Sustainability-oriented Future EU Funding: A European border carbon adjustment

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Abstract

The need to reform EU funding and recent political developments such as Brexit and the withdrawal from the United States from the 2015 Paris climate agreement could revitalise the debate about the introduction of border carbon adjustments (BCA) for the European emission trading system (ETS). The introduction of a BCA would allow the EU to phase out current carbon leakage provisions of the ETS and to auction off all emission allowances, thus rendering the ETS a more effective unilateral tool to price and reduce carbon emissions. By using a dynamic new Keynesian (DYNK) model, we estimate that a BCA for the ETS would generate substantial and stable revenues. Given different assumptions about the development of the carbon intensity of non-EU production and different BCA designs we find that estimated revenues would suffice to finance between a third and all of current EU expenditures by the year 2027, thus allowing Member States to reduce their current contributions to the EU budget accordingly. Administered at the EU borders a BCA would represent a sustainability-oriented instrument to finance the EU allowing EU Member States to cut more distortionary taxes such as those on labour, thereby increasing growth- and employment-friendliness of taxation. The proposed measure could thus contribute to tackle both environmental and fiscal challenges currently facing the EU.

1 Introduction[1]

The imminent Brexit and the current efforts to initiate fundamental reforms within the EU (European Commission 2017a and 2017b) could have considerable implications on how the post-2020 Multiannual Financial Framework (MFF) is funded. These new dynamics in the debate about future EU funding should be used to also address some long-standing criticisms of EU finances such as the net position thinking embodied in every MFF. Schratzenstaller et al. (2017) introduce an innovative sustainability-oriented perspective for EU revenue reform, capturing the social, economic, environmental and cultural/institutional dimensions of sustainability. Hereby the basic idea is to increase sustainability within public finances at Member State and EU level by introducing such taxes at the EU level which cannot be implemented effectively at the national level (Hudetz et al. 2017). These taxes typically are either green taxes (see, e.g., Krenek and Schratzenstaller 2017a, Luptacik and Luptacik 2017), or taxes on wealth (Krenek and Schratzenstaller 2017b), corporate profits (Nerudová et al. 2016), and financial transactions (Solilová et al. 2017). The revenues from these taxes should be used to reduce current Member States' contributions to the EU budget, allowing national governments to reduce other, less sustainability-oriented taxes such as the high taxes on labour. EU funds resulting from this tax swap across Member State and EU level are more adequate to finance European public goods with a true (sustainability-oriented) "added value" (Schratzenstaller 2017).

Latest international developments, such as the decision of the United States to pull out of the 2015 Paris climate accord and its reversal of clean power policies, question the likely success of global initiatives and should give cause to strengthen unilateral efforts to combat climate change. Against this background, it is all the more problematic that the flagship of EU climate policies, the EU Emission Trading System (ETS), is not allowed to work at its full potential due to concerns of carbon leakage,[2] as an oversupply of allowances, grandfathering and other carbon leakage provisions currently render this tool rather toothless.[3] Therefore approaches to deal with carbon leakage enabling policy makers to

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[2] Carbon leakage occurs when carbon emissions in third countries increase as a consequence of emission-reducing policies in a country or group of countries (Barker et al. 2007).
[3] See Brink et al. (2015) and Schleicher et al. (2015, 2016) for a detailed discussion of the reasons for the existing under-pricing of emission allowances.

tighten the supply of allowances and slowly reduce the ETS carbon leakage provisions are urgently needed.

The most cost efficient measure to deal with carbon leakage is a system of border carbon adjustments (BCA). These tariff-like levies would be imposed on EU imports based on the carbon emissions associated with the respective products, thus levelling the playing field for goods produced within the EU under a rigorous ETS. The complexity of this instrument and the fear of potential WTO disputes have so far discouraged European policy makers to pursue this avenue, although the legal framework in the form of the revised EU ETS directive is already in place. Revenues from a BCA are, similar to revenues from other green taxes levied on cross-border externalities (in particular carbon emissions), not easily attributable to individual Member States and would thus, as other tariffs, represent an ideal and "true" own revenue source for the EU budget. Furthermore the introduction of a BCA would fit well into a general approach aiming at a sustainability-oriented reform of EU finances. Given different assumptions about the development of the carbon intensity of non-EU production and different BCA designs, our estimations also demonstrate that the implementation of a BCA as a supporting tool for the ETS would create stable revenues for the EU. Given the overall need to reform the revenue side of the EU budget and given the early crumbling of a climate accord which was not very rigorous to begin with make the introduction of a BCA an interesting option to finance the EU in the future. These current circumstances have the potential to revitalise the debate about options for unilateral climate policy in general and BCA in particular.

In chapter 2 we lay out the arguments for the need of reforming the EU budget by introducing sustainability-oriented (tax-based) instruments. Chapter 3 reviews the most important aspects of a BCA and possible design options. In chapter 4 we use a Dynamic New Keynesian (DYNK) model to simulate the effects of a BCA for the ETS and to estimate potential long-term revenues from it. Chapter 5 concludes.

2 The need for a sustainability-oriented reform of the EU system of own resources

2.1 Strengths and weaknesses of the current EU system of own resource

Currently the EU system of own resources primarily rests on contributions from EU Member States' national budgets (see for a detailed description Schratzenstaller et al. 2016), with the bulk of revenues stemming from GNI- and VAT-based own resources representing, in principle, national contributions instead of "true" own resources. As pointed out, for example, by Núñez Ferrer (2008), Begg (2011), or the High Level Group on Own Resources (2016), this revenue system certainly has its advantages (Hudetz et al. 2017). It guarantees steady, predictable and reliable revenues and a balanced budget. Ex ante at least, i.e. before the application of the various correction mechanisms, it provides for a "fair" distribution of the financial burden across Member States. Moreover, national contributions respect the subsidiarity principle by leaving the decision on the distribution of the financial burden among individual taxpayers to Member States (Lipatov and Weichenrieder 2016).

However, various criticisms of the EU's revenue system have been brought forward during the last decades (Schratzenstaller et al. 2017). The EU system of own resources is being criticised for its opaqueness and in-transparency, rendering it impossible for EU citizens to assess their individual and their respective countries' contributions to the EU budget as well as the connection between EU revenues and expenditures (Schratzenstaller 2013; Fuest, Heinemann and Ungerer 2015). Other critics address the increasing dominance of direct contributions out of Member States' national budgets within the EU's overall revenues, which is continuously curtailing the EU's financial autonomy (European Commission 2011; Iozzo et al. 2008). Moreover, the application of various correction mechanisms impairs the fairness of the distribution of the financial burden across Member States. Finally, the EU revenue system does not contribute to core EU policies (Schratzenstaller 2013; European Commission 2011; HLGOR 2016; Schratzenstaller et al. 2017), such as sustainable growth and development as anchored in the Europe 2020 strategy, the 2030 Agenda for Sustainable Development, or the 2015 Paris Climate Agreement.

This lack of support of EU policies, which has been repeatedly stated also by the European Commission (e.g. European Commission 2011) and the European Parliament (e.g. European Parliament 2017), is not only caused by the concrete design of the individual

own resources as such. It also results from the perception of the VAT-based own resource (making up for 11 percent of EU revenues in 2016) and the GNI-based own resource (63.1 percent of EU revenues in 2016) as pure national contributions. Such a perception induces Member States to measure the benefits derived from the EU budget in terms of net financial contributions, i.e. as the balance of national contributions and transfers received from the EU budget, and to demand the maximisation of net benefits or at least the minimisation of net contributions from their respective country's position instead of the maximisation of an added value from an overall EU perspective (Iozzo et al. 2008). The dispute between "net contributors" and "net beneficiaries" also goes along with increasing tensions between Member States regarding the size and structure of the EU budget (HLGOR 2016) and exerts downward pressure on its overall volume (Haug et al. 2011). This is reflected in the most recent two MFF, each one lower in volume than the preceding one. Thus, the current structure of the EU system of own resources can be seen as an obstacle to further European integration as well as to policies supporting a sustainable economy and generating EU added value (European Commission 2011).

2.2 Sustainability gaps in EU tax systems

These shortcomings in the structure of EU revenues and expenditures form the general background against which tax-based own resources – to replace current own resources within a fiscally neutral approach – have been discussed by some time now. The European Commission as well as the European Parliament have been in favour of substituting part of current own resources with tax-based own resources; a position supported by the results of the High Level Group on Own Resources (2016). However, tax-based own resources are more than a tool for further European integration. They have also the potential to reduce economic, social, environmental, and institutional sustainability gaps within Member States' tax regimes (Schratzenstaller et al. 2017).

In all Member States a considerable and (at least for the EU15) increasing share of overall tax revenues stems from taxes on labour (Eurostat 2017). At the same time, the weight of corrective Pigovian taxes, i.e. environmental taxes and other sin taxes (e.g. on alcohol and tobacco consumption), is decreasing. Taxes on the financial sector, which besides fairness aspects can also be motivated by Pigovian considerations (Keen 2010), still play a rather limited role in the EU (Cannas et al. 2014; Hemmelgarn et al. 2016). While the share of property taxes in overall tax revenues has risen slightly over the last decade, their contribution to overall tax revenues has remained rather limited. Together with the declining trend in the shares of taxes on capital and the increasing weight of VAT and social security contributions, this suggests that the redistributive power of taxation and

thus its contribution to social inclusion has weakened over time – a trend Europe is sharing with the majority of countries worldwide (IMF 2017). Intense company tax competition within the EU is another sustainability-relevant issue. Company tax competition in the EU manifests itself in the decrease of statutory and effective corporate tax rates (Leibrecht and Hochgatterer 2012). Moreover, recent empirical results suggest that profit shifting by multinational firms is indeed taking place on a large scale (Fuest et al. 2013; Torslov, Wier and Zucman 2017).

2.3 Sustainability-oriented tax-based own resources as a building block for financing European public goods

In the expanding field of "international/global public finance"[4], the debate about innovative financing schemes and options for the provision of global/international public goods has been led for some time now. Somewhat surprisingly, the insights gained in this strand of the literature are only slowly feeding into the debate about the future financing of the EU. This may be explained by two specifics of EU finances in particular. First, national sovereignty in tax issues is fiercely defended by EU Member States, leaving only little space for EU competencies in tax matters in the first place, which accordingly are defined rather narrowly in the EU treaties and require unanimous decisions of Member States to become effective at all. Secondly, a large share of EU expenditures is not perceived as creating EU added value, but to serve national interests.

If – as following from the subsidiarity principle – EU revenues in the future should be used to primarily finance "true" European public goods and thus to create EU added value, establishing a financing scheme at the EU level which is strongly resting on "true" own resources instead of pure national contributions appears to be a necessary precondition. Sustainability-oriented tax-based own resources could be established within the existing political, legal and institutional framework at EU level as the basis for such an EU financing scheme. These tax-based own resources could substitute for national contributions, providing Member States with fiscal space to cut more harmful taxes at the national level, in particular the high taxes on labour. This would allow a fiscally neutral tax shift enhancing sustainability-orientation of the EU's as well as Member States' revenues systems, thus yielding a double dividend for Member States.[5]

Obvious candidates for sustainability-oriented tax-based own resources as a core element of a "true" EU revenue system are taxes or tax-like levies which cannot be enforced

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[4] See, for instance, the contributions in Atkinson (ed.) (2005) or Kaul and Conceicao (eds.) (2006).
[5] See for this double dividend argument in the context of the implementation of a system of global environmental taxation Sandmo (2005).

effectively at the national level mainly for two reasons.[6] First, because tax bases and/or tax subjects are mobile so that in an un-coordinated setting tax rates are competed down ("race to the bottom"), or certain taxes are not introduced in the first place ("stuck to the bottom"; Weibust 2009). Secondly, because of transnational externalities, in which case national taxation would imply inefficiently low tax rates (Jones, Keen and Strand 2012). Moreover, unilateral taxation may reduce the pressure on other countries to tax the respective externalities themselves, as they can free ride on the reduction of the taxed externality and at the same time enjoy a tax advantage increasing their competitiveness (Auerswald, Konrad and Thum 2011). The fact that revenues from taxes or levies on cross-border externalities are not clearly attributable to individual nation states suggests assigning them to a supra-national budget (Keen, Parry and Strand 2012).

Climate levies aiming at slowing down global warming are a prime example for such tax-based own resources. Sustainability-oriented options in the context of EU finances, which are also addressed in the final report of the HLGOR (2016), are an EU-wide carbon-based flight ticket tax (Krenek and Schratzenstaller 2017a) or an EU-wide carbon tax (Luptáčik and Luptáčik 2017). Implemented as tax-based own resources for the EU budget they would yield a European triple dividend. The first dividend consists of a contribution to European/global climate goals. As a second dividend Member States' tax systems in terms of growth- and employment-friendliness would be improved. Using the revenues of climate taxes to provide European public goods with a (sustainability-oriented) European added value would create a third dividend. Dedicating a substantial share of EU expenditures to programmes that would contribute to a European decarbonisation strategy (as for example the expansion of low-carbon transport infrastructure within trans-European networks or climate-friendly agricultural policy[7]) would establish a visible connection between EU-wide climate levies and their use and would thus strengthen their political acceptability (Grubb 2011).

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[6] See for this argumentation Boadway (2005) in the context of financing global public goods by global taxation.
[7] See Schratzenstaller (2017) for the potential contribution of EU expenditures to foster a European decarbonisation strategy.

3   The case for an EU border carbon adjustment

Attempts to reform the EU budget in general and its financing in particular might revitalise the debate about BCA as a supporting measure to price carbon effectively and to reconsider not only production-based, but also consumption-based carbon accounting. The arguments in favour of and against the introduction of BCA are well documented in the scientific literature. Since its revision in 2009, the ETS Directive (ETS directive 2009/29/EC) actually permits the introduction of a BCA: by requiring importers to participate in the ETS so as to improve and extend the EU's greenhouse gas emission allowance trading scheme (Kuik and Hofkes 2010). However, this very controversial provision was opposed right from the beginning particularly by emerging third countries such as India, which already in 2010 stated that it would challenge every form of carbon taxation imposed by the EU on Indian imports. The enormous backlash by a broad coalition of non-EU countries against the EU's efforts to include international airlines operating in the EU into the ETS in 2013 demonstrates how difficult from a diplomatic perspective it would be to introduce broad-based carbon cost levelling, not to mention the associated legal and technical issues (Fouré et al. 2016).

However, as a system of BCA would potentially raise substantial revenues, there might be a new momentum on the side of EU institutions to reconsider the measure within their current efforts to reform EU finances. A BCA, allowance-based or in the form of an actual tax, could be considered a perfect sustainability-oriented source of revenues for the EU according to the definitions by Schratzenstaller et al. (2017). Furthermore, the planned introduction of a Chinese cap-and-trade system (see, e.g., Stavins and Stowe 2017) together with the early failure of the 2015 Paris climate agreement due to the United States' decision to pull out of the 2015 Paris climate agreement[8] might create some diplomatic options to introduce BCA as the missing link between different carbon pricing mechanism (Andersen 2017). An EU BCA could be designed not only in a WTO compatible way but to take into account the concerns of European trading partners, thus representing a compromise (Monjon and Quirion 2011, Böhringer et al. 2012a, 2012b, 2012c).

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[8] The problem here is not so much the withdrawal from the non-binding treaty itself but the policy reversals accompanying the withdrawal from the Paris agreement such as the clear intent to dismantle the Obama-era clean power plan, which is crucial for the USA to meet the Paris goals.

3.1 Carbon pricing

Baranzini et al. (2017) stress that carbon pricing is the most important single measure to combat climate change. The authors make a strong case beyond the usual efficiency arguments for pricing carbon by also discussing societal and political acceptance of carbon pricing as well as induced environmental innovation.

There has been a long-standing debate in the economic literature, initiated by the seminal contribution by Weitzman (1974) in a general context and by Pizer (2002) with regard to climate policy, whether cap-and-trade systems (a quantity instrument) or an emission tax (a price instrument) are the most effective and efficient market-based instrument to limit GHG.[9] A carbon tax with a uniform tax rate, usually determined at the national level, would reduce emissions as long as tax savings are higher than the cost of reduction, but without having an overall limit of total emissions. A cap-and-trade system such as the ETS determines the cap first, usually through a political process, whereby it is set at the lowest common denominator of all actors involved. In a text book model allowances representing the total agreed amount of emissions are then either allocated or auctioned off[10].

There are certainly fundamental differences between a carbon tax and a cap-and-trade system; however, parties from all corners of the world and the society agree on the basic necessity to price carbon in order to account for the social costs of climate change. In the United States, where no form of national carbon pricing is yet in place, prominent conservative and progressive policy makers, energy giants such as EXXON, academics and part of the administration actually favour the taxation of carbon, as it is the more straightforward solution to the problem at hand (Yuan et al. 2017; Horowitz et al. 2017; Weber et al. 2017; Wittneben 2009). In the EU, a cap-and-trade system, namely the ETS, is already in place and can be seen as the flagship of European environmental policy (Wettestad and Jevnaker 2016). Once such a mechanism is in place it would be difficult to abandon, considering the money, political capital and effort invested in building the governance structure, hiring employees to deal with the bureaucracy, and learning on the part of all actors involved (Wittneben 2009).

The overall global trend of carbon pricing is positive (World Bank, Ecofys and Vivid Economics 2017), despite recent setbacks such as the decision of the United States to pull

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[9] See, e.g., Smith (2008), or Carl and Fedor (2016) and the references cited therein.
[10] Kuik and Hofkes (2010) stress that although in a text-book model it does not matter with respect to final outcomes whether allowances are auctioned off or allocated for free, in a real world with imperfect systems such as the ETS the way of allocation might matter very well.

out of the 2015 Paris accord. The introduction of some form of carbon price signals[11] in countries as diverse as Japan, Australia, certain Canadian provinces, Mexico, Korea, South Africa, New Zealand, Kazakhstan and China (Andersen 2017; World Bank, Ecofys and Vivid Economics 2017) should be a cause for optimism. According to many CGE model simulations the reason, however, why rigorous unilateral pricing mechanisms have not and as a matter of fact should not be implemented as of now is the unresolved issue of carbon leakage[12] (Burniaux and Oliveira Martins 2000; Paltsev 2000). If firms, due to unilateral environmental regulation such as rigorous carbon pricing, decided to either relocate to ("strong carbon leakage") or invest in ("weak carbon leakage") countries with less strict environmental regulation or carbon pricing, the result would often be an increase in global emissions instead of the planned reduction (Davis and Caldeira 2010). If a European steel production plant relocated to a country with no or less strict environmental regulation, let alone carbon pricing, and then reimported its products to Europe, job loss and a negative environmental effect would be the result. The EU has therefore stated in the Paris negotiations that certain provisions within the ETS such as the free allocation of allowances for certain sectors will not be changed as long as the threat of carbon leakage is not adequately addressed. Despite recent break-throughs in reforming the ETS (Jevnaker and Wettestad 2017) and the potential to optimise current carbon leakage provisions to a certain degree (Schleicher, Köppl and Zeitlberger 2016), the ETS is currently an ineffective tool.[13] It is obvious that in order to move forward towards effective carbon pricing supportive measures are indispensable. The most effective measure would be a BCA supporting either a cap-and-trade system or a carbon tax (see for example Böhringer et al. 2012a, 2012b, 2012c; Fischer and Fox 2012). Given unilateral carbon pricing a BCA basically consists of import tariffs based on the carbon content of the respective product and an exemption from a carbon price mechanism for all exported goods. It would thus level the playing field between producers subjected to different prices of carbon.

3.2 Consumption versus production based CO_2 accounting

According to Grubb (2011) the sharing of responsibility with regard to the emission of greenhouse gases (GHG) between producers and consumers is ambiguous. Many

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[11] See, e.g, https://icapcarbonaction.com/en/ and https://openknowledge.worldbank.org/handle/10986/26565?CID=CCG_TT_climatechange_EN_EXT or https://energytransition.org/2018/01/5-things-to-know-as-china-launches-the-worlds-largest-carbon-market/.

[12] See also the meta-analysis by Branger and Quirion (2014), which concludes that BCA would in fact reduce potential carbon leakage.

[13] https://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf.

developing country analysts have stressed the fact that GHG emissions are ultimately driven by consumer demand. Therefore, blaming "dirty" exporting countries such as China for their high and increasing shares of global emissions is not entirely fair. These countries are certainly benefitting from their emission-intensive economic models, but at the same time consumers in industrialised countries benefit from cheap imports. The latter aspect, however, is often lost in the debate on how to reduce global GHG emissions. Recent studies confirm the high and rising share of carbon emissions embodied in trade (Weber 2017). Emissions embodied in internationally traded goods as a share of total global emissions have risen over the last 15 years from roughly 25% before 2000 to approximately 33% as of recently. China is exporting approximately 25% of its emissions, on balance, to other countries, whereas some EU Member States are importing more than 30% of their consumption-based net emissions (Davis and Caldeira 2010; Wiebe et al. 2012). Weber et al. (2017) also discover some other worrisome trends regarding carbon emissions embodied in trade. Emission-inefficient countries tend to export more than they import and are specialising in dirty industries, so that trade increases emissions over-proportionally. It can also be shown that trade-exposed sectors are more emission-intensive than sheltered ones, so that growing trade also increases the emission intensity of overall traded goods. One important explanation for these trends is coal abundance in certain economies. The effect of trade on GHG emissions is politically contentious, however, which is why the respective data were removed from the latest IPCC's report for policy makers (IPPC 2014; Victor, Gerlagh and Baiocchi 2014).

For future effective emission reduction strategies, it is nevertheless crucial to finally also consider the demand side of GHG emissions and to tackle the channels by which trade is increasing global emissions. BCA for countries importing large quantities of consumption-based emissions, such as the EU, is the best single strategy to deal with all the problems mentioned above. The relative prices on the European market for carbon intensive products in general and carbon intensive imports in particular have to change accordingly. One of the most important features when designing a BCA for the EU will be accounting for the fact that non-EU countries in general use a more carbon intensive energy mix. If an effective BCA is implemented for economies which are net importers of emissions, it could reduce the negative impact trade has on global emissions by discouraging the relocation of production to countries with lower environmental standards, thus making future global trade more environmentally sustainable (see section 3.3.2.2 for design options targeting especially the usage of coal in energy production, thus increasing energy prices).

3.3 Design options

There are many different possible specifications for a BCA, but the goal is always the same, namely to level the playing field for goods produced under different environmental regulations. In general, the correlation between economic efficiency of a BCA specification and the chances of implementation is negative due to practical, methodological, political and legal issues (Böhringer et al. 2012a, 2012b, 2012 c). The more efficient a BCA design is the smaller are chances of implementation. On the other hand, the outcome of implementing a BCA based on minimising the above mentioned issues might well be counterproductive due to inducing carbon leakage all the more. Therefore policy makers are faced with the challenge to introduce a BCA specification which at the same time allows the ETS to work efficiently without carbon leakage and is WTO compatible, and accounts for the fact that international players such as China and India might see their whole economic model threatened (Kuik and Hofkes 2010). Failing to do so might either cause an increase in global emissions and job loss in ETS sectors, WTO disputes, or trade retaliation regardless of WTO compatibility (Fouré et al. 2016).

3.3.1 Import tariffs and/or export rebates

First, it has to be decided whether to introduce a full BCA including both carbon based tariffs on imports and carbon based rebates for exports. There is no clear-cut evidence on the importance of rebates for industrialised countries applying BCA. According to Branger and Quirion (2014), the presence of export rebates appears to be one of the most important features to reduce carbon leakage. Böhringer et al. (2012b), however, argue that the inclusion of rebates is of secondary importance for overall efficiency as well as distributional effects, since industrialised economies such as the EU are major net importers of embodied carbon. As long as rebates do not advantage domestic producers they are, however, WTO compatible (Monjon and Quirion 2011).

3.3.2 Measuring carbon content

Measuring the embodied carbon content of imports is certainly the largest practical challenge of introducing a BCA. The methodology used, i.e. the inclusion or exclusion of indirect emissions associated with the production of a product, the units of measurement, and the determination of benchmarks would also be the main negotiation topic between the EU and its trading partners.

3.3.2.1   Total embodied carbon

Based on their static, multi-region, multi-sector computable general equilibrium model of the global economy, Böhringer et al. (2012c) support the expectation that the more embodied carbon is covered by BCA, the more efficient the measure is. However, both product- and sector-specific carbon documentations are subject to a variety of issues (Robinson et al. 2017). Company documentation of carbon emissions has improved over the past decade and the Carbon Disclosure Project (CDP), the world's largest repository of carbon reporting, is annually collecting information for 1,500 companies which in total contribute to 26% of global anthropogenic emissions (Dragomir 2012; see also Matisoff, Douglas and O'Brien 2013). There are also credible standards to measure the carbon footprints of products, such as PAS 2050/GHG or ISO 14040. Nevertheless, methodological differences between the various existing standards for carbon accounting are substantial, leading to massively differing results (Dias and Arroja 2012). Furthermore, administrative and compliance costs of mandatory carbon footprint reporting for every single European product would be considerable, not to mention the impossibility of monitoring the carbon intensity of production of plants in third countries in a life-cycle perspective. Even collecting production-based sectoral data is confronted with enormous challenges, which becomes obvious when studying the process of developing GHG reference values, so-called benchmarks, for certain production activities within the ETS.[14] Finding sector-specific or even product-specific measurements to determine the carbon content of EU imports from potentially non-compliant trading partners, which would then get WTO approval, is highly unlikely. Finally, Zhang and Zhu (2017) demonstrate that even if high quality carbon footprint data were available, multiple border-crossing of certain types of products would add to the administrative burden of a BCA based on sophisticated carbon accounting.

3.3.2.2   Reduced forms of carbon accounting

The administrative, technical or legal issues rendering a complete life-cycle analysis of EU imports impossible suggest the application of some reduced form of carbon accounting. Böhringer et al. (2012c) favour a BCA based on direct fuel emissions and indirect emissions stemming from electricity.

As mentioned above, Weber et al. (2017) find that the abundance of coal and its usage in energy production in some countries is one of the most important drivers of increasing carbon emissions embodied in international trade. According to Nauels et al. (2017) an almost complete global coal phase-out would limit sea level rise by 2050 to 50 cm. These

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[14] https://ec.europa.eu/clima/sites/clima/files/docs/ets_handbook_en.pdf.

findings give cause to consider limiting BCA to indirect emissions stemming from electricity. There are several good reasons for such a narrow BCA. If more comprehensive forms of BCA, such as the one proposed by Böhringer et al. (2012c), prove to be unacceptable for the international community so that trade retaliation (with or without the approval of the WTO) would be the consequence (Fouré et al.2016), it might be useful to focus on the most pressing issues in a first step. The average carbon intensity with regard to electricity used in production in non-EU states is 35% larger than within the EU. This is due to a less energy-efficient production technology and an energy mix relying to a larger degree on more carbon-intensive sources, such as coal. The abandonment of all ETS carbon leakage provisions on the one hand and the targeting of electricity-intensive imports on the other hand would constitute a compromise between economic and environmental interests, preventing not only the bulk of carbon leakage but also providing incentives to increase the efforts of countries such as China to reduce the share of coal in its energy mix at a faster pace than pursued currently. From a practical perspective it should be noted that data on the energy mix a county employs is relatively reliable and readily available. In order to develop benchmarks (the methodology has already been established for the ETS sectors), the EU and its trading partners would only have to agree on the (indirect) energy efficiency of the respective sectors.

The most reduced form of a BCA is of course a tariff on imports based on direct fuel, i.e. combustion emissions. However, this type of BCA would not only be the most lenient, but would also provide no incentives for third countries to reduce the carbon content of electricity, which should be one of the most important long term goals of the international community's climate policy.

3.3.3 Tariff rate differentiation

Tariffs can be applied to all non-EU countries, based on the average carbon content of the abating coalition (in this case the EU) or based on the average carbon content of non-coalition (non-EU) countries or specifically for each non-EU country (Böhringer et al. 2012c). This differentiation is very important as it reflects various practical, legal and diplomatic issues in the debate about BCA. From an efficiency point of view aiming at the most accurate and most specific assignment of carbon contents and differentiating between countries is to be preferred. From a practical point of view, however, the possibility of fraudulent behaviour in the declaration of origin of EU imports is a strong argument against differential treatment between countries. From a legal perspective it is not that clear if country-specific carbon tariffs would not violate the WTO's "most favoured nation principle" demanding that all imports from all parties of the WTO should be treated

similarly in accordance with the most favoured party (Böhringer et al. 2012b). Applying tariffs based on the average carbon content of imports into the EU is of course also a less efficient and less targeted approach. However, as mentioned above, in the absence of complete international compliance it is doubtful that any estimates provided by EU institutions for the direct and/or indirect carbon content of EU imports would not be fiercely contested in ensuing WTO disputes (Kuik and Hofkes 2010). The most frictionless approach would be to assign to EU imports regardless of their origin the same carbon content as if produced within the EU. This less efficient approach as well as some of the reduced forms discussed above should only be used as a default option. No option, however, should be the employment of the so-called "best technology available (BTA)" in the benchmarks determining the carbon content of imports. Here, the best technology in terms of energy efficiency available on the market is used. Not surprisingly Kuik and Hofkes (2010) come to the conclusion that a BCA with BTA would contribute least to global emissions reductions.

3.3.4 Allowances or taxation

Since its revision in 2009 the ETS directive allows for the possibility of forcing importers to participate in the ETS. It is obvious that implementing a BCA in the form of a carbon tax is more straightforward not only analytically, but also with regard to administrative and practical issues. However, particularly two reasons speak in favour of an allowance-based BCA. First, the existence of the legal framework within the ETS to implement a BCA in the form of an allowance-based participation. Secondly, such an allowance-based BCA would be more efficient than a carbon tax levied on importers and is most likely to be WTO compatible (Monjon and Quiron 2011).

4 Revenues

4.1 The model

In order to estimate potential revenues of the proposed BCA we employ a slightly modified version of a specific DYNK (DYnamic New Keynesian) model which was developed and described by Kratena and Sommer (2014). Their approach is a hybrid between an econometric input-output (IO) and a CGE model and is characterised by the integration of rigidities and institutional frictions. In the long-run the model has similarities to a CGE model and explicitly describes an adjustment path towards a long-run equilibrium on the labour market. The term "New Keynesian" refers to the existence of a long-run full employment equilibrium, which will not be reached in the short run due to institutional rigidities. These rigidities include liquidity constraints for consumers (deviation from the permanent income hypothesis) and wage bargaining (deviation from the competitive labour market). The model describes the inter-linkages between 59 industries (NACE rev. 1.1) as well as the consumption of 5 household income groups by 47 consumption categories (COICOP) and covers the EU 27 (as one economy). The model of household demand comprises **three** nests, where in the **first** nest the demand for durable commodities (own houses, vehicles) and total nondurable commodities is derived from a buffer-stock model of consumption. The **second** nest links energy demand (in monetary and physical units) to the durable stock (houses, vehicles, appliances), taking into account the energy efficiencies of embodied carbon in the stocks. Direct CO_2 emissions of households are derived from these energy flows. The **third** nest comprises non-energy and non-durable commodities and is simulated by implementing an almost ideal demand system (AIDS) model with 8 commodity categories. The model of production links the input-output structures (Leontief technologies) of 59 intermediary inputs to a production function with a TRANSLOG specification that has 5 factors (capital, labour, energy, domestic materials and imported materials) as inputs. This specification allows simulating endogenous shares of factors in the production of each sector depending on relative prices and technological trends. The factor energy is further split up into 26 types of energy, from which CO_2 emissions of production are derived, a part of which constitutes the domestic indirect CO_2 emissions due to household consumption. The indirect CO_2 emissions of imports are based on calculations of Arto et al. (2014) using the world input output database (WIOD, Version 2013. The labour market is depicted via wage curves, where wage increases by industry depend on productivity, the consumer price and the distance to full

employment. The model is closed by endogenising parts of public expenditure in order to meet the mid-term stability program for public finances in the EU27[15].

4.2 Tax scenarios

The original version of our model was used by Kratena and Sommer (2014) to analyse the effects of two different EU27 carbon tax scenarios. One of these tax scenarios was a "classical" green tax reform, which taxes production-based GHG emissions on an increasing scale and uses revenues to reduce social security contributions, thus representing a revenue neutral tax shift. This scenario is now modified to also include the taxation of carbon embodied in imports.

In contrast to our simple two country model, where one country represents the EU27 economy and the other one the rest of the world, a more elaborate global G-Cubed model was used recently by McKibbin et al. (2017) to analyse the effects of a carbon tax-BCA combination for the United States. The study offers several important findings. The most important insight in our context is that overall welfare losses expressed in GDP growth deviating from a baseline scenario are small in general, and even smaller if a carbon tax is combined with BCA and revenues are used to reduce other distortionary taxes. Using the revenues to reduce other distortionary taxes is especially important with regard to employment. From a fiscal perspective the most important result is that revenues from a carbon tax-BCA combination are increasing over time (see also Yuan et al. 2017 for the long term stability of carbon tax revenues in general).

As in McKibbin et al. (2017), and for the sake of simplicity, our model does not consider rebates, i.e. exemptions from carbon taxation, for EU exports. Our prime focus lies on estimating revenues for the EU budget in the long run stemming from different BCA specifications in order to demonstrate that, depending on the specification, at least large parts or even more than the current yearly EU budget of about € 145 billion could be financed.

One of the main motivations for introducing BCA, however, is to provide the prerequisites for the ETS to expand to more sectors, to phase out all ETS carbon leakage provisions, to auction off all allowances and to finally limit the overall volume of allowances to actual emissions without risking carbon leakage. Once the ETS is working at its full potential, one of its latest features, the market stability reserve (MSR), can be used to keep the price of carbon stable on a long-term price path in order to meet carbon reduction targets (EU2050). In such a setting the ETS framework would resemble more closely an actual

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[15] Croatia, which joined the EU on July 1, 2013, is not included.

carbon tax. This is why we assume that the introduction of BCA would indirectly lead to a stable long-term carbon price path and why we consider our model, which features a carbon tax for domestic production-based emissions and a tax for consumption-based emissions embodied in imports, an appropriate approach.

The 3 BCA scenarios applied in our model simulations differ with regard to the emissions accounted for in EU imports. Every different BCA scenario is modelled as a tax on EU imports combined with a classical carbon tax for all domestic sectors. The price path for all scenarios is € 36 per tonne carbon emissions in 2018, increasing steadily to € 400[16] in 2050. In the model revenues from the carbon tax and the BCA are used to reduce social security contributions. This feature models the possibility that a potential BCA could fund the EU budget, allowing EU Member States to reduce their contributions to the EU budget accordingly, which in turn would create space for Member States' governments to reduce more harmful taxes on labour. Revenues from the classical production-based carbon tax would go into national coffers as well, allowing them to reduce the cost of labour even further.

Scenario 1 ("Classic") accounts for all direct and indirect carbon emissions embodied in EU imports. Tariffs are levied on EU imports and are determined based on the average sectoral carbon content of non-EU countries. Although it is the most efficient BCA design, its implementation is considered unlikely and is presented here only as a reference point for the other two scenarios.

Scenario 2 ("EU tec") accounts for direct and indirect carbon emissions embodied in EU imports but uses EU-specific benchmarks (coefficients). Tariffs on EU imports are therefore based on the average sectoral carbon content of EU countries.[17][18]

Scenario 3 ("Elec only") only accounts for the indirect carbon emissions of electricity used in production. Tariffs for non-EU countries are based on the average carbon content of non-EU electricity usage in production. If carbon intensity of energy production in general and the usage of coal in particular are of primary concern it might be a reduced form like this on which all parties could agree. In non-EU countries, especially but not only in countries such as Russia, India and China, energy efficiency is considerably smaller and the share of carbon-intensive sources in the energy mix is larger compared to Europe.

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[16] Nominal values; price path is determined in line with the EU roadmap for a low-carbon economy.
[17] Although EU industries often are the most efficient globally using these benchmarks should not be confused with the BTA scenario (see section 3.3.3).
[18] With respect to issues of practicality this scenario is particularly interesting given that benchmarks for ETS sectors are already determined.

Indirect average non-EU emissions stemming from electricity in production are approximately 35% higher compared to EU benchmarks.

4.3 Results

Our primary focus is to estimate potential long-term revenues of an EU BCA. Welfare effects of green tax shifts are in general ambiguous and certainly depend on the usage of revenues. If other harmful taxes are cut, as in some scenarios in McKibbin et al. (2017) and all scenarios in our own model, almost no effect on GDP growth and even positive effects on the labour market can be expected.

Both the results derived for the US by McKibbin et al. (2017) and our own results for the EU suggest that revenues from BCA are not only substantial but increasing over time. BCA ought to be introduced first and foremost to make domestic effective carbon pricing possible, thus reducing the tax base. Why would revenues from BCA still increase over time? Demand of imports is decreasing as prices are increased by our BCA scenarios. This effect, however, only dampens the overall increasing trend of the share of imports in EU GDP. Accordingly, a BCA would only dampen the rate of imported emission growth. The major uncertainty with regard to revenues is the future carbon intensity of foreign production. The overall trend of carbon intensity in production in non-EU countries is decreasing, but we cannot be certain that this trend continues in the long run.[19] Therefore we model our 3 scenarios twice. The first set of scenarios assumes the current carbon intensity of foreign production to be constant over time. The second set of scenarios assumes that the overall decreasing trend is continued in the future. This results in a rather large range of revenue estimates.

In all 3 scenarios potential revenues are substantial. Implementing the most efficient BCA specification ("classic") would generate enough revenues by 2027 to finance the current EU budget completely.[20] As mentioned above, however, this scenario should be regarded as a reference scenario only as its implementation is very unlikely. But even in the case of a very reduced form of BCA, accounting only for the indirect carbon emissions stemming from energy production ("Elec only") and assuming that foreign carbon intensity of electricity production is decreasing and energy efficiency in production is increasing, revenues could finance one third of the current EU budget by 2027.

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[19] For example, China, after three years of decline, increased its burning of coal again in 2017.
[20] For the sake of comparability we assume that the current EU budget (€ 145 billion) is increased annually by an inflation factor of 1.5%, resulting in a budget of € 168 billion in 2027.

Figure 1: Revenue potential of a border carbon adjustment

Year	Declining trend of carbon intensity			Constant trend of carbon intensity			Carbon price
	BCA revenues in billion €						€/tonne
	Classic	EU tec	Elec only	Classic	EU tec	Elec only	
2015	27	12	11	31	13	12	21
2016	33	14	13	39	17	15	26
2017	38	17	15	46	20	18	31
2018	44	19	18	54	23	21	36
2019	50	22	21	63	27	25	41
2020	56	25	23	72	31	28	46
2021	65	29	27	85	37	34	54
2022	74	33	31	99	43	39	61
2023	83	37	36	114	49	45	69
2024	93	41	40	129	56	51	77
2025	102	46	45	145	63	58	86
2026	112	50	50	161	71	65	94
2027	122	55	55	179	79	72	103
2028	132	60	60	197	87	80	112
2029	143	64	66	216	96	88	121
2030	154	69	72	236	105	97	130
2031	166	75	78	259	116	107	141
2032	179	81	85	283	127	117	152
2033	192	87	93	308	139	129	163
2034	206	93	101	334	151	140	174
2035	219	99	109	361	164	153	186
2036	234	105	117	390	178	166	197
2037	248	111	126	419	192	179	209
2038	263	118	135	450	207	193	222
2039	278	124	145	481	222	208	234
2040	294	131	155	514	238	224	246
2041	311	139	166	551	257	241	261
2042	329	146	178	589	276	259	275
2043	347	154	190	628	295	278	290
2044	366	162	203	668	316	298	305
2045	385	170	216	710	337	319	320
2046	404	178	229	753	359	340	336
2047	424	186	243	797	382	362	351
2048	444	194	258	843	406	386	367
2049	465	202	273	890	431	410	384
2050	486	211	289	938	456	434	400

Source: own calculations, nominal values assuming a standard inflation rate of 1.5%.

In addition to projected revenues figures 1 to 4 show the effect of the three scenarios on total EU employment. In figures 1 and 3 the model assumes constant carbon intensity of foreign production whereas in figures 2 and 4 a continuing overall trend of decreasing carbon intensity in foreign production is assumed. Although the proposed tax shifts have no significant effect on economic growth, figures 3 and 4 show that total EU employment is positively influenced by the reform. Assuming constant carbon intensity of foreign production, the "classic" scenario would even result in a 1% increase in total EU employment by the year 2040 compared to a base-line scenario (figure 3). These results are clearly encouraging but it should be noted that further research on the distributional effects of such a reform on Member States and economic sectors is necessary. If the proposed tax shift is coordinated with EU regional and cohesion spending to counter potential negative effects of such a reform the EU budget could effectively be turned into an effective tool to foster environmental, economic, social and institutional sustainability.

Figures 1 to 4: Revenues and employment effects of various BCA scenarios
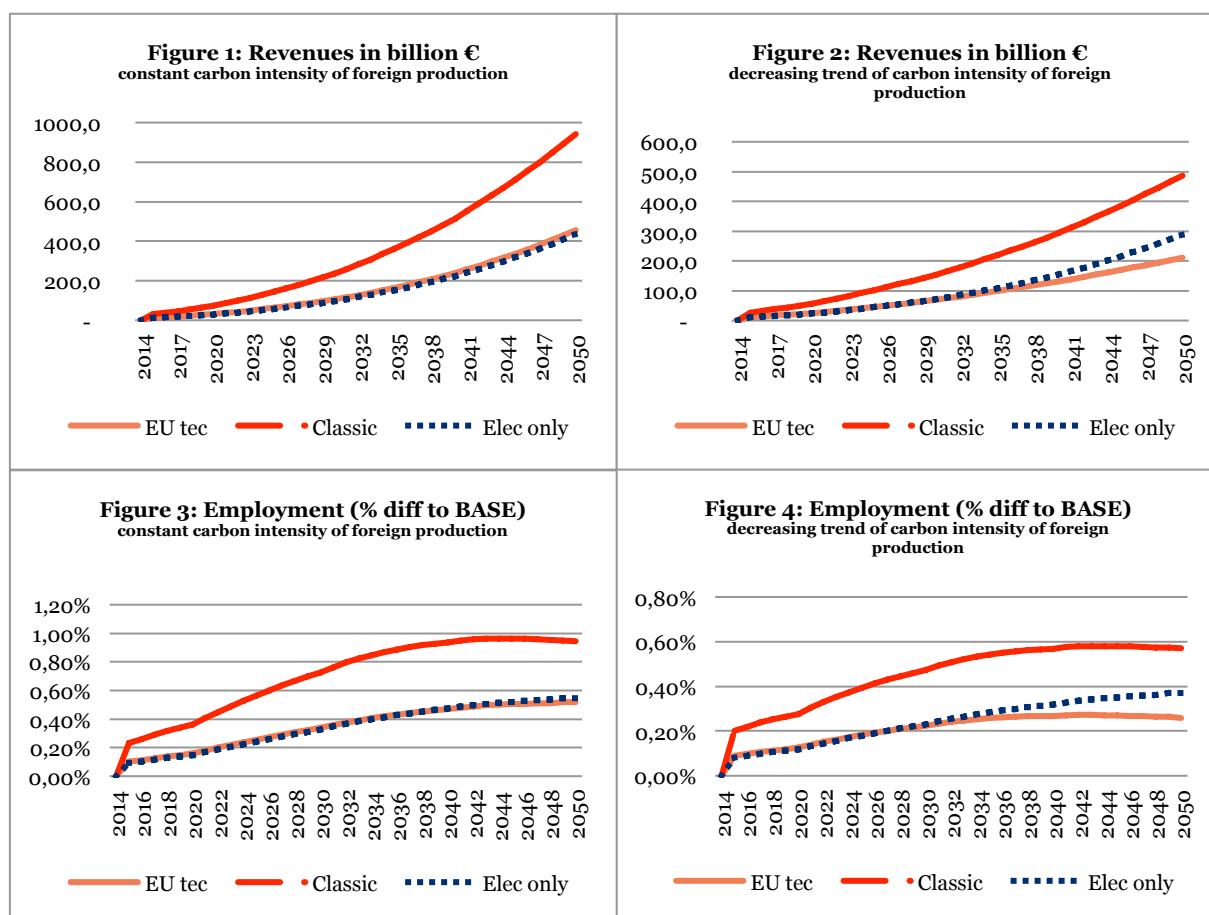
Source: own calculations, nominal values assuming a standard inflation rate of 1.5 %.

5 Conclusions

By combining the issues of necessary reform of EU funding and effective unilateral carbon pricing we aim at revitalising the debate about BCA. A BCA for the EU ETS, whether tax- or allowance-based, is an ideal instrument to finance the EU budget in the future. With its Pigovian properties and as a supporting measure for strong unilateral carbon pricing it corresponds well to the definition of a sustainability-oriented revenue source to finance the EU budget (Schratzenstaller et al. 2017). In existing ETS reform proposals, BCA up to now was not considered the best option to deal with carbon leakage in the EU ETS due to its complexity and the potential of WTO disputes and trade retaliation. As highlighted by previous authors we want to emphasise that there are design options for a BCA which are not only (cost) efficient but might also prove to be acceptable for the EU's major trading partners. Compared to a full-fledged BCA which would fully account for all carbon emissions embodied in EU imports, we discuss two less far-reaching measures which (at least in a first step) should be considered for diplomatic, legal, technical and practical reasons. The best outcome in potential disputes between the EU and its trading partners would be a tariff on EU imports based on benchmarks determined within the ETS, i.e. assuming that it takes the same amount of carbon to produce abroad.

Another even more lenient measure could be a tariff on EU imports based on their true indirect electricity-related carbon emissions stemming from the sources used in energy production. The heavy use of coal in export-oriented economies such as China is one of the channels by which the carbon intensity of trade is increasing. Recent studies come to the conclusion that one of the most pressing issues with regard to combatting climate change would be to phase out the usage of coal in energy production by 2050. Therefore, concentrating on indirect emissions stemming from usage of electricity in foreign production could constitute a compromise in a future BCA scheme. The revenues of this most-reduced form of BCA could finance one third of the current EU budget by 2027 even under the assumption that carbon intensity of foreign production will steadily decline. In the long run each one of the discussed BCA specifications could completely finance the EU budget.

Overall we find that, if revenues are recycled in order to reduce taxes on labour, there are de facto no effects on GDP and actually positive effects on the labour market. Of course more in-depth analyses are required to determine the exact effect on specific sectors in the EU if specific reduced forms should be implemented.

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7 Project information

FairTax is a cross-disciplinary four year H2020 EU project aiming to produce recommendations on how fair and sustainable taxation and social policy reforms can increase the economic stability of EU member states, promoting economic equality and security, enhancing coordination and harmonisation of tax, social inclusion, environmental, legitimacy, and compliance measures, support deepening of the European Monetary Union, and expanding the EU's own resource revenue bases. Under the coordination of Umeå University (Sweden), comparative and international policy fiscal experts from eleven universities in six EU countries and three non-EU countries (Brazil, Canada and Norway) contribute to FairTax research.