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Carbon pricing and terms of trade effects for China and India: A general equilibrium analysis

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ABSTRACT

Using country-specific dynamic computable general equilibrium (CGE) models, this paper estimates carbon prices in China and India, and compares the effects of carbon pricing policies under terms of trade effects. Estimated carbon prices are higher in China due to differences in emission intensity and in the rate of deployment of new technologies in the models. Differences in carbon prices open up the possibility of carbon trading between the two countries to achieve mitigation objectives. Further, under assumptions about different exchange rate regimes and international fossil fuel prices, the effects of carbon pricing policies on the two economies are mostly similar in terms of direction but, expectedly, different in terms of magnitude. Terms of trade effects could exacerbate carbon pricing effects to a greater degree in China as the country is significantly more dependent than India on external trade and investment. Policymakers should factor in terms of trade effects while designing or evaluating carbon pricing policies in the two countries.

1. Introduction

The relationship between energy consumption and economic growth has received considerable attention in the literature. It is of particular significance for China and India, as rapid economic growth in these two countries has been accompanied by increasing levels of energy consumption and emissions. The burning of fossil fuels such as coal, oil, and gas emits carbon dioxide (CO_2), and CO_2 emissions by sectors such as electricity, transportation, cement, and steel contribute significantly to climate change (global warming). Climate change is gradually becoming an important policy issue in the two countries in view of international climate change negotiations, such as the recently concluded Paris Agreement. It aims to hold the increase in global average temperature to well below 2 °C relative to pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5 °C relative to pre-industrial levels, to prevent catastrophic damage to the planet. China and India are among the top five emitters of CO_2 in the world, and must participate in any effort to mitigate global climate change for that effort to succeed. Several countries use carbon pricing (carbon tax) as a tool to achieve emission reduction objectives. This paper estimates carbon prices in China and India and, using country-specific dynamic CGE models, compares the economic and environmental effects of carbon pricing policies.

Several empirical studies analyse the effects of carbon pricing policies on China and India. Qi et al. (2016) report that curbing the rise in China's CO_2 emissions will require the implementation of carbon pricing, which will need to rise over $25/ton to achieve China's stated goal of peaking CO_2 emissions by 2030. Ojha (2008) finds that the negative impact of a carbon tax in India could be reduced if the emissions target is modest and carbon tax revenues are transferred exclusively to the poor. Liang et al. (2007) report that the adverse effects of carbon taxes on China could be alleviated by subsidising the production sector. Fisher-Vanden et al. (1997) report that tradable permits represent a lower-cost method than carbon taxes for stabilising India's emissions, while Weitzel et al. (2015) find that international prices of fossil fuels influence the income distribution effects of climate change mitigation policies in India. In a related study on climate change mitigation in different Asian countries, Calvin et al. (2012) find that Japan and Korea tend to reduce emissions much less than the global average for a given carbon price.

The relationship between carbon price (marginal abatement cost) and energy/emission intensity of GDP has been the focus of several studies. Stern et al. (2011) find that under a common percentage cut in emission intensity relative to the business-as-usual (BAU) scenario,

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countries with higher BAU emission intensities have lower marginal abatement costs. Paltsev et al. (2007) report that for a common percentage cut in emissions without international trade in emission permits, there is roughly an inverse relationship between carbon prices and emission intensities in several developed countries. Further, Wang et al. (2010) report that carbon abatement policies could have spill over effects, while Zhu et al. (2016) find that trade openness can mitigate carbon emissions. Thus, based on the literature, one can conclude that, in general, carbon pricing is associated with economic impacts, and similar carbon prices will affect countries differently, on account of differences in energy/emission intensities. Through changes in the prices of fossil fuels, climate policies could be associated with terms-of-trade effects also. Carbon pricing could lead to higher domestic prices which, in turn, could affect the exchange rate; that is, it could lead to currency appreciation in real terms. This linkage between carbon pricing and terms of trade is reported by McKibbin et al. (2014), which finds that climate policies in the US could reduce investment in the capital-intensive energy sector, which in turn could lower imports of durable goods and strengthen US terms of trade. Similarly, changes in international fossil fuel prices arising out of global abatement levels could also lead to terms of trade effects. Klepper and Peterson (2006) looks at `this aspect from a global carbon abatement perspective. They group all the countries into six regional blocks and point out that there is a linkage between climate policies (carbon pricing) and terms of trade effects among these blocks of countries. In this paper we attempt to compare the effects of carbon policies under different assumptions about terms of trade effects for China and India in a comparative perspective. To our knowledge such an exercise has not been carried out in the literature for these two countries. This exercise assumes particular importance as China and India are significantly dependent on external trade (more importantly fossil fuel trade) and investment, and both countries, being among the largest emitters, have started implementing carbon pricing policies.

The main objective of this paper is to estimate the impacts of changes in terms of trade, under carbon pricing policies, on China and on India. To achieve this objective, we use country-specific dynamic CGE models (described later) to compare the effects of carbon pricing on the two countries under different assumptions about exchange rate regimes and international prices of fossil fuels. CGE models have been widely used to analyse carbon pricing policies. These models provide flexibility to analyse terms of trade effects through the incorporation of alternative assumptions about the foreign exchange market and global commodity markets. The alternative assumptions about the foreign exchange market (under carbon pricing) considered in this study are fixed and flexible exchange rate regimes. Similarly, alternative assumptions about global commodity (fossil fuel) markets (under carbon pricing) are analysed by exogenously setting higher and lower world prices of fossil fuels (coal, oil, and natural gas) in the two models (10 per cent higher and lower relative to BAU). Our analysis is focused on estimating the effects on GDP, household income, and CO_2 emissions under the above scenarios. In other words, by using CGE models to construct different scenarios, we want to assess to what extent movements in the exchange rate and international prices of fossil fuels influence the effects of carbon pricing policies in the two countries. The results of this exercise suggest that global market factors such as exchange rate movements and international fossil fuel prices could influence the effects of carbon pricing, and that these factors play a particularly important role in the case of China, as the country is much more dependent on external trade and investment than India. The main policy implication of this study is that the two countries should consider these factors while designing carbon pricing policies, keeping in view their respective economic structures. Carbon prices are also estimated separately under different emission targets for the two countries, in view of the significance of carbon pricing for achieving mitigation objectives.

The rest of the paper proceeds as follows. Section 2 provides an overview of energy sector policies in China and India. Section 3 describes the models and data. Section 4 discusses the main findings of the paper, and finally Section 5 presents the conclusions and policy implications.

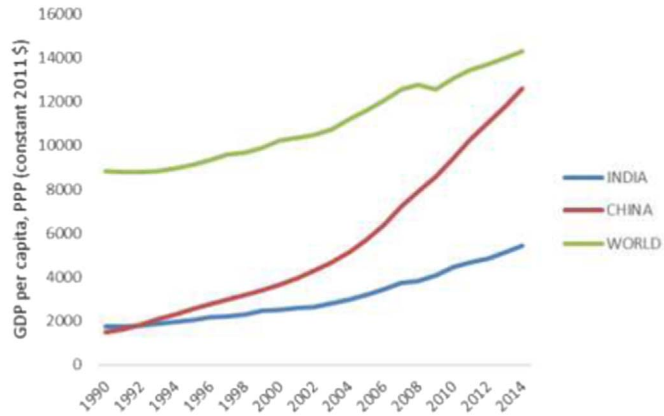

Fig. 1. Trends in per capita GDP (PPP, constant 2011 $) of India, China, and the World. *Source*: World Bank

2. Overview of energy sector policies IN China and India

We begin this section by discussing trends in economic growth and carbon emissions for China and India. We follow with a presentation of carbon pricing initiatives, and end by outlining some key energy sector policies.

In both China and India, growth performance has been remarkable over the past two decades; however, the growth drivers have been different. India's growth has been strongest in the service sector, while China's growth is broad-based, across agriculture, industry, and services (Bosworth and Collins, 2008), and much more energy-intensive than India's. Despite their impressive growth performance in recent years, per capita income in China and India is lower than the world average (Fig. 1).

The per capita income was similar until the mid-1990s, but since then China's per capita income increased dramatically relative to India's. China's growth has been fuelled by high levels of capital accumulation, due to high levels of domestic savings and foreign capital inflows. In India, the large public sector deficit has constrained capital accumulation in the economy to some extent, and capital inflows are much lower (in absolute terms) than China's. The shares of FDI in GDP are, however, similar for the two countries. For example, in 2013, the share of FDI in GDP was 10.4 per cent for China and 12.1 per cent for India (Prajakta Patil, 2014). Foreign capital inflows have played a major role in the growth process, and international trade has expanded rapidly over the past two decades due to policy reforms. Between 2005 and 2013, exports expanded at an annual rate of 11 per cent in China and at 10.5 per cent in India, while imports increased at an annual rate of 10 per cent in China and 11 per cent in China (WTO, 2014). However, the composition of exports was quite different. China's exports are concentrated in goods, whereas India's trade has a much larger services component.

In recent years, due to the rise in income levels in both countries, carbon emissions have increased rapidly. The past decade saw an average annual increase in CO_2 emissions of 2.7 per cent globally. China was the largest emitter (29 per cent of global emissions) and India the fourth-largest (6 per cent of global emissions) (PBL, 2012). China's per capita emissions, much below the world average until 2002 (Fig. 2), increased dramatically afterwards and overtook the global average in 2006. After many decades of rapid fall, China's energy intensity increased between 2002 and 2005, partly for the rapid rise in China's exports. In 2004, exports accounted for 34 per cent of China's GDP; international trade accounted for 23 per cent of its total carbon