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ORIGINAL PAPER

Equity, burden sharing and development pathways: reframing international climate negotiations

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Abstract Distribution issues have been critical in international negotiations on climate change. These have been framed as a 'burden sharing' problem since the UN Framework Convention on Climate Change. Three key difficulties are associated with this approach under a cap-and-trade system, namely the lack of consensus over what is equitable, uncertainty over estimates of policy costs, and lack of political realism and economic effectiveness of large-scale international transfers. These difficulties point to the risk of failure of post-2020 negotiations if these are based on the same premises of 'sharing the emission reduction pie' within a cap-and-trade regime. History has shown that different development paths can lead to similar economic performances with contrasted emission intensities. This paper proposes some insights into what could constitute a way forward, by recasting the discussion about emission reductions from a development perspective. It concludes that climate negotiations should depart from the current framework and shift to a debate focused on choosing a development path that would address domestic issues, while aligning pure climate policies with development policies.

Keywords Burden sharing · Sustainable development · Equity · Development pathways

Abbreviations

GDP	Gross domestic product
GHG	Greenhouse gases
LDCs	Least developed countries
NAMAs	Nationally appropriate mitigation actions
UNFCCC	United Nations Framework Convention on Climate Change

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1 Introduction

The provision of public goods raises three normative questions. One of overall volume: How much public goods should be provided? And two distinct but related questions of distribution: Who should contribute? And who should pay? This paper is concerned with the latter two in the context of the climate change negotiations, which have been plagued from the beginning by controversies over the distribution of efforts across countries. The underlying premise is that unavoidable as they may be given the global public good nature of the Earth's atmosphere, such discussions materialize in very different ways depending on how negotiations are framed. And some framing may be more conducive to agreements than others.

Precisely, in the cap-and-trade approach that has historically prevailed in climate negotiations, who abates and who pays for abatement depend on the allocation of emission allowances among participating countries. Since the mid-1990s, the literature has covered the question of how emissions allowances should be allocated. Numerous "allowance allocation rules" have been proposed. Some are ready-to-implement. Others outline grand principles, leaving operational details unresolved (Lecocq and Crassous 2003). While the literature explores how allowance allocation rules can be derived from equity principles ex ante, the debate on distribution is broader: whether a given international policy architecture is 'equitable', 'just', or 'fair' is also a 'matter of distributing costs' (Ringius et al. 2002) and thus involves a normative judgment on the *consequences* of the chosen allowance allocation rule ex post.

Such distribution issues are typically referred to as 'burden sharing', an ill-defined term. While frequently associated with *all* distributive issues (those underpinning the allocation of emission allowances, and those associated with the costs stemming from the implementation of these rules), it is sometimes restricted to distribution of costs (Müller 2001). In addition, the word 'burden' suggests that all nations will lose from international climate policies, while some may win.[1] Finally, 'burden sharing' is typically associated with cap-and-trade, while distributive issues arise regardless of the instrument. Hence, we use 'distribution issues' throughout this paper.

This paper argues that the current framing of distribution issues is not conducive to an international climate agreement. Section 2 provides a short history of the cap-and-trade framing of international climate policies; Sect. 3 discusses three key difficulties associated with this approach; and Sect. 4 argues for negotiating on a broader set of issues to try and break the current deadlock.

2 Distribution issues in climate negotiations

2.1 The quantity-based approach: a short history of climate negotiations

The quality of the climate is a global public goods: nobody on Earth can be excluded from it, and there is no limit to how many people can benefit from it (Nordhaus 1994). This calls

[1] The idea that all nations will lose can be refuted by considering not only the costs of acting, but also the benefits in terms of avoided climate damage. Even when only looking at direct costs, climate policy might trigger macroeconomic feedbacks which would lead to net direct benefits, for instance through double dividend mechanisms at the global level (Goulder 1995). In addition, benefits may accrue to some regions through carbon trading, depending on the selected quota allocation rule.

for mitigating climate change which raises deep cooperation issues, as greenhouse gases (GHG) emitters have a strong incentive to free ride. It is thus not surprising that distribution issues have been on the agenda since the late 1980s. What is contingent, however, is the framing of distribution issues in the climate negotiations (Hourcade 2002; Grubb et al. 1999).

In the late 1980s, two approaches stood out: taxing the environmental bad (i.e. GHG emissions), or capping emissions—possibly allowing agents to trade emission permits. The 1992 UN Framework Convention on Climate Change adopted a quantitative approach for its long-term and short-term objectives (Article 4.2). The perceived success of the first cap-and-trade programmes in the U.S. on SO_2 and NOx emissions (Joskow et al. 1998) combined with the loss of support for an energy tax in Europe just before the Rio Summit, influenced the quantitative approach. The 1992 non-binding target to curb 2000 GHG emissions down to 1990 levels (UNFCCC 1992) reflected a dual logic. First, only developed countries and transition economies (so-called Annex I countries) had targets, a translation of the 'common but differentiated responsibility and respective capabilities' principle of the United Nations Framework Convention on Climate Change (UNFCCC) (Article 3). Second, the underlying principle was 'grandfathering' as the target for all Annex I countries was 1990 emission levels.

After 1992, the UNFCCC 'quantity-based' approach continued in the Kyoto Protocol (KP 1997). Though the negotiation did not discuss 'sharing the pie' (as there was no pre-agreed overall emissions target to be shared among Parties), comparison of efforts among countries (and thus distribution issues) remained critical. In the KP only Annex I countries have binding commitment targets. The three major groups of emitters in Annex B (the U.S., EU and Japan) have similar absolute targets compared to 1990 emissions (−6, −8 and −7 % respectively)—though the so-called 'EU bubble'[2] and US non-ratification added complexity. A key difference with the UNFCCC, however, is the presence of explicit flexibility mechanisms that drive a wedge between the distribution of emissions allowances and the actual distribution of efforts (and thus costs).

The following international climate legislation—the EU Emissions Trading Scheme[3]—was also framed as a cap-and-trade approach. Interestingly, adopting a cap-and-trade mechanism at the EU level was not required by the Kyoto Protocol. A market-oriented European Commission, pressures from regulated industries that saw easy access to the Kyoto Clean Development Mechanism, diplomatic inertia and the need to save the Kyoto Protocol after the 2001 US withdrawal have all been identified as contributing factors for the adoption of emissions trading (van Asselt 2010; Jordan et al. 2012). Most subsequent regional climate policies are also cap-and-trade (e.g., in the U.S., Australia, or New Zealand).

Largely with pressure from the EU, political attention shifted to limiting global warming to 2 °C above pre-industrial level and led to its discussion and adoption in the non-binding Copenhagen Accord of 2009. In 2011, the Parties extended the Kyoto Protocol to a second commitment period and launched new negotiations aimed at developing a legally binding instrument for the post-2020 period, bringing all Parties under the same legal regime (Rajamani 2012; Ranson and Stavins 2012). The negotiations will need to be completed by the end of 2015 at COP21, with sufficient time to allow the agreements to come into effect in 2020.

[2] Article 4 of the KP (the 'EU bubble') allows a group of countries (e.g. the European Union) to agree on a common reduction target which can be subsequently redistributed among the group.

[3] Directive 2003/87/EC.

The Cancun Agreements (2010) introduced the concept of 'equitable access to development' (Winkler et al. 2011) and called for a 'paradigm shift' from a climate-centric approach focusing on burden sharing, towards a more development-centric approach aimed at re-directing development patterns while reducing global emissions (Hourcade and Shukla 2013). Adopting this approach has important consequences for the distribution debate; but the temptation to stick to a cap-and-trade approach for the post-2020 period remains strong. In fact, the Durban Platform (2011) has improved the chances of linking cap-and-trade systems worldwide and has opened a window to engage developing countries in a global climate architecture (Ranson and Stavins 2012; Glachant et al. 2013). There is therefore a chance that a quantity-based approach will prevail and frame the distribution discussion.

2.2 How cap-and-trade frames distribution issues

In theory, a cap-and-trade system requires virtually no information about efficiency ex ante. Once a global emissions target is set,[4] efficiency emerges ex post as a result of market forces. As a price of emissions allowances emerges on the market, rational agents note the differences between the market price and internal mitigation costs and decide to sell emissions allowances when the price of allowances is higher than the internal marginal abatement cost or buy emissions allowances when the price of allowances is lower. Once all transactions are cleared, the market price of allowances reflects the (common) marginal cost of abatement across all agents and total mitigation costs are minimized. In this model, the initial allocation of emissions allowances is immaterial to the distribution of abatement efforts ex post.[5] Initial endowments matter only for *equity* as they determine how much each Party gains or loses.

This model is very basic and raises the question whether equity and efficiency are separable. It appears that the level of provision of public goods and the cost distribution are not independent especially for climate mitigation. Chichilnisky and Heal (1994) show that the only Pareto optimal distribution has each country's contribution to solving climate change proportionate to its income. Though this result has been challenged (Chao and Peck 2000), allowance allocation rules may lead to inefficient outcomes in imperfectly competitive markets (Shukla 2006; Markandya 2011).

Even if efficiency and equity can be addressed separately, several difficulties remain: First, the choice of the allowance allocation rule depends on what is considered fair. Yet there is no consensus on what is the most suitable equity principle, and different principles lead to different assessments of possible allowance allocation rules. The same equity principle can be applied either to assess the fairness of allocation rules per se, without considering its possible outcome (the ex ante approach), or to assess the fairness of the consequences of the implementation of allocation rules (the ex post/consequentialist approach). The ex post approach requires the choice of an indicator—economists will usually opt for welfare—and the use of economic models to estimate the potential impacts of a given allocation rule (see Sect. 3.1). Second, a consequentialist evaluation of allowance allocation rules faces the difficulty that any such rule has uncertain economic impacts (see Sect. 3.2). Finally, in many cases, the implementation of an allowance allocation rule

[4] Cost–benefit analysis can help determine the optimal aggregate level of abatement using integrated assessment models like DICE (Nordhaus 1993), PAGE (Hope et al. 1993) or FUND (Tol 1999).

[5] A (unique) distribution of abatement efforts equalizes marginal abatement costs across countries, irrespective of initial endowments.

implies large-scale international financial transfers, which may be politically unacceptable and economically ineffective (Sect. 3.3).

3 Three difficulties associated with addressing distribution issues in a cap-and-trade framework

3.1 The difficulty of finding a consensus definition of "equitable"

Proposed allowance allocation rules are often based on equity intuitions that rest on limited theoretical ground (Lecocq and Hourcade 2012) such as grandfathering where emission allowances are distributed pro rata past emissions. Grandfathering is popular in international agreements over scarce resources.[6] Its ethical basis has little scholarly support (Grubb 1995), though it can be equitable as historical emissions are not ethically unacceptable per se if they remain within a limit that would prevent dangerous climate change (Müller 1999).[7] Still, the literature distinguishes four relevant equity principles based on equality, capacity, basic needs, and proportionality. They are discussed in turn below in terms of their implications (ex ante and ex post) for allowance allocation rules.

The *equality principle* (Rawls 1971) treats all humans as equal with equal fundamental rights. This principle can be translated into equal rights to emit (ex ante) through equal per capita allocation (Grubb 1990; Agarwal and Narain 1991). However, if understood in terms of strict egalitarianism, this principle could also apply to the provision of all, not just public, goods (Caney 2009). The equality principle could alternatively imply the equal distribution of costs and benefits (ex post), which could be understood as requiring comparable efforts among parties. However, equal per capita allocation has been criticized (Starkey 2011; Godard 2000) since it leads to a significantly larger burden on industrialized compared to developing countries which contradicts the comparable efforts criterion (Grubb 1995) and may be politically infeasible (see Sect. 3.3). Further, the equality principle may be inconsistent with maximizing overall utility. As per capita emissions today are extremely unequal,[8] transition schemes proposed whereby emission allowances are first allocated based on other principles (often past emissions), with increasing weight for population over time. Among transition mechanisms, the *contraction and convergence* (Global Commons Institute 1997) has been particularly influential in climate negotiations.

The *ability to pay (or capacity) principle* asserts that parties with most resources should contribute most to reaching the common objective (Shue 1999). It gives a higher value to the utility of the least-advantaged groups and relates to the concept of priority. It allows diverging from equality if it improves the conditions of all, including the least-advantaged members of society (drawing on Rawls 1971). Although Rawls (1993) thought this principle unsuitable to regulate inequalities among states, others argue that international cooperation should be designed to optimize the position of the least-advantaged group

[6] Examples include milk quotas within the European Union (Burton 1985), most Individual Tradable Quotas for fisheries and, to some degree at least, the US. SO_2 trading programme.

[7] Historical emissions are a by-product of wealth, of which all individuals can claim a share proportional to their contribution to wealth creation. Grandfathering is ethically defensible assuming that these property rights can be transferred to future generations. Müller finds the basis of this argument in the entitlement theory of distributive justice (Nozick 1974).

[8] In 2011, energy related CO_2 emissions ranged from above 16 tCO_2 per capita in the US to an average of less than 1 tCO_2 per capita in African countries (IEA 2012).

(Beitz 1979; Pogge 1989). The ability to pay thus relates to each country's capacity to contribute to the common objective without unacceptable losses of welfare (Baer 2013). This implies an allowance allocation such that the (ex post) financial burden of abatement would be distributed according to Parties' ability to pay for abatement.[9] Although supported by Parties[10] and scholars (Jacoby et al. 1999), a key issue here is how to measure ability to pay for abatement. A commonly used measure is Gross Domestic Product (GDP) per capita (Smith et al. 1993), but other measures have been suggested, such as the Human Development Index (UNDP 1990).[11]

The *basic needs principle* gives precedence to satisfying the basic needs of the least privileged (Paterson 1996; Godard 2000), as "what is important from the point of view of morality is not that everyone should have the same but that each should have enough" (Frankfurt 1987: 21). Basic needs are "those that must be met if citizens are to be in a position to take advantage of the rights, liberties, and opportunities of their society" (Rawls 1993: 38), including economic means and institutional rights. Basic needs may vary according to geographical region, climates, cultures and over time (Streeten and Burki 1978). Applying the basic needs principle to allowance allocation is difficult because basic needs refer to goods and services (e.g. food, housing) that may emit GHGs when produced or consumed, not to GHG emissions per se. Still, some allowance allocation schemes proposed in the literature may be compatible with this principle (Grubb 1995).

The *proportionality or responsibility principle* commands a distribution of efforts proportionate to each party's historical contribution, thereby relating to the Polluter Pays Principle, where the party responsible for the pollution is responsible for paying for the damages caused by the pollution (OECD 1975). This implies that emitters would be accountable for the impacts of global warming resulting from their cumulative historical emissions and 'natural debts' (Smith et al. 1993) and would also involve compensatory payments from wrongdoers to harmed parties. Estimating historical responsibilities is difficult—particularly as regards the date from which emissions should be accounted[12]—and the fairness of this scheme remains controversial. First, individuals who are required to pay for damages today are not those who emitted in the past, although they could be benefiting from past emissions.[13] Second, past emitters might have been ignorant of the harm done at the time: under international law they would not be considered liable for the damages incurred.[14] A set of (ex ante) schemes based on past data have been proposed, the

[9] Mitigation and adaptation capacity within each country—as determined by wealth, technologies, natural resources, institutions, human capital (Yohe 2001)—is broader than ability to pay.

[10] E.g. submissions by Poland (1997) Estonia (1996) Russia (1995) and South Korea (1997) to the Ad hoc Group of the Berlin Mandate.

[11] A general solution to the problem of who should contribute to the provision of public goods is provided by the Bowen-Lindahl-Samuelson framework (Bowen 1943; Lindahl 1919; Samuelson 1954).

[12] Using two earth-system models and CO_2 emission data series starting in 1751 (Wei et al. 2012) estimate the contribution of developed countries to the global temperature increase in 2005 to 60–80 %, developing countries contributing to the remaining 20–40 %.

[13] Today's individuals may be richer than they would have been had their ancestors not followed an emission intensive development path.

[14] In addition, the non-identity problem—i.e. the idea that today's individuals cannot be assumed to be the same individuals who would have lived in a counterfactual world with different emissions (Parfit 1984)—questions the concept of historical responsibility.

archetypal example of which is the Brazilian proposal (UNFCCC 1997).[15] Such schemes would require emission cutbacks from all countries (although more cutbacks from richer countries), which might be inconsistent with other equity principles (Grubb 1995).

Finally, some allowance allocation rules use multiple principles,[16] defining emissions allowances ex ante based on a combination of parameters, e.g. by combining per capita GDP, per capita emissions and emissions intensity of Gross GDP (Ringius et al. 1998); historical responsibilities and equal entitlements (Neumayer 2000); historical responsibilities and ability to pay (Smith et al. 1993), thus accounting for the distribution of income within countries (Baer et al. 2009).[17] Whether the resulting allowance allocation rules can be related to any above-mentioned principle is unclear.

All this implies first that different equity principles lead to different allowance allocation rules (out of an ex ante or an ex post analysis); second, even if there were an agreement on an equity principle, there is no univocal way to translate it into a specific allowance allocation rule. Conversely, one allocation rule may invoke several ethical principles: the equal per capita allocation is both egalitarian and supports the basic needs principle (Grubb 1995). Debating allowance allocation rules based on first principles only thus seems pointless; however, equity principles are a useful reference point and provide benchmarks against which proposals can be assessed.

3.2 From allowance allocation to costs: the role of uncertainty

The second difficulty of assessing distribution issues in cap-and-trade mechanisms is that the (ex post) consequences of the implementation of any given (ex ante) allowance allocation rule are uncertain.[18] As a result, even if one could agree on an (ex post) principle for the distribution of abatement efforts, it would not be possible to derive unequivocally an (ex ante) allowance allocation rule. This is due to uncertainties associated with our understanding of complex economic mechanisms, in particular the interplay between economic and energy systems.

First, uncertainties on abatement costs and on future economic conditions make it difficult to predict ex ante the price of allowances that would emerge in the market after a given allowance allocation rule is implemented. Under perfect information and with no uncertainty, imposing either a tax or a cap on emissions would yield identical outcomes. But the equivalence between price and quantity approaches breaks down with inadequate information or under uncertainty[19] (Weitzman 1974). Thus in the real world, quantities and prices cannot be known simultaneously with certainty.

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15 The Brazilian proposal allocates responsibility of climate mitigation among Annex I Parties according to the relative effect of each country's historical emissions on global temperature increase (Den Elzen et al. 2005).

16 Submissions by Norway (1996), Australia (1997), Iceland (1997) to the AGBM7.

17 These proposals follow a top–down logic. Bottom-up approaches have also been proposed, such as the Triptych proposal (Phylipsen et al. 1998) used to guide the sharing of the EU global −8 % target under Kyoto, and the Multi-Sector Convergence Proposal (Sijm et al. 2001).

18 Note that proposed cap-and-trade schemes have incomplete sectoral coverage or allow for delayed entry of some Parties. They would therefore possibly be supplemented by other measures, such as domestic tax schemes or standards targeted at specific sectors. The assessment of the economic burden of climate policy should therefore include all these dimensions, i.e. should not be limited to the quota allocation rule.

19 Decision-makers do not usually know the cheapest ways to abate emissions. Engineers do not always anticipate the evolution of production costs, due to uncertainties on future technological developments.

Second, the price of emissions allowances is not an easy indicator to assess the distributional consequences of a given allowance allocation scheme. Aggregate indicators such as variations of GDP might be more appropriate. But the relationships between a given price and such indicators are also complex. For instance, the effect of a given price of allowances on final energy use depends on the intensity of rebound effects that may follow energy efficiency improvements triggered by higher fossil energy prices (Greening et al. 2000; Sorrell and Dimitropoulos 2008)—with different implications for GDP in each case. Similarly, the macroeconomic feedbacks of imposing a constraint on GHG emissions are controversial and will depend on the way the constraint is implemented. For example, as energy production relies on fossil fuels,[20] imposing a cap-and-trade system that constrains GHG emissions is likely to increase energy prices, hence firms' and consumers' energy bills. With limited elasticities of substitution in the near-term, higher energy prices could lower economic growth (Pindyck 1979). The revenues raised from the auction of emissions allowances could be used, inter alia, to correct pre-existing fiscal distortions and then cap-and-trade might yield a 'double dividend' that partially or even totally offsets the direct cost of the policy. Still, the existence and magnitude of double dividend effects remain highly controversial (Goulder 1995).

Faced with the uncertainty surrounding the economic impacts of implementing any given allowance allocation rule, Parties tend to adopt prudent positions. The problem is that a cap-and-trade approach leaves the door open to climate policy sceptics to oppose agreement, based on their assessment of the possible high ex post abatement costs, which was a major factor in the US 2000 decision to pull out of the Kyoto Protocol.

3.3 International transfers: from rhetoric to sobering reality

Cap-and-trade approaches might entail large financial transfers across countries.[21] Proposed allocation rules (historical responsibilities, equal per capital allocation) imply smaller initial endowments for industrialized nations relative to developing ones and imply large North–South (and also South–South) transfers[22]—all the more so as models assume more abatement opportunities in developing countries. This is unlikely to be palatable to developed countries and "no international agency can coerce countries to comply with a climate change agreement they find significantly inconsistent with their national interest" (McKibbin and Wilcoxen 2002: 115). Canada faced high domestic abatement costs under the Kyoto Protocol, while Russia, had emissions allowances in excess of its actual emissions (Paltsev 2000). To meet its Kyoto target, Canada could thus have bought this so-called 'hot air'. The current Harper government withdrew from the Kyoto Protocol in 2011 to avoid buying C$ 14 billion of carbon credits on the international market, partly because these credits were regarded by many as 'illegitimate' because resulting from an economic slowdown and not from targeted efforts to

[20] In 2010, fossil fuels (coal, oil, gas) represented over 80 % of World primary energy demand (IEA 2012).

[21] This section focuses on international transfers entailed by the implementation of an allowance allocation rule in the context of a cap-and-trade mechanism. North–South financial transfers may also be used as a way to help vulnerable countries adapt to the harmful effects of climate change, for instance through the Adaptation Fund under the Kyoto Protocol.

[22] Lecocq and Crassous (2003) show that a per capita allocation would result in significantly larger North–South money transfers than grandfathering and contraction and convergence schemes.

abate emissions,[23] and partly because its implications in investment flows to foreign countries. This points to the difficulties of organizing international transfers, especially in times of economic crisis and financial austerity when Northern citizens view themselves as victims of globalization.

4 Broadening the scope to development pathways might improve chances of agreement on distribution issues

Since the cap-and-trade framework is not conducive to negotiating distribution, we now broaden the discussion. We argue that sustainable development is a multi-objective problem which includes climate mitigation and adaptation (Sathaye et al. 2007). Aside from the Small Island States whose existence is threatened, no country sees climate change as sufficiently acute to forfeit other, pressing development goals. Countries thus make trade-offs between these different objectives. The linkages between development objectives—including health, education, wealth, social inclusiveness—and GHG emissions are not rigid relationships. Emissions originate from the complex interplay of resources, technologies and behaviours, and are a co-product of the wider economic system. There is no conclusive relationship between per capita GDP and emissions to test the so-called 'environmental Kuznets curve' hypothesis (Dinda 2004). Similar levels of growth can support different GHG emissions patterns. For instance in the 1970s, France, Western Germany, Italy and Japan, four countries with similar levels of development, responded to the first oil shock in different ways. While France turned to energy efficiency and nuclear power and used its exchange rate to reduce the burden of oil imports, Western Germany compensated its trade balance deficit in the energy sector by increasing industrial exports, and Italy and Japan moved away from energy-intensive sectors, while the appreciation of the Yen and Lira lowered energy import bills. This halved the French CO_2 intensity of GDP, reduced it by a third in Japan and a quarter in Germany between 1971 and 1990. However, these countries showed very similar macroeconomic performances in the early 1990s, which suggests that very different emission pathways can be obtained with very similar macroeconomic performances. These outcomes were driven by pre-existing technologies and country institutions (Hourcade and Kostopoulou 1994; Sathaye et al. 2007). This does not imply that a given country can reduce its emissions at no or little welfare cost. However, the mechanisms that underlie the observed differences open up three complementary directions to broaden the perspective.

First, real economies are rarely Pareto-efficient. In a world with perfect information, efficient markets and no externality, markets would lead to the efficient allocation of resources (which is unique given initial endowments) as rational agents maximize global welfare, while they pursue their own interests. But in the real world with inefficient markets externalities persist if only because policy reforms are likely to be resisted if they benefit a large but diffuse group but adversely affect few but well-organized individuals. Even strictly Pareto improving reforms may be opposed, due to the lack of confidence from stakeholders about commitments from government, sub-optimal bargaining in the case of imperfect information, and uncertainties about the consequences of these policies (Stiglitz 1998). When economies are on an efficiency frontier, improving along one policy objective

[23] This is despite Russia's promise to invest the trading money from its spare permits in clean energy projects (Pearce 2000).

implies losing against another. But when economies are within the efficiency frontier, well-designed policies can improve along two policy objectives or more at the same time (Hourcade 1996). For example, correctly internalizing the externalities of SO_2 emissions on health may shift electricity generation away from coal; removing economically inefficient fossil fuel subsidies may also reduce GHG emissions; and improving insufficient energy security might be best achieved, in some cases, through the development of domestic renewable resources.[24] Of course, such moves benefit all only to the extent that the current situation is sub-optimal with regard to the other (non-mitigation) policy objective. If the other externality is already correctly internalized, one can reduce it even further, but with a loss of welfare, not a gain. In addition, the political economy reasons explaining why these externalities exist in the first place constitute as many obstacles to achieving win–win reforms, though the recognition of gains in the climate mitigation arena might help.

Second, the multiplicity of development pathways stems in part from cumulative effects in the dynamics of energy systems. As a result, energy systems are path dependent (Arthur 1989): Initial differences in economic, social, institutional or geographical factors can be subsequently sustained by different economic structures and result in different technological systems, spatial structures and consumption patterns (Grübler et al. 2012). For instance, some specific energy technologies may enter the market at an early stage if the initial conditions and policies are favourable. These technologies may perform better with cumulative experience—coming down the learning curve—and thus lock the system on a particular technological pathway, as other technologies become unable to compete. Modelling exercises that capture cumulative effects have shown that energy systems could evolve along high- or low-carbon pathways at similar overall system costs (Gritsevskyi and Nakićenovic 2000) even in the absence of dedicated climate policies. Similarly, cumulative mechanisms (e.g., economies of agglomeration) lead to path dependency on the energy demand side. The fact that there *can* be pathways with similar levels of welfare and very different levels of emissions does not mean that one can easily *transition* from one pathway to the other. In fact, the same cumulative mechanisms that generate different pathways also make transitions complex and sometimes very costly or impossible (lock-in). For example, shifting from individual to collective passenger transport when city density is too low soon becomes economically unattractive. Similarly, premature retirement of long-lived fossil fuel power plants bears important economic costs. Still, transitions between pathways can occur over time, when the opportunity to rebuild the system, introduce a new technology or take a different direction arises. Though when it opens, the window of opportunity might be short-lived in some cases, and require large investments as networks of long-lived capital stock are often developed in a lumpy way (Shalizi and Lecocq 2010). For example, half of the French nuclear power generation capacity was built in 10 years. When these units retire (presumably at similar time), a large window of opportunity will open to change the electricity mix in the country.

Third, many developing countries, particularly Least Developed Countries (LDCs), have the twin characteristics of low emissions and low development indices. For LDC governments, creating the conditions for accelerated economic growth and broad-based improvements in human well-being will remain the main driver of national development policies (Victor et al. 2014). The question is whether it is possible to expand critical

[24] It might be impossible to think of development paths for each country independently, without accounting for general equilibrium mechanisms. For instance, removing inefficient fossil fuel subsidies worldwide may alter the functioning of fossil fuel markets, which may affect emission intensity.

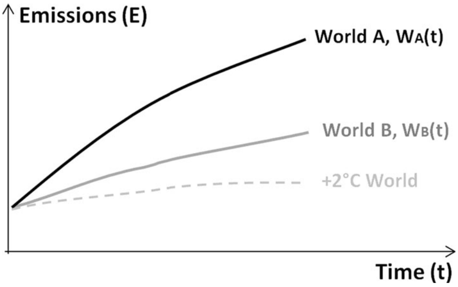

Fig. 1 Different development pathways. *Source*: own diagram

infrastructures for development with reasonable growth of future GHG emissions and lower mitigations costs. Within climate change negotiations, Nationally Appropriate Mitigation Actions (NAMAs), as termed in the Bali Action Plan, allow developing countries to embark on low-carbon development pathways. Within this framework, developing countries may receive international support in the form of financing, technology or capacity building. More generally, African countries like Ethiopia, Rwanda and Ghana have developed ambitious growth plans alongside some bold climate strategies (Ministry of Finance and Economic Development (MoFED) 2010; Ministry of Finance and Economic Planning (MINECOFIN) 2012; Government of the Republic of Ghana (GRoG) 2010). These efforts have been lauded as some of the positive ways to align development and climate policies that may influence the tenor and direction of future climate negotiations.

This suggests that combining policies addressing non-climate externalities and policies targeting path-dependent sectors (as windows of opportunities open up) could yield similar or even possibly higher welfare than the default baseline, while emitting less. Let us imagine two possible future development paths (Fig. 1). World (A) assumes no particular measure to correct for existing externalities or to weigh in on path-dependent sectors: high emissions (E_A) prevail, and W_A is the global welfare over time. World (B) assumes policies to correct these externalities at the regional or national levels, regardless of climate change concerns, and policies targeted at path-dependent sectors. The evidence gathered suggests that it is possible to imagine a world where $E_B < E_A$ while W_B is very similar to W_A, or even superior to W_A. Of course, there is no reason a priori why emissions, even in World B would be conveniently at the level required to internalize the climate change externality.[25] So abating emissions might still be necessary even in World B, see for instance (Shukla et al. 2008) for the case of India. But at least the amount of abatement necessary to achieve a given climate target—the effort required to reach the dashed line—would be smaller in World (B) compared to World (A). Whether the costs would also be smaller is another matter, as it depends on the abatement opportunities left in World (B) relative to World (A): World (B) could either have fewer remaining affordable mitigation options compared to World (A), or new options could that would not have been available in World (A).[26]

[25] Note that the terms of the cost–benefit analysis may have changed in World (B), and the new optimal response may be to stabilize global warming to a lower target, simply shifting the issue in time.

[26] For instance the development of cities in combination with transportation systems as a way to anticipate congestion issues in World (B) would result in lower CO_2 emissions, but would also lower the additional cost of further abatement compared to World (A), where few substitutes to private cars are likely to exist as in Barcelona and Atlanta (Bertaud and Richardson 2004). Retrofitting the metro in Atlanta to allow for the same type of mobility as in Barcelona would indeed be very costly.

It might be argued that pricing carbon (e.g., via a cap-and-trade approach) might be sufficient to reduce other non-carbon externalities, and to induce the right choices in path-dependent sectors. While partly true as non-climate policies can have co-benefits in terms of mitigation, cap-and-trade policies can have co-benefits in achieving other objectives.[27] Similarly, to the extent emissions caps can be set up in advance with sufficient credibility, a cap-and-trade policy impacts on investment choices. Still, pricing carbon alone is unlikely to be sufficient to trigger this transition due to policy uncertainty on carbon prices (Blyth et al. 2007), myopic expectations from decision-makers (Waisman et al. 2013), lack of capital to finance investments in projects or networks (Shalizi and Lecocq 2010) or inconsistencies between the technical characteristics of sectors and market structures (Finon 2013). Hence the need to align 'pure' climate policies and development policies that remove externalities and weigh in on path-dependent sectors. Though the balance and interactions between these three sets of policies remains to be studied, we assume that climate policies supplement development policies, not the other way around. More explicitly, negotiators could discuss emission control under the constraint of achieving predefined national development goals. However, taking development goals as constraints could mean that negotiations are so encompassing that they may never lead to an agreement on development targets, let alone emissions targets.

If one were to reframe international negotiations to explicitly discuss development pathways, and not just climate mitigation, how would this approach perform against the difficulties mentioned in Sect. 3? Distribution issues would not disappear. Broadening the framework may complicate the discussion, as equity or fairness must now be judged against multiple dimensions (not just mitigation costs). Nevertheless, countries would then discuss what really matters for them (development paths), and not a limited subset of the problem (climate mitigation). Increasing the dimension of the negotiation space may improve the chances of finding bargains acceptable by all Parties with losses in some dimensions, but gains in others.

The uncertainty on mitigation costs will not disappear. Large infrastructure decisions will still be required, and decision-makers may be reluctant to embark on a radically different development path. However, the level of abatement required from 'purely climate' policies would be smaller, and therefore the cost of climate mitigation would presumably be lower, hence more acceptable. Finally, there may well be global conditions under which the (preferred) national development paths can emerge (e.g., some form of international guarantee on energy supply, some form of technology diffusion, etc.) that could be mutually beneficial.

Fundamental difficulties in terms of the economic effectiveness and political acceptability of financial transfers will remain, though in a broader negotiation, transfers to purchase allowances in another country might be compensated by other benefits. Financing the non-climate components of the deal would also require significant financing. However, these measures would respond to local challenges. They would not be directly associated with the provision of global public goods and may therefore involve refundable international transfers. In fact, the emerging literature on financing low-carbon investments makes the point that the separation between the carbon- and the non-carbon-components of

[27] Note however that in some cases, climate change mitigation measures may have adverse side effects as regards other environmental issues. While the co-benefits of climate change mitigation outweigh its adverse side effects in energy end-use sectors (transport, buildings and industry), this may not always be the case for energy supply (Fleurbaey et al. 2014).

investment finance is artificial, and what matters is to which extent carbon-related incentives can have an overall leverage effect (Hourcade et al. 2012).

The issue here is that there is no guarantee that the current round of negotiations will be successful. This outcome could politically paralyse future negotiations and undermine the prospect for building common platforms for action. Recasting the climate narrative away from emissions reduction targets (through cap-and-trade) towards country-specific development objectives may allow countries to integrate concrete outcomes into their negotiations repertoire such as widening energy access, infrastructural development and developing an integrated approach to food security. Our proposal gives some insights on what could constitute a way forward to recast negotiations from a development perspective. However, further work is required to sketch a fully operational alternative to climate-focused negotiations. In practice, different countries may face different issues for orientating their development paths. Climate mitigation options and support for key development policies should be therefore discussed jointly in each specific case. Though not always the limiting factor, financing—and not just for the additional investment costs associated with low-carbon technologies—is likely to be a key issue, requiring innovative strategies.

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