INDIA IN THE COMING 'CLIMATE G2'?

Jonathan Camuzeaux,* Thomas Sterner** and Gernot Wagner***

China and the United States are the two largest emitters of greenhouse gases, making them pivotal players in global climate negotiations. Within the coming decade, however, India is set to become the most important counterpart to the United States, as it overtakes China as the country with the most at stake depending on the type of global burden-sharing agreements reached, thus becoming a member of the 'Climate G2'. We create a hypothetical global carbon market based on modelling emissions reduction commitments across countries and regions relative to their marginal abatement costs. We then analyse net financial flows across a wide range of burden-sharing agreements, from pure 'grandfathering' based on current emissions to equal-per-capita allocation. Among the four largest players – the United States, the EU-27, China, and India – it is China that would currently be the largest net seller of emissions allowances in all but the grandfathered scenario. The United States would be the largest net buyer. However, India is poised to take China's position by around 2030. That leaves the United States and India as the two major countries with most to gain and lose, depending on the type of climate deal reached.

Keywords: India, China, G2, climate club, carbon emissions trading, allowance allocation, burden sharing, climate change.

JEL codes: Q5; F5.

1. The importance of relative emissions

It is difficult to overstate the complexity of climate negotiations. It is similarly difficult to overstate the importance of two players: the United States and China, the world's largest emitters of greenhouse gases. Call them the current 'Climate G2' (Foot and Walter, 2010). Together, these two countries produce over two-fifths of the world's carbon dioxide (CO_2) today. While US fossil fuel CO_2 emissions declined by around 10 per cent between 2005 and 2015, and are projected to decline by another 5 per cent by 2025 under our baseline projection, China's contribution keeps growing, commensurate with its rapid GDP growth. China's fossil fuel CO_2 emissions increased by almost 70 per cent between 2005 and 2015 and are projected to grow further by roughly 30 per cent by 2025; per capita emissions increased by over 60 per cent and are projected to grow roughly by another 25 per cent by 2025 (Enerdata, 2016; International Energy Agency, 2015).

While emissions projections, of course, are hugely uncertain, especially in China (Grubb *et al*., 2015), China has taken significant steps toward reducing its emissions despite rapid economic growth. China has invested heavily in renewable energy, subsidising the rapid deployment especially of solar photovoltaic technologies (Wagner *et al*., 2015). Overall, China's CO_2 emissions are typically forecast to peak by around 2030, even though its Belt and Road Initiative (BRI) might lead to significant emissions leakage (Tsinghua PBCSF *et al*., 2019).

As China's emissions might peak within a decade, India's are projected to keep increasing. While India's current per capita emissions are just a quarter of China's, its total fossil fuel CO_2 emissions and per capita emissions grew by around 80 per cent and 55 per cent, respectively, between 2005 and 2015, and are projected to grow by 30 per cent and around 15 per cent through 2025 under our baseline assumptions (Enerdata, 2016; International Energy Agency, 2015). India's per capita emissions growth rate would be projected to increase after that, assuming a baseline pathway of no further climate policies beyond those implemented in the past decade (figure 1).

*Environmental Defense Fund. E-mail: jcamuzeaux@edf.org. **University of Gothenburg. E-mail: Thomas.Sterner@economics.gu.se. ***New York University, Department of Environmental Studies and NYU Wagner School of Public Service. E-mail: gwagner@nyu.edu (corresponding author).

For a less technical exploration of aspects of this argument, see Ahuja *et al.* (2015). We thank Richie Ahuja, Shoibal Chakravarty, Frank Convery, Geoffrey Heal, Nathaniel Keohane, and Johannes Urpelainen for helpful comments and discussions. We thank Dominic Watson for research assistance. Thomas Sterner thanks Mistra Carbon Exit for funding. All remaining errors are our own.

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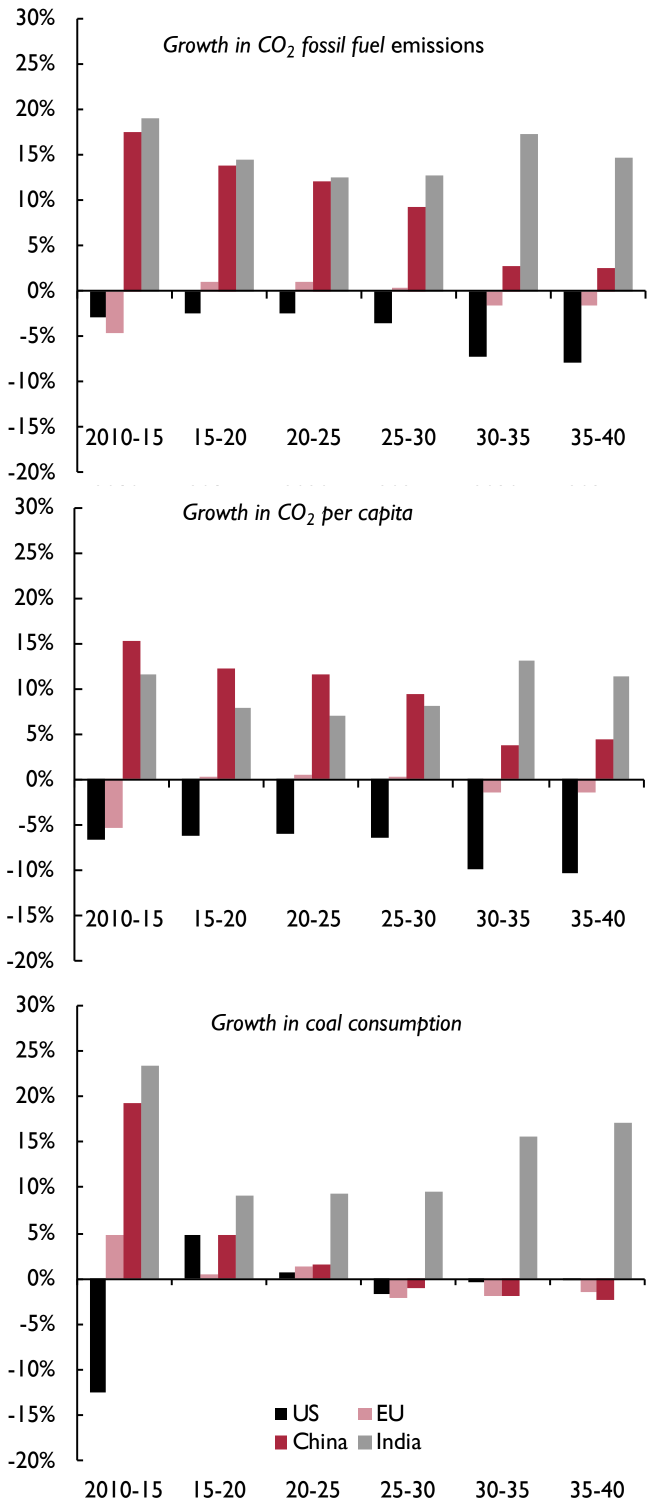
Figure 1. Past and projected five-year growth rates of fossil fuel CO_2, per capita CO_2 and coal consumption for the US, the EU-27, China and India, 2010–40



Sources: Enerdata, 2016; International Energy Agency, 2015; U.S. Energy Information Administration, 2016.

India has been catching up by some other important measures as well. As early as the mid-1990s, India's carbon intensity of consumption had surpassed that of China and was almost one third higher than China's by 2005 (Birdsall and Subramanian, 2009). India's consumption of coal has been increasing steadily and, under our baseline assumptions, would continue to grow at a faster rate than Chinese coal consumption between 2020 and 2040, suggesting the risk of technology lock-ins (U.S. Energy Information Administration, 2016).

This alone already provides indicative evidence of the importance of India in global climate negotiations, in particular as a 'counterweight' to the United States, with negotiating positions directly opposed to each other. India is not the only country in this position, but it is by far the largest in terms of absolute emissions. Meanwhile, China is surely important, but its continued move into the global emissions 'middle class', with average per capita emissions resembling those of the EU, may turn it into less of a pivotal player than often assumed in any negotiated outcome. That does not diminish China's role *per se*, nor that of any of the other significant players in any global climate deal. But if India continued on its current path along our baseline projections, it would surely elevate its relative standing. In fact, it is precisely the relative standing – and the resulting net financial flows – that is crucial in any climate negotiations.

India's formal negotiating position has a number of complex internal and external drivers (Rastogi, 2011). We do not enter this debate directly. Instead, we focus on a summary statistic that captures the most salient aspect within international negotiations: India's relative emissions reductions obligations under any hypothesised global climate deal. While the climate ultimately is affected only by absolute emissions, relative emissions outcomes have long been the focus of climate negotiations. That is particularly pertinent for developing countries, including India. The all-important 'fairness' debate is centred around relative outcomes in terms of the burden of emissions adjustments borne by individual countries (Dubash, 2013).

To model relative emissions reductions obligations, we develop a global financial flows model incorporating regional and country-level marginal abatement cost curves as well as different levels of abatement ambition by country and region. We are not the first. Similar modelling, often at a much greater level of complexity, is common in the climate policy literature. Some notable efforts include the Stanford Energy Modeling Forum (e.g., Clarke *et al*., 2009), MIT's Joint Program on the

Science and Policy of Global Change (e.g., Gavard *et al*., 2011; Jacoby *et al*., 2008; Paltsev *et al*., 2012), as well as inter-model comparison efforts such as den Elzen *et al*. (2008, 2007) and Höhne *et al*. (2014). Gavard *et al*. (2011) focuses on the US-China relationship, Paltsev *et al*. (2012) focuses on China, and Johansson *et al*. (2015) focuses on China and India.

Our financial flows model zeros in on the essence of the relative emissions reductions obligations of countries: any particular country's share in emissions permits under an idealised, global, emissions trading system. A hypothetical global carbon market would achieve efficiency, once marginal costs of abatement are equalised across countries. But such a market is neither the likeliest, nor perhaps even the most desirable overall outcome (Nordhaus, 2015a, b; Weitzman, 2016). Our results presented here do not depend on such a market actually existing. It simply serves to illustrate the relative obligation of countries under different emission share scenarios.

There are many ways to allocate the right to emit, and different countries will win or lose depending on the allocation mechanism in place (Bretschger and Mollet, 2015; Rose *et al*., 1998). In our idealised model, a country with high-cost abatement, such as the United States, could attain its domestic emissions target by buying reductions from a country that can produce them at a lower cost. Much depends on initial allocation, which is precisely what makes global climate negotiations so difficult. India, for example, would gain significantly under an allocation based on equal per capita emissions, while it would lose under a grandfathered allocation system or (less so) under a uniform carbon tax (Bretschger and Mollet, 2015). The effects crucially depend on how revenues from a carbon tax or (auctioned) allowances are distributed.

This paper proceeds as follows: Section 2 lays out the methodology. Section 3 discusses results under our baseline projections and explores sensitivity tests. Section 4 presents some policy implications.

2. A global emissions reductions financial flows model

2.1 Projected emissions pathways

We divide the global economy into twelve geographic regions based on Enerdata's Prospective Outlook on Long-term Energy Systems (POLES) model (Enerdata, 2016): the United States, the European Union, China, India, Canada, the Commonwealth of Independent States (with Russia as its most prominent member), Latin America, Rest of Europe, Rest of Asia, Australasia, the Middle East, and Africa. Our baseline emissions pathway for each geographic unit relies on data and projections from POLES. This 'business-as-usual' projection follows historical emissions trends closely and assumes no additional climate policies beyond those implemented by 2013. Policies since placed on the books would largely skew our results toward seeing outcomes presented here as occurring in, say, 2030 to come to fruition slightly earlier, exacerbating our results.

We subsequently construct five different emissions target scenarios, each a combination of one of three global emissions caps – 20, 25 or 30 billion tonnes (giga-tonnes, Gt) of fossil fuel CO_2 emissions by 2030 – and one of three emissions allocation methodologies: grandfathering of allowances based on historic emissions, and two equity-driven allocation mechanisms.[1]

In the grandfathered allocation approach, we assume that each of the twelve geographic regions gets a share of total allowances for year 2030 equivalent to its share of total emissions at the beginning of the past decade, 2010. At the opposite end, in the equal per capita emissions allocation, global emissions caps are distributed equally among all global citizens and allocated to countries depending on the size of their population, again based on a recent historic baseline of 2010 World Bank data (World Bank, 2016). A third scenario is what we call the 'Billion High Emitters Allocation', following Chakravarty *et al*. (2009): an allocation framework in which fossil fuel CO_2 emissions are divided among a country's citizens based on its income distribution. The ultimate goal is to apply the concept of 'common but differentiated responsibilities' to individuals rather than nations. Under this goal, individuals who contribute comparable levels of emissions are expected to reduce their emissions by similar amounts, irrespective of which country they live in. With these per capita emissions caps set, and assuming that policies are still implemented at the national (or regional, e.g. EU) level, we then aggregate the individual data at the level of our twelve geographic units to determine overall emissions targets.

In each case, we apply the allocation methodology to an emissions reductions target in the year 2030. We then fit emissions pathways from 2015 onward through the 2030 reductions targets and close the model in 2050.[2]

Our allocation scenarios mirror those of Bretschger and Mollet (2015), who compare the distributional consequences of three different burden sharing policy mechanisms: a global carbon tax; an egalitarian approach to sharing atmospheric resources akin to an equal-per-capita allocation (Winkler *et al.*, 2011); and an allocation mechanism based on equity and efficiency principles introduced by Bretschger (2013). While a global carbon tax produces similar results to our grandfathering scenario, the latter two approaches tend to benefit developing economies even more than our equal-per-capita allocation, especially when historic responsibility is taken into account.

Table A1 in the appendix displays the emissions targets for the five main scenarios and three more considered in the sensitivity analysis in the appendix.

2.2 Residual demand for CO_2 permits

Consider a hypothetical global carbon market in which each geographic unit – country or region – has a baseline CO_2 emissions pathway and faces its own reduction target, generating a demand for emissions allowances. Each geographic unit also has its own marginal abatement cost curve, the all-important relationship of emissions reduction goals to costs per ton abated, taken directly from POLES. The residual demand, $RD_{i,t}$, for CO_2 permits for each geographic unit i in year t is given by:

$$RD_{i,t} = Q_{BAU_{i,t}} - Q_{TAR_{i,t}} - R_{i,t}(p_t), \qquad (1)$$

where $Q_{BAU_{i,t}}$ and $Q_{TAR_{i,t}}$, respectively, refer to fossil fuel CO_2 emissions under a baseline business-as-usual (BAU) and a target scenario. In the top-down Kyoto-style climate negotiations, and effectively through the Copenhagen negotiations (COP15), Q_{TAR} itself was the ultimate object of negotiation. In the Paris Conference of Parties (COP21), the closest equivalents were the Nationally Determined Contributions (NDCs). R is the quantity of emissions abated at CO_2 price p: the supply of emissions reductions given by the marginal abatement cost curve.

We solve for an equilibrium price path and associated allowance flows, such as to minimise the net present value, NPV, of the total cost of abatement across geographic units for all years 2015 through 2050:

$$\min\left[NPV\left[\sum\nolimits_{i=1}^{12}(C_{i,t}(p_t))\right]\right] \qquad (2)$$

subject to:

$$\sum\nolimits_{t=2015}^{2050}\left[\sum\nolimits_{i=1}^{12}(RD_{i,t})\right] = 0, \qquad (3)$$

where $C_{i,t}(p_t)$ is the total cost of abatement for country i in any given year, as a function of allowance prices p_t. Crucially, (3) states that the cumulative balance of banked CO_2 permits across all twelve geographic units is constrained to equal zero in 2050. For simplicity, we assume p_t grows at a rate of 5 per cent per year in equilibrium. This assumption has little bearing on the final outcome.

3. Results

The annual residual demand for CO_2 permits is the statistic that shows the strength of commitments to reduce emissions relative to the costs of doing so. Figure 2 shows the results for the grandfathered and equal per capita allocations for the years 2015 to 2040 for four of the twelve geographic units modelled: the United States, the EU-27, China, and India.[3]

In the grandfathered case, all four are net sellers of allowances until 2030, pointing to relatively loose initial targets, which triggers considerable banking of allowances for use in later years. Something similar holds for most other geographic units, making them net sellers of allowances through around 2030. Most geographic units, including China and India, then turn into net buyers of allowances, drawing down the stock of banked allowances through 2050, in line with equation (3). Both the EU-27 and, significantly more pronounced, the United States remain net sellers of allowances under the grandfathered allocation. In later years, it is the United States then that continues to benefit the most from the grandfathered allocation, with both China and India as the counterweights standing to lose the most. Grandfathering locks in past emissions and hurts those with rapid (relative) economic growth.

In the equal per capita case, the United States would be a net buyer of allowances beginning in year one, a complete switch from its position under the grandfathered allocation, reflecting the fact that US per capita emissions are among the world's highest. The EU, too, switches from net seller to net buyer, though much less pronounced. Meanwhile, China's position remains much the same under both allocations: a significant net seller in early years, a significant net buyer after around 2030–35. In fact, in both allocation scenarios, China emerges as the single largest net buyer of permits by around 2040.

India, meanwhile, experiences a large shift in fortune: While still a net seller in early years under equal per capita, it now becomes the largest and only major net seller by around 2030. It, thus, has the most to gain from a switch from grandfathered to equal per capita; the United States has the most to lose, and *vice versa*.[4]

Figure 2. Annual residual demand for CO_2 permits in the grandfathered and equal per capita allocations ($GtCO_2$)

Grandfathered (20GtCO₂ global target by 2030) — *Equal per capita (20GtCO₂ global target by 2030)*

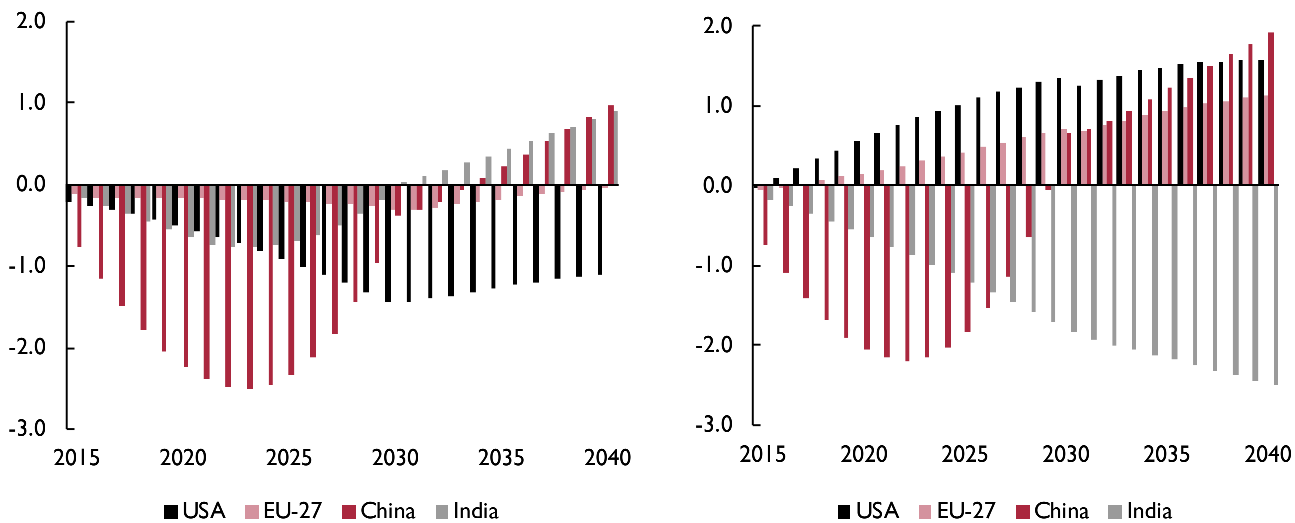
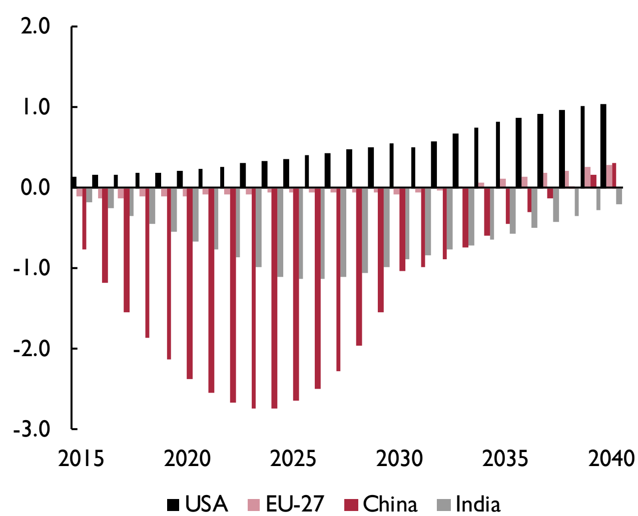


Figure 3. Annual residual demand for CO_2 permits in the billion high emitters allocation case ($GtCO_2$)

Billion high emitters (20 $GtCO_2$ global target by 2030)



The billion high emitters case presents an intermediate scenario (figure 3), with the United States showing the highest net demand in CO_2 permits throughout. China is the largest net seller through around 2030, only to become a net buyer in later years, while India remains a net seller throughout, emerging as the only major net seller in later years.

Much of India's increasing importance in climate negotiations is due to economic convergence (Barro, 1998): our baseline projections assume China's economic growth slows down, while India's is expected to pick up in relative terms. In the forecasts used, both China and India are expected to increase their per capita emissions through 2030, though growth rates there, too, are expected to converge, leading to India catching up with China in absolute terms (table 1).

These scenarios crucially depend on the interaction between baseline emissions projections, marginal abatement costs, and relative strengths of proposed emissions reductions. The 'rise' of India, thus, is all about relative positions. In particular, none of this diminishes the important role of strong Chinese climate policies. The reason for India's increased importance in a global deal, in fact, is, at least in part, because of China's strong domestic commitments to decrease its emissions (White House, 2014, 2015). The combination of high business-as-usual growth and ambitious domestic policies catapults China onto an equal plane with that of the EU: the global emissions 'middle class'.

Chakravarty *et al.*'s (2009) billion high emitters allocation provides one robustness test of our results. Figure 4 shows the results for 25 and 30 Gt global CO_2 emissions targets for 2030.

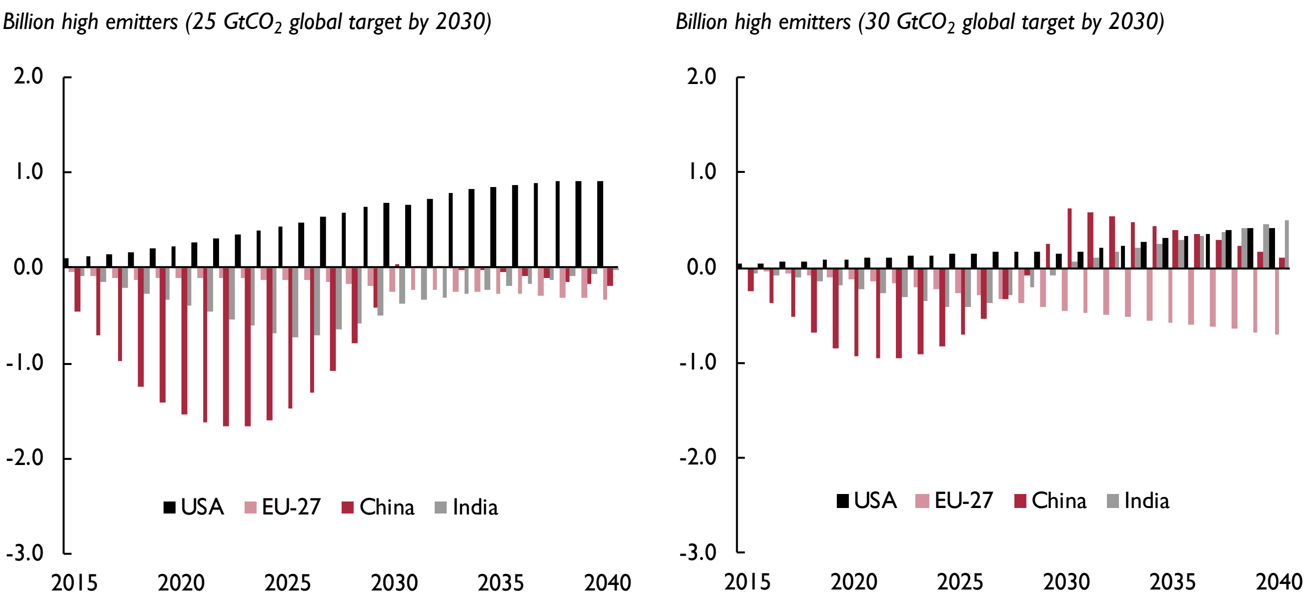
Results for the 25 $GtCO_2$ by 2030 global target case remain consistent with the dynamics we saw in the 20 Gt CO_2 case in figure 3: India overtakes China as the main net seller of allowances by around 2030, though

Table 1. Past and predicted per capita emission and GDP in China and India

		2010	2015	2020	2030	2010–20 change	2020–30 change
China	Emissions per capita (tCO_2e/person)	5.4	6.7	7.5	9.3	39%	25%
	GDP per capita (US 2005 PPPs)	6,713	9,508	12,360	18,102	84%	46%
India	Emissions per capita (tCO_2e/person)	1.4	1.6	1.75	2.0	23%	15%
	GDP per capita (US 2005 PPPs)	3,004	3,705	4,683	7,561	56%	61%

Source: Enerdata, 2016; OECD, 2014; World Bank, 2016.

Figure 4. Annual residual demand for CO_2 permits in the Billion High Emitters allocations ($GtCO_2$)

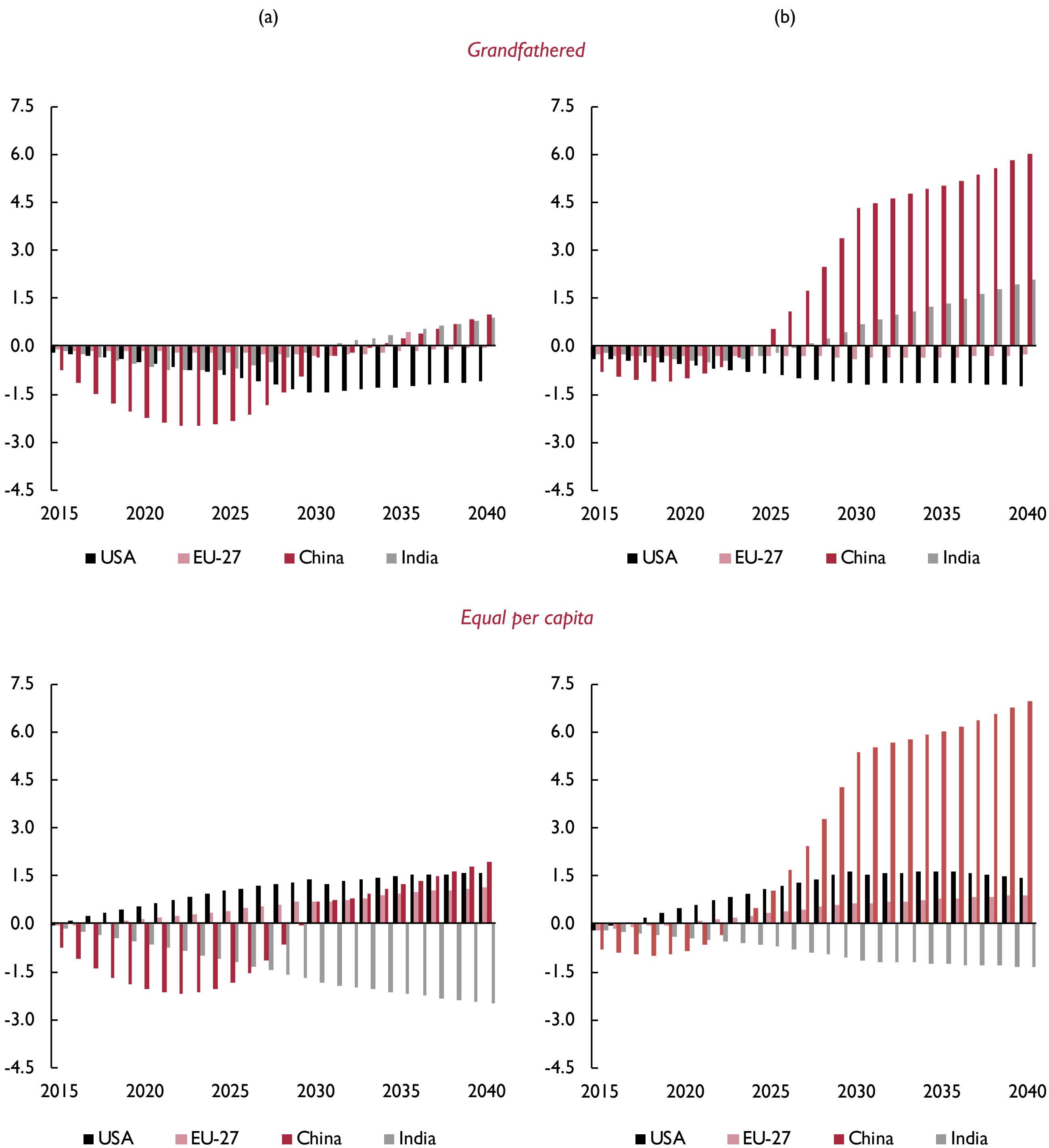


the effect is much less pronounced. Moreover, the EU-27 quickly overtakes India and becomes the United States' main counterweight. With an even less stringent global emissions reductions goal of 30 $GtCO_2$ by 2030, it is no longer India but the EU-27 that replaces China and establishes itself as the highest net supplier of emissions allowances by 2030 among the four geographic units here. This is largely due to the fact that the EU-27 is already reducing its emissions and is projected to continue its abatement efforts, therefore putting it well ahead of the others in a world with an undemanding climate target. That is true even compared to a developing country such as India, whose emissions are projected to grow significantly by 2030.

Results so far have all been based on POLES baseline projections and marginal abatement cost curves (Enerdata, 2016). That provides an internally consistent set of projections (figure 2 above). It is also limiting. To test the sensitivity to this baseline, here we present model results using U.S. Energy Information Administration (EIA) (2016) baseline emissions projections and McKinsey marginal abatement cost curves, and every combination: POLES emissions projections and McKinsey cost curves (figure 5b); EIA emissions projections and POLES cost curves (5c); and EIA projections and McKinsey cost curves (5d).

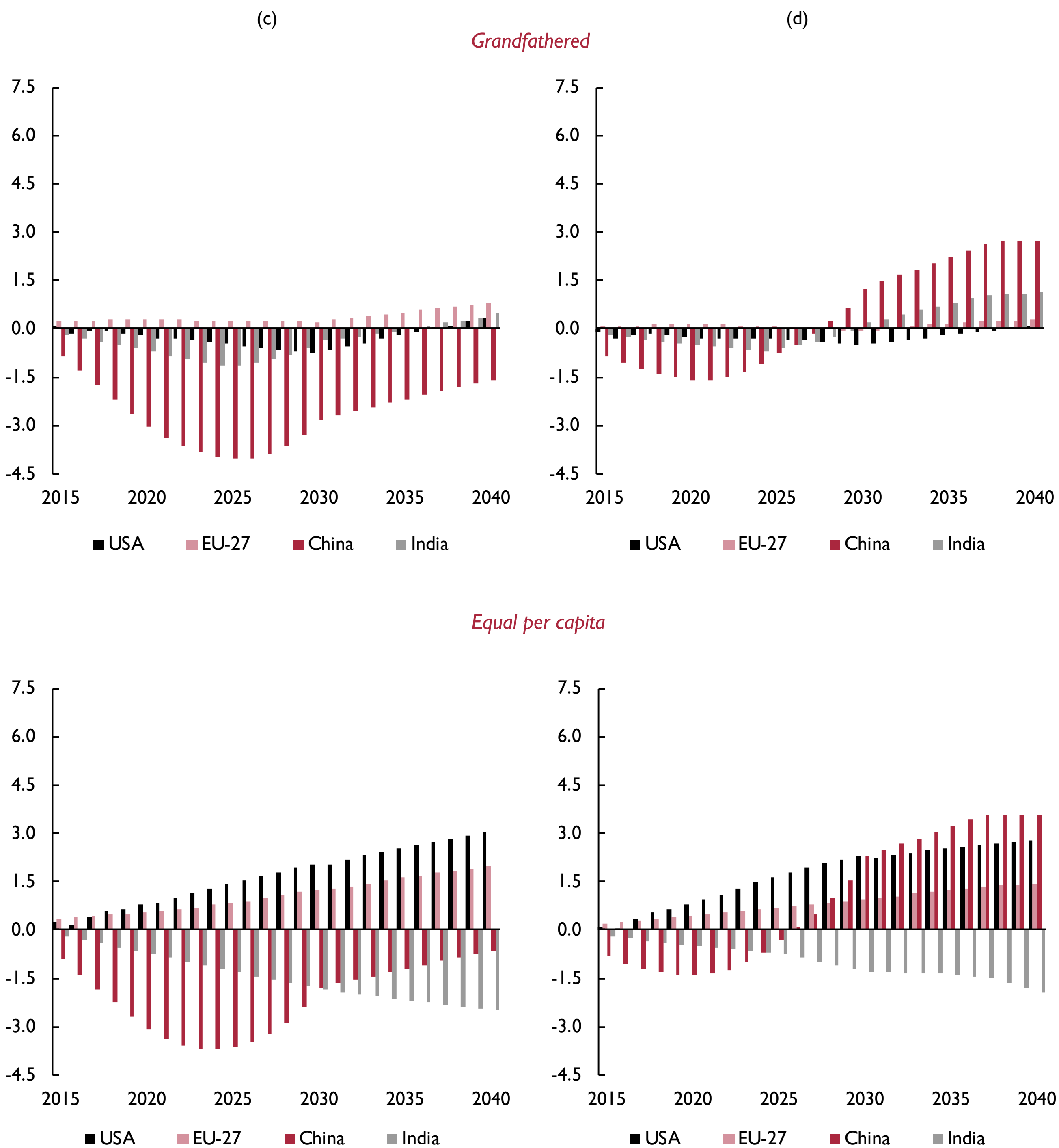
Absolute residual demand numbers predictably jump around across panels in figure 5. China, in particular

Figure 5. Annual residual demand for CO_2 permits, comparing grandfathered (GF) allocations (top, in each panel) and equal per capita (EpC) allocations (bottom, in each panel)[(a)]



Notes: (a) Baseline projection of POLES emissions projections and marginal abatement cost curves (5a, mirroring figure 2), and combinations of POLES emissions projections and McKinsey cost curves (5b), EIA emissions projections and POLES cost curves (5c), and EIA projections and McKinsey cost curves (5d) (GtCO2).

Figure 5.(a) (continued)



Notes: (a) Baseline projection of POLES emissions projections and marginal abatement cost curves (5a, mirroring figure 2), and combinations of POLES emissions projections and McKinsey cost curves (5b), EIA emissions projections and POLES cost curves (5c), and EIA projections and McKinsey cost curves (5d) (GtCO2).

experiences major swings in absolute residual demand across panels. The same goes for other geographic units. It is striking, though, how persistent the main result is: Each of the panels in figure 5 shows the United States switching from net supplier to net buyer of allowances around 2030, while India emerges as a major net buyer around the same time. That is true for our baseline projection (figure 1, reproduced in figure 5a) and for all three combinations.

4. Policy implications

India's importance for climate negotiations is undisputed (e.g., Greenstone, 2014; Mandhana, 2014; Volcovici and Wilkes, 2014). This analysis shows why; in climate negotiations – whether they are truly global or bilateral between two countries – much of the outcome depends on the relative position, given by projected emissions and relative cost of abatement. That leads to the two most crucial points of negotiation: who abates how much, and who pays.

Our model focuses on precisely these two questions, pointing to net financial flows across major countries and regions to equilibrate marginal abatement cost curves. Such a framework brings to the fore the type of allocation mechanism used – whether it is grandfathered allocation at one end, or equal per capita emissions at the other. While not intending to diminish the role of any country or region, we focus on the United States, the EU-27, China, and India as the largest players. All four are important to any global climate deal, and so are many others. But a clear pattern emerges; for one, while the EU is a large absolute emitter, it has also committed to large emissions reductions. Combined with marginal abatement costs around the global average, the EU's relative position does not change wildly based on the allocation mechanism used. Something similar applies to China; under our baseline projections, it is expected to switch from a net supplier of allowances to a net buyer, switching its absolute role in the coming two decades. But that switch changes little with the allocation mechanism used. The same cannot be said about either the United States or India.

By around 2030, the United States and India have the most to gain and lose depending on which allocation mechanism is chosen – turning the two into the most significant negotiating partners in any form of global climate negotiations. In particular, the United States has the most to gain from a grandfathered allocation, with India losing the most. These relative positions reverse with equal per capita allocations; India gains, and the United States loses, measured in terms of monetary flows in a hypothetical global financial flows model.

The relative importance of India in future mitigation scenarios brings to the fore a number of domestic policy issues, first and foremost perhaps its currently limited internal institutional capacity for strong climate policy. Unlike China, India's ability for top-down, nation-wide policy is limited, requiring different domestic approaches (Dubash, 2013). The jury is out on which type of international climate negotiations framework has the most potential to lead to strong domestic climate policy (e.g., Green *et al*., 2014). But regardless of whether international negotiations happen in the form of bilateral talks, in UNFCCC-style global negotiations, or in a multilateral 'Climate' or 'Carbon Club' (Keohane *et al*., 2015; Nordhaus, 2015a, 2015b), India's prominence will only continue to grow.

NOTES

1 All three assumed global emissions caps represent ambitious targets relative to fossil-based CO_2 emissions in 2018 of around 40 Gt.
2 Developments in the final 3–5 years are simply an artefact of us closing the model by 2050, hence our graphs present results through 2040.
3 The EU-27 here includes the United Kingdom and excludes Croatia.
4 This general result follows Bretschger and Mollet (2015), who present conclusions similar to ours with regard to the importance of allocation mechanisms for the relative positions of the United States and India.

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