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Summary

The EU has a consolidated climate and energy regulation: it played a pioneering role by adopting a wide range of climate change policies and establishing the first regional Emission Trading Scheme (EU ETS). These policies, however, raise several concerns regarding both their environmental effectiveness and their potentially negative effect on the economy, especially in terms of growth and competitiveness. The paper reviews the European experience in order to understand if these concerns are supported by quantitative evidence. It thus focuses on key economic indicators, such as costs, competitiveness and carbon leakage as assessed by quantitative ex-ante and ex-post analyses. A dedicated section, extends the investigation to the potential extra-EU spillover of the EU mitigation policy with a particular attention to developing countries. The objective of the paper is to highlight both the limits and the opportunities of the EU regulatory framework in order to offer policy insights to emerging and developing countries that are on the way to implement climate change measures. Overall, the European experience shows that the worries about the costs and competitiveness losses induced by climate regulation are usually overestimated, especially in the long term. In addition, a tightening climate policy regime in the EU might in fact negatively impact developing countries via deteriorated trade relations. Nonetheless it tends to facilitate a resource relocation that if well governed could be beneficial to those countries where the poor are mainly involved in rural activities.

Keywords: Climate Change, Climate Policy, Mitigation, Economic Impacts, GDP, Competitiveness

JEL Classification: F64, H23, O44, O52, Q54, R11

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Economic implications of EU mitigation policies: domestic and international effects

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Abstract

The EU has a consolidated climate and energy regulation: it played a pioneering role by adopting a wide range of climate change policies and establishing the first regional Emission Trading Scheme (EU ETS). These policies, however, raise several concerns regarding both their environmental effectiveness and their potentially negative effect on the economy, especially in terms of growth and competitiveness. The paper reviews the European experience in order to understand if these concerns are supported by quantitative evidence. It thus focuses on key economic indicators, such as costs, competitiveness and carbon leakage as assessed by quantitative ex-ante and ex-post analyses. A dedicated section, extends the investigation to the potential extra-EU spillover of the EU mitigation policy with a particular attention to developing countries. The objective of the paper is to highlight both the limits and the opportunities of the EU regulatory framework in order to offer policy insights to emerging and developing countries that are on the way to implement climate change measures. Overall, the European experience shows that the worries about the costs and competitiveness losses induced by climate regulation are usually overestimated, especially in the long term. In addition, a tightening climate policy regime in the EU might in fact negatively impact developing countries via deteriorated trade relations. Nonetheless it tends to facilitate a resource relocation that if well governed could be beneficial to those countries where poor are mainly involved in rural activities.

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Disclaimer

This is work in progress. Its dissemination should encourage the exchange of ideas about issues related to climate change mitigation and economic development. The findings, interpretations and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the funding institutions or those of the institutions that are part of the research consortium.

1. Introduction

Climate change became a key part of the European Union's policy since the early '90s when, on the wake of the Rio 1992 summit, a first set of widespread measures to mitigate greenhouse gases (GHGs) emissions started to be implemented at national and regional levels. In fact, early measures tackling fossil fuel use can be tracked well before, back to the first decades of the 20th century. However, they consisted mainly (a topical example is the 1924 petrol and diesel tax in Sweden) in domestic energy taxes levied with the main purpose to raise revenues. Since the beginning of 1990s, Environmental Tax Reforms (ETR) were gradually introduced in a number of European countries, including Sweden, Denmark, The Netherlands, Finland, Slovenia, Germany and UK, as an explicit mean to achieve environmental, together with economic and social objectives. In 1996, the EU officially embraced the long-term climate protection target suggested by the scientific community - the 2°C limit (European Union Council, 1996) - which was subsequently reaffirmed in a number of policy documents. One year after, the EU signed the Kyoto Protocol committing to reduce GHG emissions by 8% compared to 1990 level under the "first commitment period" (2008 – 2012). Functional to these goals, the Union, while increasing its leadership in post-Kyoto international climate negotiation rounds, adopted a wide range of domestic policies and established in 2005 the world's first regional Emission Trading System (EU ETS). In 2008, through the so called 20-20-20 package, the EU renewed its commitment and launched an "integrated approach" to climate and energy policy with the objective to transform Europe into a low carbon economy. In particular, Member States agreed to cut their overall emissions by at least 20% by 2020, as compared to 1990 levels. This target is being implemented through three main measures: stronger efforts under the ETS, support to renewable energy sources, and energy efficiency improvements. In 2010, with the aim to better integrate its climate change with economic development objectives, the EU launched the 'Europe 2020 Strategy' for a 'smart, sustainable and inclusive growth'. Specific flagship initiatives are meant to support high levels of employment, productivity and social cohesion, also by promoting the decoupling of economic growth from the use of resources (Resource Efficient Europe) and developing a strong, sustainable and competitive industrial base (an industrial policy for the globalization era). In 2011, as part of its long-term vision, the European Commission released 'A roadmap for moving to a low-carbon economy in 2050', which sets a further emission reduction's objective of 80-95% by 2050, as compared to 1990 levels. Now, in 2015, five years ahead of the 2020 deadline, and as a step towards 2050 target, the European Union is setting the stage for its low carbon strategy for 2030 with the objective of integrating and enhance synergies among economic and environmental aspects.

The EU climate policy has been periodically examined both prospectively and retrospectively (see Laing et al., 2013; Oberndorfer & Rennings, 2007;). One of the main, and most obvious, indicators of its effectiveness is the extent of the achieved/achievable emissions reduction. Noteworthy, the EU seems to be on track towards achieving its mitigation target. Having fulfilled as a whole those of the Kyoto first commitment period, it is in fact expected to reach larger reduction than planned also relatively to domestic targets that are estimated to be in the range of 24 – 25%, in 2020 (EEA, 2015). However, there are other aspects in addition to effectiveness, to consider. A major, and much debated concern, remains the broader effects of EU mitigation policies on the EU economic growth and competitiveness.

This paper, focuses on this issue. In what follows: section 2 characterizes and briefly comments the potential economic feedbacks triggered by mitigation policies inside and outside the borders of an implementing country or groups; section 3 summarizes the empirical evidence of these effects focusing on the EU mitigation policies. The section introduces first the insights from ex-ante analyses based upon different macro-economic modelling exercises, then discusses the results from the rather narrower literature conducting ex-post empirical assessments. A dedicated section is devoted to the description of potential spillovers of the EU mitigation policy with a particular attention paid to developing countries. Finally, section 4 concludes.

2. Domestic and international effects of mitigation policies. The theoretical background

The primary aim of climate change mitigation policies is to curb GHG emissions to reduce the associated negative environmental externality. This can be achieved using market based instruments, like carbon/energy taxes, command and control, like emission quotas, and cap and trade systems that can be considered an hybrid between the former and the latter. Each of these mitigation instruments lead, more or less directly, to an increase of the production cost, and eventually, of the relative price of carbon-energy intensive commodities, discouraging their use. As a consequence, the environmental regulation is expected to negatively affect production and profits of the fossil fuel-energy intensive industries subjected. This effect can be strengthened further in open economic systems, where demand and supply can adjust also internationally in response to price signals.

This is the "carbon leakage", which has primarily an environmental content: it denotes an increase in GHG emissions in those countries not subjected to or non-adopting strict emissions control, as a reaction to the emissions reduction by a country or group.

The literature identifies three main causes for the carbon leakage (Reinaud, 2008)[1]:

1) Carbon intensive industries located in the countries adopting strict emission standards can de-locate production in non-regulated countries to keep on producing at lower costs, using less carbon/energy efficient technologies (pollution heaven);

[1] Bosetti & De Cian (2013) identify also a "free rider effect" in determining leakage dynamics: non-constrained countries can increase their emissions in response to emission reduction elsewhere as they may perceive climate change becoming less threatening .

2) The demand by both domestic and international consumers may shift away from more expensive "clean" goods towards "dirtier" and cheaper substitutes produced in non-regulated countries.

3) If the mitigation policy induced a sufficient contraction of fossil fuels demand, this could, on its turn, reduce fossil fuels price and provoke a "rebound" in non-regulated countries leading to increased fossil fuels use and GHG emissions.

Carbon leakages are detrimental under the environmental view point as they undermine the effectiveness of unilateral-uncoordinated emission reduction effort. They are also of a more direct economic concern as they reveal a policy-induced loss of international competitiveness of the regulated carbon/energy intensive sectors that can affect the country economy as a whole.

In this simplistic scheme, a mitigation policy would always entail costs for the implementing countries, and benefits, in the form of competitive gains, for the non-regulating countries. Continuing with the simplification, and assuming that weaker mitigation commitments characterize low income countries, these could be expected to gain from climate change policies implemented in developed countries.

However the literature also emphasizes growth and competitiveness enhancing opportunities offered by mitigation policies. Perhaps the most popular, discussed theoretically, and analyzed empirically is the "Porter hypothesis" (Porter & van der Linden, 1995). It states that a stringent, but well-designed environmental regulation may lead to increased innovation, productivity and competitiveness with the potential to partially or more than offset the cost of policy compliance.

At the basis of the Porter hypothesis rests the idea that "excessive pollution" is a signal of inefficient use of resources. Therefore, a policy correcting for that, could move the entire production system closer to the efficiency frontier with net gains over the policy costs. More precisely, Porter and van der Linden (1995) quote five virtuous effects that can be triggered by environmental/mitigation regulation:

✓ it signals companies where likely resource inefficiencies and potential technological improvements are;

✓ when focused on information gathering, it can achieve major benefits by raising corporate awareness;

✓ it clearly signals that investments to address the environment are valuable, therefore reducing the uncertainty;

✓ it creates a dynamic incentive towards innovation and progress;

✓ it levels the transitional playing field.

Without invoking the Porter hypothesis, however, there are other effects that may contribute to limit the leakage effects and blur the dichotomy between developed-mitigating-losing countries and developing-non mitigating-winning countries.

Firstly it is important to distinguish between competitiveness effect at the industry and at the country level (Ekins & Speck, 1999). While a sector shrinks, others in the economy can expand due to a relocation of production factors and resources. The result is that the country performance is affected differently than the firm performance even though relocations can remain costly, and, during the transition phase, increased unemployment can be experienced.

Secondly, competitiveness effects channeled through international trade relations, have to be analyzed in their entirety, not just under the narrower perspective of energy or carbon intensive import-export. Accordingly, a GDP contraction in developed countries induced by the mitigation policy likely translates into a decrease in the aggregated demand, including also that of goods exported by developing countries. This "income effect" can thus smooth the substitution effect triggered by changes in relative prices. Furthermore, a decrease in fossil fuel prices has not univocal effects on developing countries. It can be beneficial if the developing non mitigating country is a net energy importer, but can conversely worsen its trade balance and GDP if, like Nigeria or Indonesia, it is a net energy exporter. These effects thus shift part of the compliance burden outside the mitigating countries, especially toward net energy exporters.

Thirdly, mitigation policies are more articulated than the "simple" imposition of taxes, quotas or emissions trading. On the one hand, there are different ways in which all these schemes can be implemented. On the other hand, they are typically composed by a rich package of policy objectives and measures that can play a non-negligible role in determining the distribution of cost and benefits across sectors and countries.

In this vein, revenues from carbon-energy taxes can offer the possibility to shift the burden of taxation away from capital or labor toward pollution to increase growth and/or employment through a less distortionary tax system, in addition to the environmental benefit. Potential for this "double" or even "triple" dividend from green tax reforms fostered huge applied and theoretical research and a still unsettled debate (see e.g. Bosello et al. (2001), Schob (2003), Jaeger (2012) for surveys). Similar considerations apply to the alternatives to auctioning or grandfathering emission allowances in a cap-and-trade system (see Cramton & Kerr (2002) for a detailed discussion). The latter, consisting in allocating emission credits for free to the regulated sectors, is typically invoked as a means to reduce the compliance costs and competitive losses. However, the former too could produce benefits to (or lower costs for) the mitigating economies through a proper use of auction revenues. Cap-and-trade systems themselves can allow for different degrees of flexibility. Most obviously, the possibility to involve in the abatement effort countries without binding commitment, allows abating countries to exploit lower-cost abatement options abroad and reduce the abatement burden for domestic firms. This kind of flexibility is exactly what the Kyoto Clean Development Mechanism tries to achieve. The recipient countries should on their turn benefit from increased trade (in CERs) FDI, financial inflows, skills and technology transfer, all of which can stimulate growth.

Turning to specific mitigation measures, some can potentially play a relevant role to channel internationally the economic effects of mitigation policies. Two topical examples are the expansion of biofuels and the reduction of deforestation. For instance, particularly ambitious de-carbonization targets for the transportation sector in a sufficient number of countries, could determine an increase in world demand and prices of biofuels. This would benefit major biofuel producing countries. Nonetheless, due to the crop for food versus crop for fuel competition, biofuel exporters could experience a negative rebound on welfare should they be or become net food importers and food prices also boomed. Similarly, regions with large forestry resources, can greatly benefit from reducing their deforestation activities if they were allowed to sell the resulting reduced emission to abating countries. But, it is worth recalling that, at least in principle, a booming in reduced deforestation credit (and of biofuel) exports may have its shortcomings too. Huge foreign payment inflows can lead to an appreciation of the real exchange rate with loss of competitiveness of the exporting countries. This is the "Dutch disease" phenomenon that in the longer term could also lead to an undesired contraction of the manufacturing sectors crowded out by the expanding resource-based sectors.

Finally, countries adopting strict mitigation policies may implement explicit tariff measures in order to level the competition field and offset the potential competitive advantage of countries with loose environmental standards. These are the so called Border Tax Adjustments (BTAs), consisting in taxes based upon the carbon content of foreign commodities, levied when these cross the borders, with the aim to increase the cost and reduce the demand of imported energy intensive products. BTAs are thus expected to reduce the competitiveness losses related to mitigation policies. But this will also affect negatively the welfare of the exporters of energy intensive goods, including that of developing countries when this is the case. Once again, non-mitigating developing countries which are net importers of those commodities and do not implement BTA could benefit if the price of their import are driven down by the contraction of global demand.

In conclusion, the multiplicity of effects triggered by uncoordinated mitigation policies and their strict interdependence make it difficult to clearly disentangle a-priori winners and losers among implementing and non-implementing countries and among developed and developing countries. Final welfare effects depend upon many variables characterizing mitigation policy design and country specificities that should be tested empirically.

This evidence is discussed in the next sections.

3. The effects of EU mitigation policies. The empirical evidence.

The empirical literature on mitigation policies, the competitiveness effects, and associated carbon leakage, is wide. It can be distinguished into two main streams of research. The first, and ampler, includes "ex ante" modelling studies that attempt to forecast the costs and competitiveness impacts of one or a set of future environmental measures (in the case of the European Union, typically the 20-20-20 targets). These studies are conducted at the country or EU-wide level, at the sectoral level or at the business level. These last typically focus on the firm location, productivity/production, innovation, trade or investment choices. A second, and rather narrower stream of studies, analyses ex post, usually with econometric techniques, the effectiveness and consequences of environmental tax reforms already adopted in specific countries or, more recently, the consequences of the first phases of the EU Emission Trading System.

3.1. Impact on the EU: Results from “ex-ante” modelling assessments

The first, crucial interest in this context is to determine the costs related to the introduction of carbon pricing in Europe. The issue is certainly not new to the modelling community, engaged in these kind of exercises since the first mitigation targets were set during the 1992 Rio conference (see e.g. IPCC 1996). More recently, several efforts have been devoted in understanding the economic consequences of the different aspects of the EU 20-20-20 climate and energy package.

The literature (see Table 1) agrees that the GDP cost in the EU could be rather limited especially if full flexibility across sectors were allowed. Therefore, the decision to split the carbon market across ETS and non ETS sectors seems to introduce high inefficiencies that drive up compliance costs. Peterson and Klepper (2008), for instance, foresee a EU GDP loss of 0.2% in 2020 under an efficient and all-encompassing allowance scheme with a peak between 0.7-1.2% in the Netherlands. Eastern European regions, with excess emission rights, would even gain from the EU ETS. Assuming, however, trading only among the ETS sectors and uniform national carbon taxes across non-ETS sectors the average loss rises to 1.6%. Similarly, Bohringer et al. (2009), comparing the results from three general equilibrium models (DART, PACE, Gemini-E3) find that under full efficiency the EU target for 2020 may lead to a EU27 welfare loss in the range of 0.5–2.0% compared to the BAU. Differentiated carbon prices, for the ETS and the non-ETS sector, could increase costs by 50%, while a regional price for the ETS and a national non-ETS price for each Member State, could increase costs by another 40%. The further addition of the target on renewables raises the policy costs by 90%. Overall, inefficiencies in policy lead to a higher cost in the range of 100-125%. Small negative costs are also estimated by a study of the European Environmental Agency (2011), which combines the ETS with a carbon tax for non-ETS sectors in EU-27 Member States. Impacts on GDP of meeting the 20% emissions reduction target in 2020 would be 0.57% at the most. The European Commission itself published detailed analyses of the 20-20-20 policy with a set of top-down and bottom-up modelling tools (EC 2008, EC 2010). The estimated direct costs of the policy is roughly 0.6% of GDP in 2020 assuming pre-2008 growth rates (European Commission, 2008) and could drop to 0.34% of GDP accounting for the 2008 economic downturn (European Commission, 2010). Somewhat higher policy costs are estimated by Alexeeva-Talebi et al. (2012), which implicitly warn on the use of GDP as a measure of the economic consequences of the policy. Welfare losses – measured as reduction in real consumption – of unilateral 20% and 30% emission reduction in the EU can be as high as 1.6%, and 2.5% respectively.

The picture can substantively change when EU abatement effort is backed by emission reduction commitment outside the EU. Peterson et al. (2011), consider the EU emissions reduction target in the wider international mitigation framework depicted by the Copenhagen Accord. In this case they note that the EU could experience an increase in GDP. Bosello et al. (2013) find similar results: the EU wide GDP contraction amounts to roughly 0.56% in 2020 if the EU acts alone to pursue its 20-20-20 targets, but in a Copenhagen context, GDP gains of 0.12% can be experienced. The main driver of these results are the EU relatively lower energy and carbon intensities. These dampen the effect of a higher cost of CO2 emissions on energy prices and make EU firms more competitive, leading to increases in output.

Table 1. Macroeconomic costs of EU emission reduction target from different modelling exercises

Reference	Policy	Model	
Klepper and Peterson, (2008)	EU 20% target	CGE (DART)	0.2% - 1.6% GDP loss in 2020
EC (2008)	20-20-20 package (pre-crisis)	bottom-up energy (PRIMES)	0.58 – 0.61% GDP loss in 2020
		CGE (GEM-E3)	0.54% GDP loss in 2020
Boehringer et al., (2009)	EU 20% target	CGE (DART, PACE, Gemini-E3)	0.5–2.0% GDP loss in 2013 – 2020. Fragmentation increases the cost by 50% - 90%
EC (2010)	20-20-20 (post-crisis)	bottom-up energy (PRIMES)	0.32% GDP loss (global EU-27)
EEA, (2011)	EU 20% GHG target	E3ME and GINFORS	0.04 – 0.57% GDP loss in 2020
Peterson et al., (2011)	EU 20% target+ Copenaghen Pledges	DYE-CLIP	≈ 0.1% GDP gain in 2020
Alexeeva-Talebi et al., (2012)	EU emission reduction target (up to 30%)	CGE	1.6 – 2.5% reduction in real consumption (20% - 30%)
Bosello et al., (2013)	20-20-20 package	CGE (ICES)	0.56% GDP loss in 2020
	20-20-20 package + Copenaghen Pledges		0.12% GDP gain in 2020

Findings are more nuanced and differentiated at the sectoral/firm level (Table 2). Overall, modelling research highlights that decarbonization effort induces a structural change that can affect costs and competitiveness of energy-intensive sectors, in particular aluminum, much more than the country as a whole. However, it also shows that sectoral trading schemes, tax differentiation and permit allocation criteria, are important to dampen sectoral losses. The literature also points out the existence of a trade-off: typically gains at the secoral level translate into efficiency losses for the overall economic system with increases in total policy costs. In their survey on the sectoral effects of the EU Emission Trading System, Oberndorfer & Rennings (2007) conclude that, if well designed, ETS greatly reduces, and in some cases eliminates, adverse sectoral competitiveness effects. Alexeeva-Talebi et al. (2012) show that pronounced tax differentiation in favor of carbon-intensive industries can largely neutralize the negative impacts of emission constraints on their competitiveness, but also worsens the overall efficiency shifting adjustment costs of emission abatement to energy-extensive sectors, deteriorating their ability to compete and in fact doubling overall policy cost. Accordingly, the authors suggest that a moderate tax differentiation would sectorally balance competitiveness effects of emission reduction policies and at the same time limit overall efficiency losses. In a similar vein, Bosello et al. (2013) demonstrate that grandfathering rather than auctioning emission permits to the ETS sectors reduces sectoral compliance costs by 80%, but increases the total cost for the EU economic system by 9.5%.

Other measures to offset negative competitiveness effects are border tax adjustments (BTAs) - also referred to as border carbon adjustments (BCAs) or embodied carbon tariffs (ECTs). The literature on this topic agrees on the positive effects of BTA for the protected sectors (see for example Demailly & Quirion,2005;Mathiesen & Maestad.2002), but the potential net effects on the GDP of countries implementing this policy seem of a quite small entity and not necessarily positive. Thus some authors conclude that BTAs are ultimately not worth the complex administrative costs of implementation (Veenendaal and Manders, 2008; McKibbin and Wilcoxen, 2009).

Table 2: Sectoral competitiveness effects of the EU ETS (vs BAU or no trade scenarios)

Reference	Model	Effects on competitiveness: policy with emission trading vs BAU
Klepper and Peterson (2004)	CGE (DART)	Negative effects: effects overall, output −0.3% Negative effects: energy sector, output −2%
COWI (2004)	CGE (GTAP-ECAT)	Negative effects: effects overall, output −0.36% (−0.48% with sluggish technology adaptation)
Reinaud (2005)	Partial equilibrium model	Most sectors: very small and diverse effects Negative effects: aluminium industry, costs +3.7%, demand −2.9%
Smale et al. (2006)	Cournot oligopoly model	Positive effects: cement, printing, petroleum, steel, positive effect on earnings Negative effects: aluminium industry, −100% earnings
Alexeeva-Talebi et al. (2012)	CGE	Negative effects: energy intensive sectors output −6% Negative effects: mineral oil industry output − 25%

Bosello et al. (2013)	CGE (ICES)	Negative effects energy intensive sectors: -1.5% output Negative effects non ETS sectors (- 0.3) and ETS sectors – (2%)(excl. energy)
Reference	**Model**	**Effects on competitiveness: policy with emission trading vs policy without trade**
Capros and Mantzos (2000)	Bottom-up energy (PRIMES)	Positive effects: abatement costs −25% on average
IPTS (2000)	Bottom-up energy (POLES)	Positive effects: abatement costs −25% on average
ERM and Eurelectric (2002)	Bottom up energy market model (GETS 3)	Positive effects: abatement costs −80.5 billion € (maximum)
Klepper and Peterson (2004)	CGE (DART)	Positive effects: effects overall, small output growth Positive effects: energy sector, output +3%
Böhringer et al. (2005)	Partial equilibrium model (SIMAC)	Negative effects: compliance costs +400% (actual NAPs, costs accrue mainly in non-participating sectors)
Kemfert et al. (2005)	CGE (GTAP-E)	Positive effects: abatement costs −98% (maximum)

Source: our adaptation from Oberndorfer and Rennings (2007)

Strictly related to competitiveness, are the carbon leakage effects. This area highlights a great variability of results , and some difficulty of drawing clear cut conclusions, partly due to the different methodologies, targets, and assumptions (e.g. the importance of energy and trade elasticities) underpinning the different studies. However, a useful attempt to quantify the growing research on the topic, is the meta-analysis from Branger & Quirion, (2014) conducted on 310 estimates of carbon leakage ratio. Their results show, somewhat at odds with the small GDP losses estimated for the EU policy, substantive carbon leakage that in the case of EU unilateral abatement range from 3% to 33%. The authors also estimate the impacts on leakage of BTAs, which seem to reduce the effect on average by 21% in the case of a “light” intervention or by 52% if a “strong” BTA is considered. Further insights on the sectoral characterization of leakages are provided by the survey from the Öko-Institut (2013): these seems to be then particularly high for the cement sector, assessed to range from 19 to 73% if no countermeasures are implemented, 9% in the case of output-based allowances allocation (current production) and 50% with grandfathering allocation. As for other sectors exposed to the risk of carbon leakage, estimates for iron and steel sector ranges between 35 – 40% while aluminum sector’s leakage rates are at 20% (Öko-Institut, 2013).

3.2. Impacts on the EU: Results from “ex-post” economic analyses

A first strand of ex post literature analyses the effects of Environmental Tax Reforms (ETRs) that some, mainly Northern European, countries started to implement in the early 1990s. Then, with the adoption of the European Emission Trading System, an increasing attention has been paid in assessing the impacts of the EU carbon pricing. Notwithstanding the analytical difficulties induced especially in the latter case by relatively short time series available, both study streams, suggest in most cases low competitiveness losses and leakage effects. In particular, it is shown that revenue recycling mechanisms can be very effective in counterbalancing the potentially negative effects of the tax.

This is for instance the result by Ekins (2007) that investigates the impacts of the ETRs in Denmark, Finland, Germany, Netherland, Slovenia, Sweden and UK in the period 1994 – 2012 with the macroeconomic E3ME model. In the absence of revenue recycling mechanisms, the ETR leads to a net loss of output in all examined countries, except Finland[2]; an increase in fuel prices, and a reduction in fuel demand. The ETR proves to be particularly inflationary when the tax (like in Sweden and the Netherlands) is levied on households rather than on industry energy consumption as the whole tax rather than just the share that is passed on by industry is reflected in the consumer price index. Nonetheless only in the cases of non-metallic mineral and food products in Sweden, price rises above 1% have been observed, while generally the increases stayed in the range of 0.2-0.4%.

The recycling of the tax revenues in the form of reductions in employers' social security contributions in Germany and the UK has been found to have substantive overall deflationary effects. On its turn he ETR seems able to produce a small 'double dividend' effect in most countries, with GDP increasing by up to 0.5% compared to the Reference case.

In a subsequent study, Eakins and Salmon (2007) find that the implementation of energy taxes in Denmark, Finland, Germany and UK, that took place over the 1990s and early 2000s had only a very small impact on unit production costs, which increased by 0.4%, and on production levels which reduced by the 0.1%. The paper also highlights significant potential for cost-efficient improvements in energy efficiency in all the sectors with the exception of meat processing even though the scale of the resultant reductions in unit production costs is less clear. Overall, policy driven innovation seems more than offset the impact of higher costs, leading to an overall output increase by 2.96%. Looking at indicators, such as the sectoral share of global production, import and export intensity, authors find in 45 cases out of 56, no support for worsening competitiveness. All this provides some even if patchy evidence of a Porter hypothesis effect.

Turning to carbon leakages, ex-post analyses tend to highlight milder effect from ETR than ex ante research. In some cases, the presence of technological spillovers has been found to foster abatement outside the country implementing the ETR. Barker et al. (2007), for instance, who look at Denmark, Germany, Finland, the Netherlands, Sweden and the UK between 1995 and 2005, find an average carbon leakage in non ETR countries small initially, 3% in 1995, and then fluctuating around zero with some evidence of 'negative' leakages in some years. Even considering the countries where relocation of energy-intensive industries was most likely, namely, France, Spain, Italy and Belgium, the leakage, never exceeded the

[2] Authors explain the short-term boost to Finland GDP with country's improvement in trade balance, driven, on its turn, by the carbon tax-induced reduction in the demand for imported fuel .

2%. The study also suggests that ETR had very little effect on total and sectoral intra-EU trade and that, GDP has increased albeit modestly in all of the ETR countries. Authors conclude that evidence of leakage is missing.

After 2006 an increasing number of studies investigates the impact of the EU ETS on the European firms' performance. A major difficulty in these assessments is to disentangle the effect of the ETS from that of other confounding economic trends, amplified by the relatively short time series available. This said, there is a general consensus that, so far, the ETS costs have been quite limited. This is mainly due to the abundant allocation of free permits in both the first and the second phase of the EU ETS that depressed the carbon price (Bolscher et al. 2013, Dechezleprêtre and Sato 2014, Ellerman et al., 2010). Some energy intensive sectors, such as the power sector, seemed to have suffered more than others. Anyway they were able to pass through to consumers a significant portion of their costs (Bolscher et al., 2013; Chan et al. 2013; Laing et al., 2013). These two elements also contributed to limit the carbon leakage effects (Bolscher et al. 2013, Ellerman, 2010,). Another consequence is that, at its current stage, the system does not seem ambitious enough to provide substantial incentives to establish an EU leading market for low-carbon innovations.

However these findings are not univocal. For instance Abrell et al. (2011) find anyway evidence of some "under allocated firms" whose profit margins declined between 2004 and 2008, and of "disproportionately hit firms" in the non-metallic mineral sector. On the basis of firm-level panel data, Commins et al. (2009) estimate that the experimental phase of the EU ETS actually had a negative impact on productivity and profits (in the order of 6%) for European firms, however not on employment and investment. Constantini and Mazzanti (2012) published results suggesting that, at least in the short term, the EU ETS had a negative impact on the economic performance of all of the participating firms, with the exception of medium-low technology industries, where in some circumstances the effect may have been positive. However, the results are far from conclusive and the approach used by authors makes it impossible to distinguish the EU ETS impact from other macro level shocks (Martin et al. 2012a).

Sartor (2012) examines econometrically the leakage effects of the first 6 ½ years of the EU ETS on primary aluminium producers'. The author does not find any evidence that the carbon price has caused a rise in net imports of primary aluminium between 2005 and 2011, whereas other variables, such as the level of European demand, the price of coal, the EUR/USD exchange rate, and the price of natural gas in Europe, were found to be statistically significant explanatory factors. Among the possible reasons, Sartor (2012) mentions the long-term electricity contracts, which would be expected to limit the responsiveness of the aluminium producers' decisions to the carbon price, and the technical constraints that make short-run production shifting too expensive in this sector. Eventually, the results highlight that the decline in the share of the European consumption, which is being met through local production, is mainly due to reasons not related to the ETS regulation. Similar results can be found in Bolscher et al. (2013), that find no concrete evidence of carbon leakage in the majority of sectors during the first two phases of the EU ETS. Even when increasing imports and/or decreasing exports were observed (namely in: cement, steel, ceramic and paper sectors) these can be easily explained by global demand trends and input price differences.

Finally, Martin et al. (2012b) examine information collected in 761 interviews with managers in six European countries. Managers were asked whether carbon pricing led them to plan to downsize operations or re-locate abroad over a time horizon until 2020. For firms part of the EU ETS, it was further asked how this re-location risk depended on the availability or not of free allowances after 2012. Most firms reported no impact of future carbon pricing on activity relocation decisions, thus the authors concluded that downsizing risk was overall low. However, the downsizing risk – albeit lower than a 10% reduction in production or employment scores - was significantly higher for the average ETS compared to non-ETS firms. Anyway, the group of EU ETS firms highlighted substantial variation in both the level of downsizing risk as well as in the degree to which such risk could be mitigated by free permits.

3.3. EU mitigation policies and effects outside the EU, with a focus on developing countries

As seen in the previous sections, there is quite an extended literature that discusses the potential leakage and competitiveness effects of unilateral mitigation policies for the EU. What happens outside EU borders is addressed rather indirectly. If the competitiveness loss for EU countries is limited, it can be inferred that potential competitiveness gains for non-mitigating countries is also limited. Furthermore, if these countries are also net energy or energy intensive-good exporters they are likely to experience welfare losses through adverse trade effects. This said, the research explicitly addressing the impact of developed countries mitigation on welfare and poverty in developing countries is narrow, and, once more, based on modelling prospective assessments rather than on the analyses of existing policies.

Tol and Dowlatabadi (2001) applying the FUND integrated assessment model, highlight a potential trade-off between mitigation in developed countries and "enhancement of adaptive capacity" in Africa in the specific case of malaria. They show that a Kyoto-like mitigation effort in Annex I countries can in principle reduce malaria mortality as a result of a slower rate of warming (-4% of deaths over the 21st century). Nevertheless, the abatement policy cost, resulting in reduced growth rates in OECD economies, rebounds negatively on developing countries, and particularly on the African economy, in the form of lower international aid and worsened trade relationships. Africa thus becomes not only poorer, but also more vulnerable (less able to adapt) to climate-induced malaria. Eventually, the authors estimate that Annex I mitigation effort, without any corrective measure, might potentially increase malaria mortality in developing countries.

Hussein et al. (2013) analyze with a computable general equilibrium model the poverty impacts of climate change mitigation in Annex I regions, implemented with different combinations of fossil and non-fossil fuel GHG taxes coupled with a forest carbon sequestration subsidy to all regions, on seven socio-economic groups in fourteen developing countries. The general finding is that the policy increases poverty in eleven out of the fourteen countries. Interestingly though, the main driver of the result is the carbon sequestration subsidy. In fact, especially the non-fossil fuel GHG tax in Annex I countries, boosts agricultural production and helps reduce poverty in countries where there are large concentration of the poor in the agricultural stratum. A similar, but much smaller outcome is induced by the fossil fuel tax. On the contrary, the forest carbon sequestration subsidy in the developing countries leads to increased poverty and that happens to be the dominating sub-component of the policy package. Hussein et al. (2013) identify three forces at work. The direct effect of the subsidy is to reduce the land available to agriculture and thus to benefit landowner with higher prices of agricultural commodities. At the same time agricultural output declines and so does factor income. For most countries, the latter effect seems to dominate and hence the worsening poverty. The third effect is related to the inflow of REDD credits that creates a “Dutch disease” phenomenon, which affects the manufacturing output negatively and reduces non-agricultural income substantially.

Zotz (2012) notes that there is already a detectable tendency of Latin America emission intensive exports to shift from the EU and the US toward the Asian, especially Chinese markets. Even though the majority of Latin American countries ratified the Kyoto protocol, and countries like Brazil, Mexico, Chile and Costa Rica announced voluntary post-Kyoto de-carbonization commitments as part of the 2009 Copenhagen Accord, these trend can highlight a particular vulnerability of Latin America exports in a tightening climate regime in the OECD. Zotz (2012) suggests accordingly that a set of actions going from the establishment of carbon accounting and disclosing schemes, removal of barriers to the diffusion of green technologies, reduction and possibly elimination of subsidies for energy intensive industries and access to financing and support to clean technologies are necessary to help Latin America countries to maintain their market shares in the EU and US.

In this narrow literature, a notable exception is the research investigating the economic effects of biofuel expansion. The main producers of biofuels are the EU, Brazil and the US, nonetheless, many developing countries in Asia and Africa are supporting the production of biofuel with specific domestic mandates and economic incentives to pursue, with different emphasis, the increase in energy security, the environmental-friendly de-carbonization of the energy system, and, last but not least, the support to agricultural production and farmer income.

Therefore, the next sub-section is going to focus on the potential social-economic consequences of the EU biofuel EU mandates, in developing countries[3].

[3]The discussion on if, and how, biofuel production is effectively able to deliver its carbon/energy saving and energy security goals is not tackled here as beyond the scope of the present survey. We just report that there is a huge debate on these issues (see e.g. Charles et al., 2013; Kretschmer et al., 2012).

3.3.1. The case of biofuels

Biofuel development can affect welfare in developing countries through a multiplicity of impacts on the economic, the environmental, and the social dimensions. Assessing these impacts is, however, very complex as:

- ✓ all these effects are intertwined and therefore not always clearly isolable;
- ✓ it is also very difficult to isolate biofuel impacts from more general trends affecting agricultural markets, like increasing in food demand, speculation on food/grain commodities, stock effects;
- ✓ biofuels themselves are not an homogeneous category. They are produced in very different locations, at different scales, using different feedstock, technologies, involving different farm practices and land uses. No result thus can be easily generalizable;
- ✓ information on biofuel and feedstock cultivation is not generally available with a good level of resolution.

3.3.1.1. Economic effects of biofuel in developing countries: trade, prices, GDP, employment and technology

The empirical literature agrees that the EU could not meet its entire biofuel blending target domestically. Even though EU land could be in principle physically sufficient to support the required increase in biofuel production, the severe restrictions imposed by the EU directive on land conversion and the magnitude of the implied displacement of food production in favor of energy crops would make that possibility in practice unfeasible. The EU policy is thus expected to foster biofuel and feedstock production in and imports from non EU producers. If the general direction of trade effects is clear, notable differences can be found in their quantification proposed by the different studies. This depends on the methodology applied, the assumptions on the availability and productivity of land, the presence of first or second generation biofuels and the openness of trade relations. For instance, according to the European Commission (2007), which assumes that all EU set aside land is devoted to biofuel production, 18% of the EU biofuel demand has to be imported, to avoid an overstretching of land availability and a return to pre 1980's fertilizer and pesticide intensity. Eickhout et al. (2007, 2008) under more conservative assumptions on increases in land yields estimate that more than 50% of the EU biofuel demand in 2020 would be imported. This share ranges between 28.5% and 58% of biofuel crops used in the EU petrol sector, according to the CGE modelling analysis conducted by Banse et al. (2008), depending upon the mandatory nature of the blending targets and different assumptions on the openness of international trade exchanges. In the same direction are the findings reported by Blanco-Fonseca et al. (2010). They develop a three agro-economic model inter-comparison exercise which all agree in highlighting an increase in net imports (and decrease in net export) of biofuels in the EU peaking to a 614% and 407% for ethanol and biodiesel respectively, in 2020 compared to baseline trends. Al-Riffai et al. (2010), estimate in 2020 an EU biodiesel import increase of the 17.8% and that of ethanol of the 686%.

This literature also agrees that the increased biofuels demand, in addition to the obvious effect of rising biofuels and their feedstock price, can impact food price level either directly, when feedstocks are used for fuel rather than for food, or indirectly, when more land is devoted to biofuel rather than to food production. Furthermore, by tightening the connection between the price of agricultural commodities and that of oil products, biofuel development can increase food price volatility (Kretschmer et al., 2012, Diop et al., 2013).

There is quite an extended retrospective literature, spurred especially by the 2008 food prices spikes, trying to quantify these effects. Rosegrant (2008), using the IFPRI's IMPACT partial equilibrium model estimates that biofuel accounted for 30% of the food price increase during the 2008 food price crisis. Mitchell (2008) considering all direct and indirect consequences of biofuel production raises this share to 70-75%. Other studies (de Santi 2008, Sheeran, 2008, von Braun 2008, Birur et al. 2008), although recognizing the positive impact of biofuel growth on food price, are more cautious in quantifying the role of biofuels which interacts with many other confounding factors in rising food prices. In their exhaustive survey, Kretschmer et al. (2012), conclude that "averaging" the existing literature, the impact of biofuel demand from 2000 until 2010 has increased world grain prices by about 1-2% and oilseed prices by around 4%.

The biofuel literature is also rich of perspective analyses, assessing the effects of the many different biofuel mandates that both developed, thus including the EU, and developing countries are implementing in the near-term future. Kretschmer et al. (2012) estimate that without any cap on crop-based biofuels, EU policy could raise grain prices by 1% and oilseed prices by 10% by 2020. According to Banse et al. (2008) the increase in world prices for cereals induced by the EU mandate could range between the 5% and more than 18% in 2020 compared to the reference case with a full trade liberalization. Blanco-Fonseca et al. (2010) report peak increases of 22% for maize, 12.5% for wheat, and 27.1% for vegetable oil, 21% for sugar. According to Timilsina et al. (2010), agricultural commodities such as sugar, corn and oil seeds (as oil), that serve as the main biofuel feedstocks, would experience 1% to 8% price increases in 2020 as compared to that in the baseline.

Higher production sold at higher prices, benefits primarily current biofuel and food exporting countries. The literature however does not usually quantify the overall GDP effects, being mostly interested in the dynamics in the agricultural-energy markets. When reported, overall economic impacts tend to be small, either because the agricultural sector contributes with limited shares to overall country GDP, or because increased food prices tend to compress the demand of other commodities. According to Al Riffai et al. (2010), for instance, the EU biofuel mandate has eventually minimal positive effects on national incomes of biofuel exporters, reaching the maximum of a tiny +0.06% compared to the baseline in 2020 in Brazil, basically spurred by improvement in terms of trade thanks to their exporting status of oilseeds for biodiesel and sugar cane. Similar results are found by Timilsina et al. (2010) where gains are lower than 0.05% of GDP in the majority of biofuel exporters.

Conversely, net biofuel and/or food importers, can be adversely affected. The high international prices may constitute for them a barrier from importing needed food supplies, thus exacerbating malnutrition, hunger and related health diseases. For instance, in Sub-Saharian Africa, the average percentage of total cereal demand that is met through imports was 33% in 2000, reaching higher dependency level percentage up to 80% in Sudan, Gambia, and Zambia (FAO, 2003). Not surprisingly Sub-Saharan countries are often amongst the largest losers in modelling exercises (e.g. -0.12% and up to -0.15% of national income and of GDP in Al Riffai et al. (2010) and Timilsina et al (2010) respectively)[4].

Gains (and losses) are larger when the focus is on the agricultural sector. In this vein, Al Riffai et al. (2010) quantify the effects of the EU mandate in 2020 on agricultural value added detecting an increases by 1% in Brazil, 0.5% in Indonesia and Malaysia, which are the top three winners. All the studies typically report positive effects on trade balance for biofuel producers and negative for the EU.

All the studies however stress also that these potential gains could be enjoyed by those countries already endowed with a sufficient technological and productive capacity to meet the increasing demand, i.e. traditional biofuel producers (i.e. amongst middle income and developing countries Brazil, Malaysia and Indonesia). It is highly unlikely that by 2020 new developing African and Asian incumbent could play a significant role in the biofuels market. This situation is not expected to change after 2020 when second generation biofuels could play a more prominent role. Even in this case, in the light of the high investment in technology required by these productions, only those countries that already implemented large bioenergy projects set up at the right scale, like Brazil, China, India, South Africa, Mexico and Thailand could grasps benefits in the medium term (Eisentraut,2010).

Within country distributional effects are also expected. Farmers could be reasonably advantaged by the expansion of biofuels in the form of higher land rent (but see below the issue of land grabbing, land eviction), but households not deriving their income from the agricultural sector will face higher prices for food commodities without counterpart. These effects are however difficult to assess.

In principle, tension on food prices (and indirectly on land uses), could be lower when second generation biofuel are developed. On the one hand, they are not food crop themselves, thus they will not trigger the crop-for-food crop-for energy competition, on the other hand, like for instance Jatropha, they could grow on marginal land not suitable for cereal production reducing the land competition (Croezen and Brouwer, 2008). In fact, both problems will persist (Diop, 2013; Eisentraut, 2010). Indeed, second generation biofuels involve expensive and technology intensive production processes that can only be rewarded if implemented on high yield/high quality land with proximity to markets, infrastructure and irrigation potential. It is very unlikely that huge investments are conveyed on marginal land.

[4] The fact should not be neglected that food exporting countries themselves may opt to export their food products instead of selling them domestically, because of higher return due to high export prices, therefore increasing the population of food insecure (Rosegrant, 2008).

More promising seems the use of biofuel by-products. Taheripour et al. (2008) show that the extensive use of byproducts from grain ethanol and oil meals from biodiesel as animal feed would greatly reduce indirect land use changes, whereas Kampman et al. (2008) estimated that incorporating by-products into the calculations for land requirements of biofuels reduce the land demand by 10-25%.

Another important economic effect of biofuels is linked to potential job creation in developing countries. Unfortunately, the quantitative evidence is poor and analyses in this respect can be mostly speculative. To assess this effect it is critical to compare biofuel labour intensity with that of alternative land uses. The ultimate answer thus depends upon the feedstock grown and the technology/level of mechanization adopted. For instance, due to the crop characteristics oil palm, cassava and Jatropha production, can never be fully mechanized whereas sugarcane farming is more suitable to a larger use of machinery. Furthermore, mechanization is more limited in small-scale bio-energy production that thus seems likely to generate more rural (and pro-poor) employment than large-scale bio-energy production, which will probably be more capital intensive. However, it tends to be also less productive and less economically competitive, and, accordingly, potential increase in employment can be only temporary.

The development of a biofuel industry in developing country could also spill over positively on innovation, technology, and productivity. However, some requisites are necessary. Firstly limitations on the use of technology and related knowledge put by investors should not be excessively severe, secondly the agricultural sector itself should be permeable to technology spreading, thirdly, and most importantly, the country concerned should be characterized by a sufficient absorptive capacity (Diop et al., 2013). In this, the role of efficient and capable institutions is crucial: they can support farmers with training programs and technical advice, facilitate the dissemination of best practices and farmer-to-farmer participatory learning, offer adequate infrastructures. It is also important to notice that spur to invention, patenting and innovation is expected to come mostly from the development of second generation biofuel whose technology is complex and application very expensive. But exactly for this, intellectual property right are higher there (Eisentraut, 2010), which coupled with weaker institutional capacity makes it very unlikely, as noted already, that second generation biofuels production can be achieved in developing countries in the near term. This on its turn, would suggest a limited role for biofuel-driven technological improvement in developing countries[5].

3.3.1.2. Environmental effects

The environmental threats associated typically to biofuel expansion are land and water depletion and degradation, deforestation, biodiversity loss.

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[5] In principle, this bottleneck could be by-passed via the biofuel feedstock production. But Investment in feedstock production anyway necessitates stable and predictable political conditions and targets, within the developing countries as well as from EU side which is a potential buyer of the bio-energy.

Land and water degradation phenomena linked to biofuel are those common to all land uses which are intensive in land and water, fertilizers and pesticides. Furthermore, it is worth stressing that water competition across agricultural, domestic and industrial uses is expected to increase anyway due to increased population and income levels, strengthened in the medium-term, by water scarcity phenomena, driven by climatic changes. Thus biofuel expansion would at a time affect, but be also affected by this competition. These problems are then strictly linked to the specific cropping practices used and could be limited by the adoption of appropriate sustainable agronomy and cultivation models. This however requires a sufficient capacity in national authorities to enforce and monitor this adoption.

The relationship between biofuel production and deforestation is very complex and difficult to quantify especially for the incomplete data both on global deforestation and biofuel feedstock plantation. As often in the biofuel case, it is not possible to generalize. For instance sugarcane in Latin America, is generally expanding on lands already cleared for agriculture and is unlikely to cause direct deforestation. On the contrary, several studies highlight that biodiesel from oil palm may have been important responsible for direct deforestation in Indonesia, Malaysia, Thailand, Borneo while biodiesel from soybean in the Brazilian state of Mato Grosso (Diop, 2013, Leahy 2007, Buchland 2005). For our purposes is important to notice that sustained deforestation trends will limit the possibility of given developing countries to use REDD credits in the carbon market .

Biofuel impacts on biodiversity can be relevant for developing countries welfare when they induce loss of biodiversity rich areas that can be a direct source of touristic income, and when the generated genetic uniformity increases the vulnerability of agricultural sectors to pests and diseases.

3.3.1.3. Social effects of biofuel in developing countries: land, gender, energy security/access issues.

Biofuel production can entail important social implications when changes in land uses bring about displacement of smallholders (Eisentraut, 2010, Diop et al. 2013,). Women can be particularly affected by a weakening in land entitlements especially when they are poor and their access to land is dependent on male relatives, as is the case in most customary land systems in Africa. Of course, this risk is not specific to biofuel, but is potentially associated to all large scale investments program of agricultural development undertook by national or international companies when land property rights are not well defined and when institutional capacity is weak as not uncommon in developing countries. For instance, Diop et al. (2013) note that most large-scale land investment is taking place in countries with weak land tenure governance structures and very high foreign investment protection and incentives with Africa as the most targeted region. Large-scale biofuel development can be a further pressure in this direction. Adverse social effects could arise even when biofuel develop on marginal or officially “unused” land as in developing countries, this usually offers anyway an important public access natural resource which supports the income of poorer households.

A potentially positive social effects from biofuel expansion could instead derive from improved energy security and access in remote areas in developing countries. For this to happen it is however necessary that investors/producers do not consider domestic markets just as secondary targets. Currently this is happening in very few Countries[6]. This lack of interest in domestic markets depends also upon the fact that in many developing countries fossil fuels are relatively "cheap" as less subjected to heavy taxation and quality requirements in comparison with the EU, if not substantively subsidized. This reduces the incentive to develop alternative energy generation technologies. At the same time, small-scale biofuel projects based on the use of straight vegetable oil for generating electricity or to be used in multi-platform applications such as electricity generators, mills and water pumps can substantively improve energy access in remote areas where traditional energy sources are particularly costly, not only in terms of market price but also in terms of amount of time needed for collecting energy source. These projects are seen particularly compatible with sub-Saharan Africa context, but again are linked to less productive and thus more economically risky production processes.

4. Conclusions

The EU longstanding experience on GHG emissions reduction policy can offer important insights to emerging and developing countries that are on the way to implement climate change measures. In particular, it shows that the worries about the costs and competitiveness losses induced by climate regulation at the country level, might be overestimated.

The evidence on how the EU climate policy affected the economic performance of regulated sectors is less conclusive though. Some studies found negative effects on employment, profits, or productivity, but these findings were not confirmed in other studies that relied on different statistical models. It is important to highlight here that the magnitude of the results strongly depends on model assumptions or on indicators selection.

Anyway, productivity and employment drops, triggered by emissions reduction policies remain moderate and confined mostly within energy-intensive sectors and especially during the initial transitory period. These findings also characterize the more recent EU ETS experiences. The competitiveness of firms and sectors has not been damaged by the trading system that therefore did not lead to market share reductions or changes in the composition of supply of regulated firms. There is, on the contrary, fairly robust evidence that a number of energy-intensive sectors were able to pass through the (opportunity) costs of emission permits through increased prices for consumers. Little evidence also supports the

[6] Diop et al. (2013) reports the cases of Brazil where the fulfillment of its ambitious mandate has been facilitated by/facilitated the contextual development of industry for ethanol utilization, such as flex-fuel cars; of Mauritius island, where around 1/5 of total electricity is generated from bagasse; and of Malawi exploiting the potential of sugarcane for electricity generation

assumption that EU climate regulation deteriorates international competitiveness. Indeed, the relocation effects of current measures can be considered negligible compared to other factors such as market conditions or developments of the global demand. Overall, there is agreement on the fact that both costs and impacts of the ETS have been limited. However, the low price of allowances caused by the abundant initial allocation of free permits in the first periods of the scheme has to be considered. This lack of ambition of the EU ETS system affected also the Porter Hypothesis, since it seemed not to be able to provide the sufficient incentive to spur the deployment of low-carbon innovations. There are indications, highlighted by ex-ante modelling assessments, that this situation could change in the third period of the ETS as the cap becomes more stringent and market reforms will be approved or, more in general, when the EU de-carbonization effort will become more ambitious.

There is finally a general agreement on the fact that the fragmentation of the policy - i.e. the European decision to differentiate between ETS and non ETS sectors coupled with the implementation a single target for renewables - introduces important inefficiencies and increases compliance costs compared to the implementation of a carbon price encompassing all sectors.

The spillover effect of the EU climate policy on developing countries are somewhat complementary to the EU ones. In the presence of leakages, developing countries could in principle benefit from it. However, especially in the case of net energy exporters, they can be worse off via deteriorated trade relations. Some studies finally point out that a tightening of the EU climate policy regime, might facilitate a resource relocation “from energy, industry to agriculture” that if well governed could be beneficial to those countries where poor are concentrated in rural activities.

A particular case is represented by the EU biofuel mandate. It is widely recognized that the EU could not meet its entire biofuel blending target domestically as the severe restrictions the EU regulation imposes on land conversion and the magnitude of the implied displacement of food production in favor of energy crops would make that possibility in practice unfeasible. The EU policy is thus expected to foster biofuel and feedstock production in and imports from those developing economies which are biofuel exporters. Nonetheless, potential gains are expected to remain limited as positive effects experienced in the agricultural sector will be partly offset by adverse welfare effects associated to increasing food prices. This can happen either directly, when feedstocks are used for fuel rather than for food, or indirectly, when more land is devoted to biofuel rather than to food production. Furthermore, food-importing developing countries are likely to experience a worsening in both welfare and poverty that overwhelms gains by biofuel exporters.

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