also the effect on export and import prices becomes more similar across countries when the adjustment is applied, showing that no country would immediately either gain or lose in competitiveness. From a political point of view, such an equalization of the inflation burden is likely to make a global carbon price more likely to be agreed upon. Of course, the point of a global carbon price is to put greater pressure on carbon-inefficient economies to reduce their dependence on carbon. Over time, the price paid by Chinese and Indian firms should increase. The price adjustment should only be temporary to limit the short-run costs.

For developed countries, differentiating the carbon price by the price level has only a limited effect, because most of the economic value of what is consumed in developed countries is also produced in these countries. The reduction in inflation for developed countries is low, approximately 0.1 percentage points, except for import prices, where the reduction is between 2.5 and 6 percentage points.

In Scenario 3, we assume that all countries are as carbon-efficient as the US (i.e., have the same CO_2/unit of output). Because developing countries are less carbon-efficient, a simple way to reduce emissions is to adopt already existing technologies. The results are presented in Table 2. The top half of the table presents the results for a uniform global price of 100 USD/ton, and the bottom half of the table shows the results for the price level–adjusted carbon price. What is notable from the results is that the Chinese and Indian consumption patterns are not more carbon intensive compared to developed countries. If China and India adopted the same technologies as the developed countries, the inflation effects would be of a similar magnitude in all countries between 1 and 3 percent, depending on country and consumer group. In this case, there is no need for a price level adjustment. The inflation effects are also so small, even with our unrealistic assumptions, that implementation of a carbon price of more than 100 USD/ton would probably be politically feasible.

[TABLE 2]

To further our analysis, we next consider: i) how the inflation effects have changed over time, by considering what the inflation effects would have been in 1995 and 2002 (the carbon price is adjusted for inflation) given the technology and consumption patterns that existed at that time, and ii) for consumers, which consumer items would be the most affected by a global carbon price by decomposing consumer price inflation into the consumption groups of food, textiles and clothes, other goods, transport, utilities, and services.

Figure 1 shows the results over time for a uniform carbon price, and Figure 2 shows the results for a price level–adjusted carbon price (i.e., Scenario 2). The most notable change over time is for China, which has become much more carbon intensive compared to 1995. A uniform carbon price in 1995 would have increased consumer prices by 40 percent compared to the estimated increase of 8.2 percent in 2008. Similar effects are found for government, investment, and export prices. For developed countries, the inflation effect is also estimated to be smaller compared to 1995, but the reduction is only approximately 1 to 1.5 percentage points. Nevertheless, this is a reduction of the inflation effect by between one quarter and one third over a 13-year period. Economic development is clearly important to reduce the relative (although not the absolute) carbon intensity of the economy. Further economic development over time is likely to lead to further reductions in the inflation effects for both China and India.

The price level–adjusted numbers in Figure 2 clearly reduce the inflation impacts in China and India. The reduction is larger in 1995 compared to 2001, when China and India were less developed compared to 2008. This result illustrates that a price level adjustment of the carbon price will lead to increasingly smaller benefits for the developed country as it develops and improves its technology. The price level adjustment would end completely when the developing countries have fully caught up with the developed world.

[FIGURE 1]

[FIGURE 2]

Finally, we decompose the consumer price effect into different consumer goods. A concern is that a carbon price may hit the poor more than the rich through a greater impact on goods items such as food and clothing. For all countries, the effect on food, clothes, and services are minimal—between 0.3 and 2.3 percent—when a uniform carbon price is applied, see Table 3. For these items, a price level–adjusted carbon price is unnecessary, as the inflation effects are similar across all countries with a uniform price. Food inflation in China and India, for example, is 1.0 percent and 2.1 percent, respectively. In the EU and the US, the corresponding inflation effects would be 0.7 percent and 1.2 percent, respectively. For the poorest in society, which spends a relatively high share on food the inflation effects are limited. The inflation effects are also limited for textiles and clothing (between 1.1 and 2.3 percent).

[TABLE 3]

For other goods, and transport there is greater heterogeneity across countries, but it is not necessarily just developing countries that would observe the greatest inflation effects. The second-highest inflation effect on transport is observed for the US, and India has the lowest estimated inflation effect.

The largest difference by far in price effects among the countries is for utilities, where the inflation effect ranges from 29 percent (EU) to 460 percent (India). For utilities, electricity generation through coal, in particular, leads to high inflation effects not only for China and India but also the US compared to the EU. There are two key characteristics of utilities that need to be considered. First, they take time to build and commonly have a relatively long life span. Second, in many countries, they are either government-owned or at least heavily regulated. In China, utilities are almost entirely owned by the state, and, in India, only 16 percent of the electricity generation is privately owned (Shukla and Tampy, 2011). Both countries also rely heavily on coal for electricity generation. In China, coal prices used in the production of electricity are often subsidized and set below the market value (Zhang, 2014).

The high dependence on state-owned firms in electricity generation in China and India implies that the choice of technology is a government decision rather than a market decision. This has two important implications. Frist, the pass-through rate is likely to be high, as the firms in the sector face no or little competition. Our assumption of a 100 percent pass-through rate is, thus, likely to be accurate at least for this sector. Second, the market is a key mechanism for reducing emission intensities. Without competition, there is more waste and energy use. A carbon price may reduce energy waste from the consumer's side but not the producer's side, as the producer can pass on the entire cost to the consumer. Thus, the carbon price will not automatically lead to new technologies and energy sources being introduced. Moreover, the carbon price, in itself, is thus an insufficient policy to reduce emissions and limit its impact. The carbon price must be accompanied by other policies aimed at the state-owned firms in the electricity (utilities) sector.

So far, we have assumed a 100 percent pass-through rate. Given previous studies, this rate is realistic for utilities where most of the inflation effects take place. For other sectors with greater competition, such as food and textiles, the pass-through rate is potentially smaller. A lower pass-through rate will lead to a lower inflation rate. Given that the inflation effects on prices, except for transport and utilities, are so small, the welfare losses, even with a 100 percent pass-through rate, are so small that the carbon price is unlikely to have any major negative welfare effects. The conclusion is that it is already possible to impose a relatively large carbon price, given existing technologies. The only problem is the utilities sector and, potentially, the transport sector in developing countries such as China and India.

4. Conclusions

This paper estimates the maximum inflation effects of a carbon price. Our results show that the inflation effect is modest in developed countries: between 1 and 3 percent for consumer prices, government prices, and investment prices. Export and import prices will increase by up to 10 percent; however, this effect is similar across countries, whereby no country will gain in competitiveness from the carbon price. For developing countries such as China and India, the inflation effect is higher, mostly stemming from a carbon–inefficient utilities sector. Adjusting the carbon price based on development stage through a purchasing power adjustment will equalize the burden across developed and developing countries and potentially make the global carbon price more acceptable to all countries.

Our estimates are derived under restrictive and unrealistic assumptions. They indicate the maximum inflation effect. The actual effect will be lower. What our results show is that a global carbon price of 100 USD/ton leads to modest inflation effects and may, thus, be implemented with only minor expected difficulties in terms of political resistance and disruption of the economy. A simple price level adjustment of the price will likely also make the carbon price politically acceptable across all countries, including developing countries, which are relatively carbon-inefficient.

Thus, the overall conclusion of our paper is that a global carbon price can be implemented, and the inflation effects are limited. A simple price level adjustment of the price equalizes the short-term economic costs of a global carbon price, which is likely to make a global political agreement on a common carbon price more likely.

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Appendix A. Countries included in the study

Australia
Austria
Belgium
Bulgaria
Brazil
Canada
China
Cyprus
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Indonesia
India
Ireland
Italy
Japan
South Korea
Latvia
Luxembourg
Lithuania
Mexico
Malta
Netherlands
Poland
Portugal
Romania
Russia
Slovakia
Slovenia
Spain
Sweden
Turkey
Taiwan
United Kingdom
United States
Rest of the World

Appendix A. Industrial sectors included in the study

Agriculture, hunting, forestry, and fishing
Mining and quarrying
Food, beverages, and tobacco
Textiles and textile products
Leather and footwear
Wood and products of wood and cork
Pulp, paper, and printing and publishing
Coke, refined petroleum, and nuclear fuel
Chemicals and chemical products
Rubber and plastics
Other non-metallic minerals
Basic metals and fabricated metal
Machinery
Electrical and optical equipment
Transport equipment
Manufacturing
Electricity, gas, and water supply
Construction
Sale, maintenance and repair of motor vehicles and motorcycles, retail of fuels
Wholesale trade and commission trade, except motor vehicles and motorcycles
Retail trade, except motor vehicles and motorcycles, repair of household goods
Hotels and restaurants
Inland transport
Water transport
Air transport
Other supporting auxiliary transport activities, activities of travel agents
Postal and telecommunications
Financial intermediation
Real estate activities
Rent of M&Eq and other business activities
Public administration, defense, compulsory social security
Education
Health and social work
Other community, social, and personal services
Private households with employed persons.

Tables and Figures

Table 1: Estimated inflation (%) effect of a global price on carbon of 100 USD/ton in 2008.

	Consumer	Government	Investment	Export	Import
			100 USD/ton		
European Union	2.3	1.1	2.2	3.9	16.1
United States	3.4	2.5	3.1	9.2	11.6
Other developed countries	2.8	1.7	3.2	10.1	7.2
China	8.2	7.3	13.3	12.0	9.9
India	7.9	6.3	11.4	17.3	14.3
			100 USD/ton PPP adjusted		
European Union	2.2	1.0	2.0	3.9	9.2
United States	3.2	2.4	2.7	9.2	7.7
Other developed countries	2.6	1.6	2.9	10.1	4.9
China	3.9	3.4	6.3	5.4	9.3
India	2.4	1.9	3.7	4.9	9.7

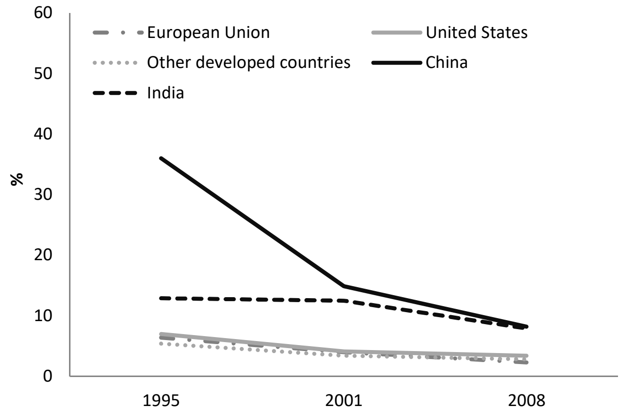
Table 2: Price effects of a global price on carbon of 100 USD/ton in 2008 assuming all countries have the same carbon intensity as the United States.

	Consumer	Government	Investment	Export	Import
			100 USD/ton		
European Union	2.8	0.8	0.8	2.0	1.1
United States	1.8	0.9	0.5	1.0	1.0
Other developed countries	2.1	0.8	0.5	0.7	1.9
China	1.7	0.7	0.5	1.3	0.6
India	1.7	2.0	0.6	1.1	0.9
			100 USD/ton PPP adjusted		
European Union	2.8	0.8	0.8	2.0	0.9
United States	1.8	0.9	0.5	1.0	0.9
Other developed countries	2.1	0.8	0.5	0.7	1.8
China	0.7	0.3	0.3	0.6	0.6
India	0.5	0.6	0.2	0.3	0.9

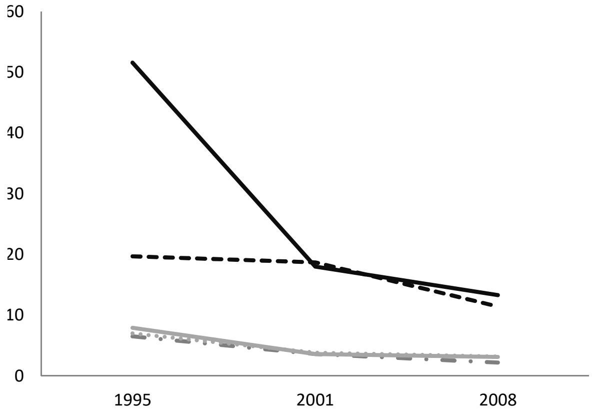
Table 3: Consumer price inflation with a global price on carbon of 100 USD/ton.

	Food	Textiles and clothes	Goods	Transport	Utilities	Services
			100 USD/ton			
European Union	0.7	1.1	3.1	8.2	29.2	0.3
United States	1.2	2.0	5.1	14.0	90.3	0.6
Other developed countries	0.6	1.5	4.8	7.4	43.4	0.6
China	1.0	1.6	15.5	21.1	364	0.9
India	2.1	2.3	11.7	3.5	460	0.5
			100 USD/ton PPP adjusted			
European Union	0.7	0.7	2.8	8.0	26.9	0.3
United States	1.2	1.4	4.7	13.7	86.6	0.6
Other developed countries	0.6	1.0	4.3	7.0	40.0	0.6
China	0.5	0.7	7.7	11.1	168	0.4
India	0.6	0.7	4.0	1.2	135	0.2

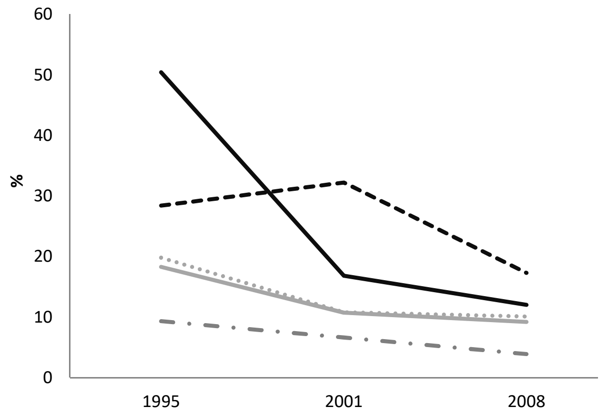
Figure 1: Inflation effects of a global 100 USD/ton carbon price



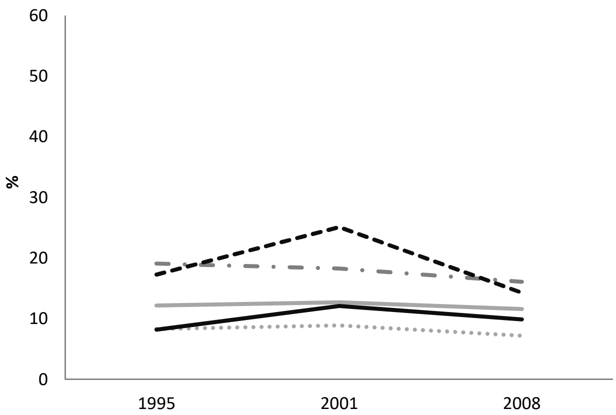
Panel A: consumer inflation



Panel B: investment inflation

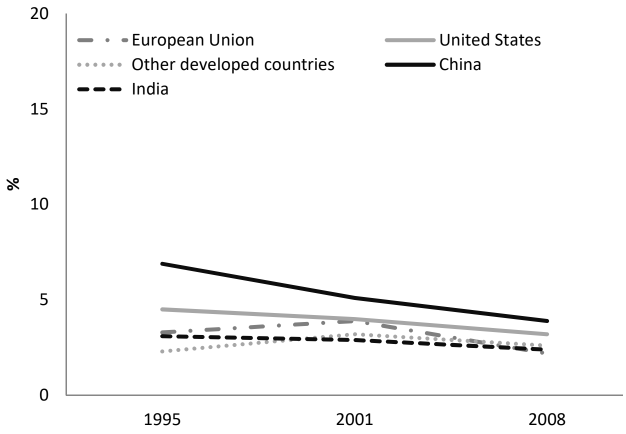


Panel C: export inflation

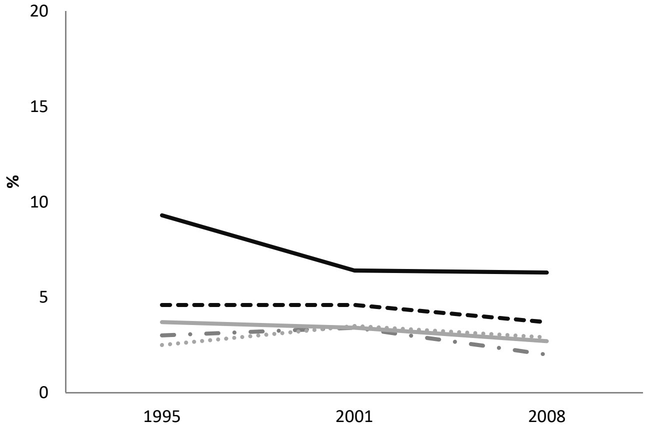


Panel D: import inflation

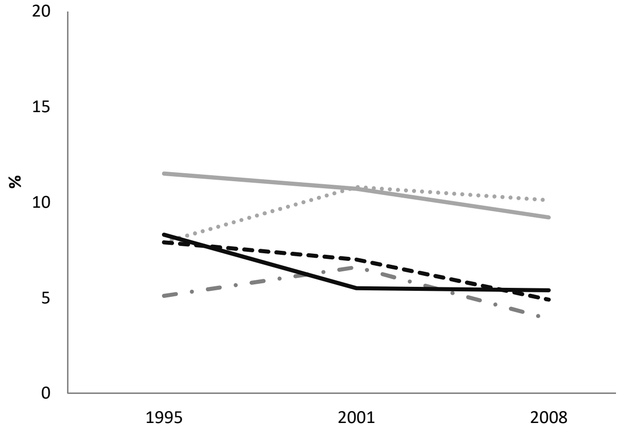
Figure 2. Inflation effects of a purchasing power–adjusted 100 USD/ton carbon price

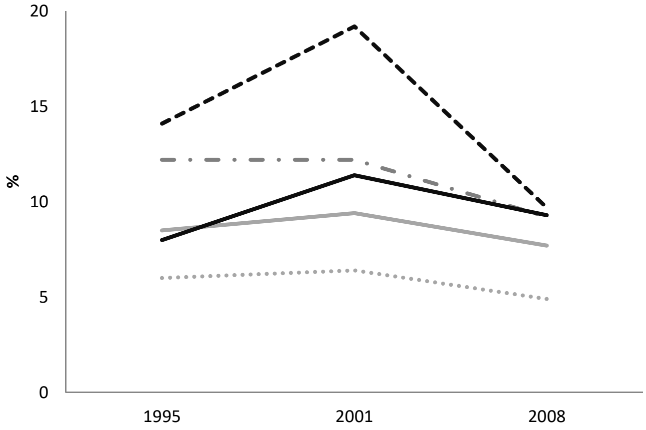


Panel A: consumer inflation



Panel B: investment inflation





Panel C: export inflation

Panel D: import inflation