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Assessing the socio-economic impacts of different ways to recycle revenues from carbon pricing

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SUMMARY

The low-carbon transition is expected to generate large socio-economic implications across regions and sectors, but the revenues collected from a carbon tax can be used to alleviate the potentially adverse societal impacts of decarbonization. Here, we use four leading macroeconomic models with high regional and sectoral disaggregation to assess the potential economic and structural changes of decarbonisation and how these are affected by the use of carbon revenues. We show that the absolute GDP and employment impacts differ depending on economic narrative behind each model, and we derive conclusions that are robust across modelling paradigms. Using carbon revenues to reduce labor taxes alleviates 30%-70% of mitigation costs in CGE models, while directing them to households through lump-sum payments has limited GDP impacts but with a positive trade-off for equity and, therefore, constrain the potential to avoid unfair burden sharing within countries .

EXTENDED ABSTRACT

Decarbonisation is expected to cause large macro-economic, structural change and distributional impacts across countries, sectors and households. Well-designed strategies are required to achieve progressive outcomes of climate policies by considering appropriate compensation schemes using revenues collected from a carbon tax, either by increasing household income through lump-sum payments (“climate dividend”), reducing pre-existing, distortionary taxes, or through transfers towards the social security system. Here, we explore the macro-economic impacts of using carbon revenues in alternative ways, using four well-established multi-sectoral macro-economic models (IMACLIM, GEM-E3-FIT, E3ME-FTT, JRC-GEM-E3). These models have distinct features and integrate different theoretical assumptions on how the economy operates [1, 2]. E3ME-FTT is a demand-driven, nonequilibrium model that assumes that both labour and capital are not fully utilized, whereas GEM-E3-FIT, Imacim-R and JRC-GEM-E3 are supply-driven, Computable General Equilibrium (CGE) models that assume that any additional decarbonisation-related investment crowds-out investment in other productive sectors, increasing the price of capital and thus having negative economic impacts (Table 1).

These models were used to develop scenarios with increasing climate policy ambition: the NPi scenario assumes the continuation of currently implemented policies, while Paris temperature goals are met in the 2C and 1.5C target scenarios through universal carbon pricing. We explore the macro-economic impacts of different ways of recycling carbon revenues, focusing on two main options suggested by the World Bank (2016) [3]: 1) reducing labour taxes and social security contributions (2C_Lab and 1p5C_Lab scenarios), 2) providing lump-sum transfers to households based on an equal-per-capita basis (2C_Lump and 1p5C_Lump scenarios).

Table 1 Overview of modelling tools

	E3ME-FTT	GEM-E3-FIT	Imacim-R	JRC-GEM-E3
Model type	Macro-econometric model	CGE model	CGE model	CGE model
Macro theory branch	Non-equilibrium (Demand driven)	Equilibrium (Supply driven)	Equilibrium (Supply driven)	Equilibrium (Supply driven)
Technological change	Endogenous	Endogenous	Endogenous with high inertia	Endogenous

Energy system representation	Bottom-up, explicit technologies	Bottom-up, explicit technologies	Bottom-up, explicit technologies	Bottom-up in electricity supply Top-down with CES functions in other sectors
Labour market representation	Imperfect and flexible market	Imperfect and flexible market	Imperfect market with limited flexibility	Imperfect and flexible market
Investment & Finance	Unlimited	Crowding-out of investment	Crowding-out of investment	Crowding-out of investment
Sector coverage	43	52	12	31
Regional coverage	71 countries/ regions	46 countries/ regions	12 countries/ regions	49 countries regions

The transition towards a Paris-compatible pathway entails the restructuring of economic production and consumption across sectors and agents. The uptake of zero-carbon technologies, electrification and energy efficiency bring about a shift from high operating expenditures to technology- and capital-intensive processes. Fossil fuels are substituted by low-carbon alternatives, which may cost more in the short-term. This can increase overall production costs with depressing activity impacts especially in CGE models assuming crowding-out of investment (Figure 1). However, this transition has the potential to increase domestic value in fossil importer countries as low-carbon options are largely produced domestically and improve their energy import bill, thus the terms-of-trade. As expected, more stringent climate policy in a 1.5C scenario increases GDP losses relative to the 2C scenario in all CGE models. The higher technical inertia of the energy system in IMACLIM-R (imperfect expectations, lower availability of low carbon technologies, etc.) imply that high carbon prices are required, which combined with other market rigidities (e.g. for the labour market) cause larger GDP losses than in other models. The integration of detailed energy and transport modelling and bottom-up low-carbon technologies with faster endogenous technological change reduce GDP losses in the GEM-E3-FIT and JRC-GEM-E3 models. The lack of crowding-out effects in E3ME creates positive economic effects triggered by the assumed investment stimulus and endogenous learning [1, 2].

Using carbon tax revenues to reduce labour taxes and social security contributions has positive macro-economic impacts in the CGE models with GDP losses reducing by 30%-70% across models and scenarios. This comes from two channels: reduced labour costs would lower the production cost for firms and distortions are gradually removed so the allocation of resources is more efficient, while additional labour demand would increase household income and consumption. Transferring carbon revenues directly to households on an equal per capita basis can reduce inequality (as shown in [4]) and alleviate negative macro-economic impacts, in particular if their consumption pattern depends on goods and services with a large domestic content. However, this misses opportunities for enhanced productivity and for the creation of new jobs especially in resource-constrained CGE models. In contrast, lump-sum transfers have stronger positive GDP impacts than reducing labour taxes in E3ME as they further increase private demand in the non-equilibrium demand-led modelling framework.

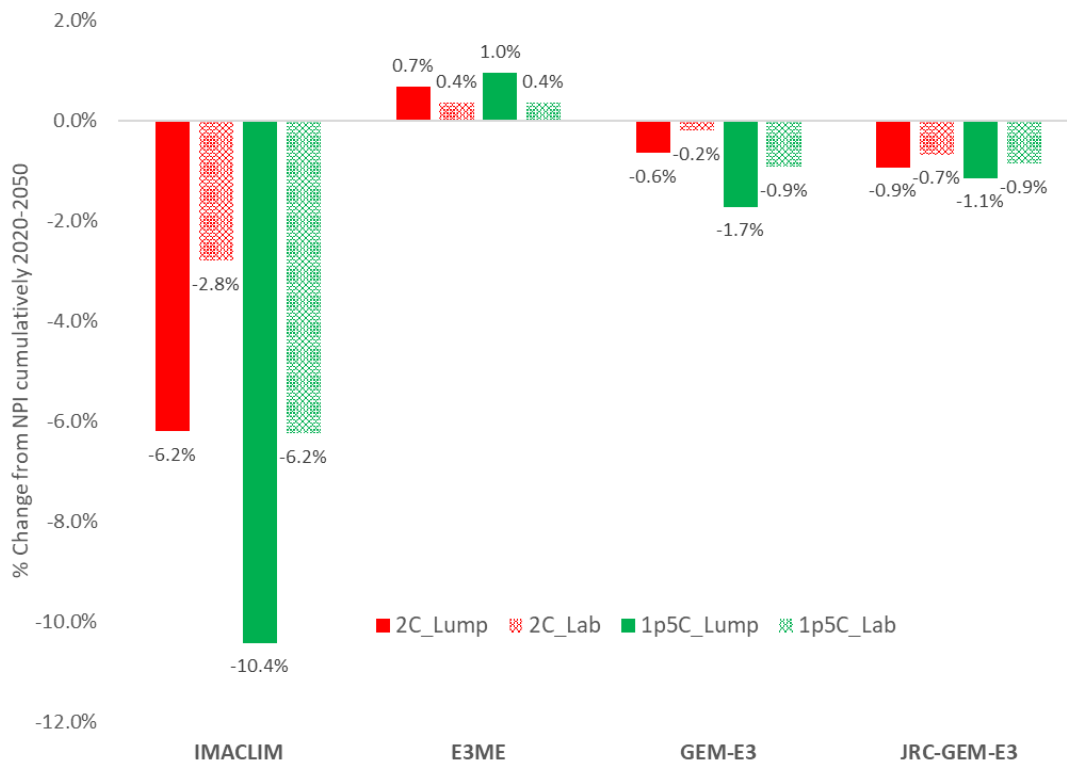


Figure 1: Global GDP impacts of ambitious mitigation scenarios across models

The impacts on aggregate employment are driven by two contradictory trends (Figure 2): declining economic activity tends to reduce employment (in CGE models); but the economy could move toward a more labor-intensive structure as renewable technologies and energy efficiency have higher labor intensity on average compared to fossil fuels [4]. The trade-off between jobs lost in some sectors (e.g. in fossil fuel supply) and jobs creation in others (e.g. renewable electricity, biofuels) would lead to lower impacts on employment than on GDP. The LAB scenarios lead to more positive employment effects in all models as they directly reduce labor cost thus increasing labor demand; this effect is pronounced in GEM-E3 showing that this policy can even lead to net creation of jobs globally by 2050. Meanwhile, in E3ME-FTT, the additional demand created through lump sum transfers has a stronger job creation effect than reducing labour taxes because of the demand-driven nature of the model.

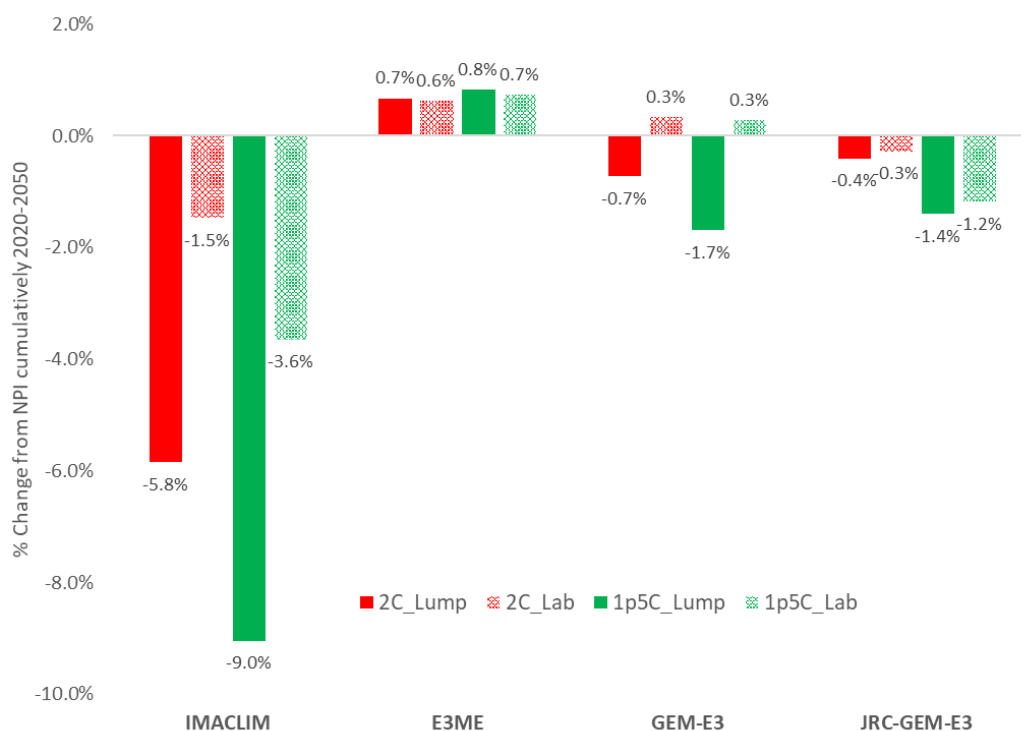


Figure 2: Employment impacts of ambitious mitigation scenarios across models

In the Labor tax recycling scenarios, the services sector production registers the largest increases compared to Lump sum transfer scenarios in the CGE models accounting for about [49%-60%] of total GDP gains, while industries account for [28%-30%] across scenarios. This relative positive effect on services is explained by (i) its large contribution on total economic activity (ii) the fact that it is more labor intensive than industries on average, with a higher labour cost share on total costs (iii) and is less carbon intensive than industries. Regional differences are also observed depending on the initial carbon intensities of the economies, labour costs and the initial share of industry in GDP (Figure 3).

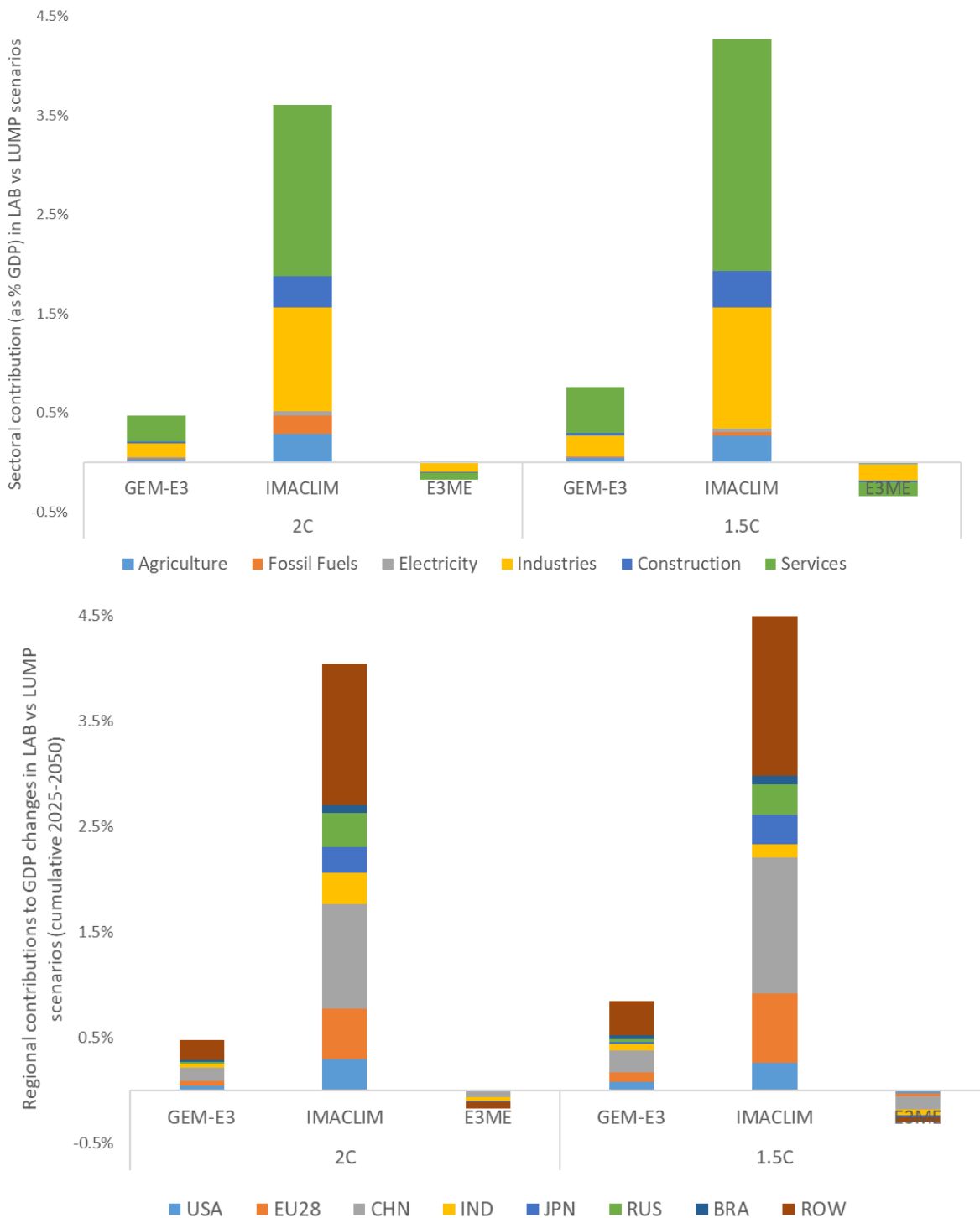


Figure 3: Sectoral (upper) and regional (lower) contribution to changes in LAB scenarios relative to LUMP scenarios

Emission trading systems can support governments to achieve ambitious climate goals. The generated carbon revenues can be used for various purposes, each having benefits and costs. We demonstrate the socio-economic benefits of using carbon revenues to reduce distortive labour taxes, while lump-sum transfers to households can reduce inequality. Carbon revenues, if carefully and strategically considered, can represent a large financial resource for governments to support public policy goals, including growth, societal cohesion, and decarbonization. Finally, we will assess the equity-effectiveness trade-offs of different ways to

use carbon tax revenues as lump-sum transfer to households can improve income equity despite the lower GDP than the labour tax reduction scenario.

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