European Commission

Green taxation and other economic instruments

Internalising environmental costs to make the polluter pay

Annexes

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1. Annex 1: Justification of selected external damage cost estimates for air pollutants and GHGs

1.1. Chosen method

The valuations for the external costs of air pollution and GHGs used in this study are taken from the Handbook on External Costs of Transport that a consortium led by CE Delft prepared for the European Commission in 2019 (CE Delft et al, 2019). That Handbook focusses on emissions of transport. The Handbook used earlier results from the Impact Pathway Analysis (IPA) from the NEEDS (New Electricity Externality Developments for Sustainability) project (NEEDS, 2008) – a part of the series of the so-called ExternE projects that were funded by the European Commission between 1995 and 2008. The results from this study were updated in the Handbook by various adjustments:

- The Concentration Response Functions (CRFs) were adjusted to the WHO (2013) guidelines;
- The valuation was based on a more recent literature review (since 2008) that resulted in higher values of impacts on human health and CO_2 emissions; and
- The price level was adjusted to the year 2016.

The Handbook provides values in €/kg emissions for transport and average values for SO_2, NMVOC, NO_x (values depending on rural or urban environments) and PM_{10} for the EU28 and the individual Member States. The method of updating NEEDS results was also used in CE Delft (2018) which finds for some other substances, such as NH_3, values for the EU28 and also finds specific values for electricity generation for $PM_{2.5}$.

In our research we have used for the air pollution theme the values from the Handbook supplemented by the corresponding and more extensive analysis in the Handbook of Environmental Prices (CE Delft, 2018) that has estimated, using the same methodology, external cost estimates for pollutants that are not common in transport (such as NH_3) or occur in other sectors.

The values derived from the handbooks used in this study are shown in the table below (in 2016 prices).

With regard to GHGs, the approach used in the European Commission Handbook is based on an assessment of the literature since 2009 concerning GHG abatement costs, with a central value chosen of €100/t through to 2030. For a full discussion of the methodological implications of using abatement costs as opposed to damage costs, and of the relevant literature reviewed in this regard, see pp77-78 and Annex D of the European Commission Handbook.

Table 1: Unit damage costs, expressed in €/kg (2016), for inclusion in this research

	NH_3	NMV OC	SO_2	NOx	NOx	NOx	PM2.5	PM2.5	PM2.5
Sectors	*All*	*All*	*All*	*Agricult.*	*Transport*	*Average*	*Transport*	*Electricity*	*Average*
EU-27 + UK average	17.5	1.2	10.9	12.6	16.3	14.8	127.7	19.4	38.7
Austria	27.8	2.3	16.2	24.3	31.8	28.7	174.9	26.8	53.7
Belgium	38.2	3.6	17.1	15.1	19.0	18.0	157.8	34.6	81.1
Bulgaria	5.6	0.0	4.2	5.9	8.0	7.0	73.2	7.1	9.2
Croatia	17.9	0.9	8.8	11.4	14.5	13.3	106.8	16.2	21.2
Cyprus	3.8	0.0	7.8	4.5	6.4	5.4	40.0	10.9	14.0
Czechia	27.4	1.1	11.6	14.8	19.5	17.4	144.7	22.6	35.0
Denmark	14.0	1.5	11.1	9.6	12.4	11.3	142.2	13.9	25.8
Estonia	10.5	0.3	6.2	3.4	4.2	3.9	58.1	5.9	8.4
Finland	7.0	0.4	5.8	3.5	4.2	3.9	112.8	4.8	10.1
France	15.4	1.5	15.0	16.2	20.3	19.0	156.5	25.1	42.9
Germany	28.1	1.8	17.8	21.6	27.8	25.5	154.5	37.6	68.5
Greece	4.8	0.3	6.8	3.1	4.2	3.6	125.9	7.7	14.6
Hungary	18.9	0.8	10.9	15.8	20.5	18.6	124.8	20.3	33.0
Ireland	4.1	1.7	13.6	10.1	13.5	12.1	248.0	13.6	29.6
Italy	21.6	1.1	14.0	15.1	18.4	17.7	141.7	21.1	46.2
Latvia	8.7	0.4	5.6	4.4	5.5	5.1	107.6	5.7	9.6
Lithuania	7.9	0.6	7.3	7.1	9.6	8.4	101.3	7.7	13.9
Luxemb'rg	60.0	6.2	31.7	38.4	48.3	45.7	212.0	63.7	111.8
Malta	6.4	0.4	5.0	1.4	1.9	1.7	44.8	6.2	8.5
Netherlands	30.0	2.8	21.5	15.3	19.8	18.2	144.1	37.3	81.3
Poland	14.4	0.7	9.0	8.9	11.2	10.4	104.1	16.3	27.9

Portugal	4.3	0.5	5.1	1.7	2.4	2.0	112.5	5.2	21.2
Romania	9.4	0.5	8.1	11.2	15.4	13.3	86.8	12.4	20.9
Slovakia	24.4	0.7	11.1	14.7	19.5	17.3	76.9	18.4	28.3
Slovenia	23.8	1.2	10.0	13.7	17.5	15.9	63.9	16.0	26.7
Spain	6.4	0.7	7.9	5.1	7.0	6.0	132.5	9.8	20.3
Sweden	10.6	0.7	6.8	6.0	7.4	6.9	127.0	6.2	17.6

Note: The values for SO_2 and NMVOC are similar to those in the European Commission Handbook of External Costs of Transport: the damage from those emissions barely varies with the height of emission. Hence valuation of such emissions is considered similar for all sectors (see also the discussion in CE Delft, 2018). Emissions from transport have been recalculated by combining the two values for NOx in the handbook of transport (rural and cities) and calculate the share of transport (measured by the vehicle.km) in rural and city areas in each country based on underlying data obtained in the handbook. A similar approach has been taken for the PM2.5 emissions for transport, which are calculated as an average of the share of transport (measured as vehicle.km) in cities and rural areas. The share of transport in cities has further been allocated to metropolitan areas (>500.000 population) and cities (100,000-500,000 population) on the basis of Eurostat statistics (Urban Audit database).

1.2. Comparison with EU-wide studies of air pollution costs

There have been two EU-wide studies that have estimated damage costs to the environment from air pollution[1]. The original NEEDS (New Electricity Externality Developments for Sustainability) study, stemming from the large ExternE series of studies between 1995 and 2008 published their results in 2008 as a spreadsheet with outcomes from the EcoSense model. These are reported in the table below. Additionally, EEA (2014) published an analysis of damage costs of industrial emissions in facilities that had to report to the E-PRTR. For comparison we compare these with the Handbook that was used in the present research (CE Delft, 2019).

Table 2: Overview of EU wide studies that have estimated unit damage costs from air pollution

Author	NEEDS (2008)	EEA (2014)	CE Delft (2019)
Method	IPA	IPA	IPA (Needs adjusted)
Concentration of PM	Yes	Yes	Yes
Concentration of O_3	Yes	Yes	Yes

[1] We have processed new studies up to December 2020. Eventual later studies have not been included as the material for the workshops was finalized early January 2021.

Concentration of NO_2	No	No	Yes
Concentration of other toxic substances	Yes	Yes	Yes
WHO (2013) CRFs?	No	Yes^^	Yes^^
Sectoral aggregation	Electricity General	Industry (E-PRTR facilities)	Average*, transport, electricity
Differentiation	Height of release (low, unknown, high), EU MS and neighbouring countries	Low, high values, EU MS and neighbouring countries	For NOx and PM2.5: Rural, city, metropole, EU MS
Endpoints included			
Mortality	Yes	Yes	Yes
Morbidity	Yes	Yes	Yes
IQ	No	Yes	Yes
Biodiversity	Yes	No	Yes
Ecosystem services	Crops	Crops	Crops
Buildings/materials	Yes	Yes	Yes
Valuation			
Price level	2005*/*2016*^	2005/*2016*^	2016
Income elasticities	0	0	0.8
PM2.5 (€/kg)	24.4 / *29.6*	n/a	38.7 as average*** 70-381 transport
PM10 (€/kg)	Na	23.0** /*27.9*	22.3
SO_2 (€/kg)	6.5 /*7.9*	9.8** / *11.9*	10.9
NOx (€/kg)	6.9/*8.4*	4.4** / *5.3*	12.6-21.3
NH_3 (€/kg)	12.7/*15.4*	10.5 **/ *12.7*	17.5***
NMVOC (€/kg)	0.7/*0.8*	1.4**/ *1.7*	1.2
CO_2 (€/t)	N/a	9.5**/*11.5*	100
Value of a life year lost	€ 40,000/€48,500	€57,700**/€70'000	€ 70,000

*Notes: *Values for scenario 2010, based on aggregation scheme "SIA_E_PPMc" for Human Health Impacts, based on average meteorology - corresponding to emissions from All SNAP-Sectors - unknown height of release; ** EEA (2014) also provides a calculation with a valuation of a Value of Statistical Life (VSL) which is based on a value of 2.2 million/case. This yields a valuation for each pollutant a factor 2.9 higher than the values based on the VOLY. *** values taken from CE Delft (2018) using the same methodology as CE Delft (2019); ^ The 2005 prices have been expressed in the price level of 2016 for comparison with the CE Delft values by using the EU28 Harmonized Consumer price index (PRC_HICP_AIND); ^^As stated by the authors, see also CE Delft (2020) for further explanation.*

In general the NEEDS figures are lower than the studies by EEA (2014) and CE Delft (2019). The reason is primarily laying in the chosen VOLY. The EEA and CE Delft values produce very similar outcomes in the price levels of 2016, where CE Delft is providing slightly lower figures for PM10, SO_2 and NMVOC and higher values for NOx and NH_3 than EEA, but all in all the differences are within confidence bounds (which are typically in the range of 25-30% for air pollution) with the potential exception of NOx which is based on in CE Delft on the majority opinion in the British COMEAP project on the double counting of NOx and PM10. As NEEDS and EEA do not attribute an individual health effect of NO_2 pollution, their values are lower (see CE Delft, 2020 for explanation). All three studies also provide a further differentiation to values for individual Member States. The CE Delft study is the only one of the three to apply an income elasticity which partially explains the broader ranges of values for PM2.5 and NOx for individual Member States. Wealthier citizens are held to be willing to pay more than less wealthy ones, which results in a wider range of values for average WTP at Member State level. CE Delft also use a higher value for CO_2 than EEA.

1.3. Comparison with Clean Air Outlook

In 2018 the European Commission published the First Clean Air Outlook (EC, 2018) . In this report, cost-benefit analysis have been conducted for policies tor reduce air pollution. The effects that have been analyzed in this framework are completely similar to the European Commission Handbook of CE Delft with two exceptions (see also CE Delft, 2020):

- Mortality and morbidity impacts from NO_2 have been included in CE Delft, following the results of the COMEAP study (COMEAP, 2018), but are not included in the First Clean Air Outlook.
- Prevalence of bronchitis in children aged six to twelve was included in the Clean Air Outlook for PM2.5 emissions but not for NO_2, while it was exactly reversed in the CE Delft study where it was included for NO_2 but not for PM2.5. Overall it should be noted that the contribution of this impact to the damage costs is less than 1% as this is a very small impact as the incidence rates and relative risks are very small for this impact.

The table below provides an overview of all the effects that have been included in both studies and the values that have been chosen.

Table 3: Comparison of impacts and valuation of the Clean Air Outlook (EC, 2018) and the European Commission Handbook (CE Delft, 2019) in €/unit

		Clean Air Outlook (EC, 2018)**		European Commission Handbook (CE Delft, 2019)	
Impacts	**Unit**	**2005**	**2016^^**	**2016**	**Applies to**
Chronic mortality	VOLY	57,700	70,004	70,000	Ozone effects, PM2.5 effects, NO_2 effects*
Acute mortality	VOLY	57,700	70,004	70,000	Ozone effects, PM2.5 effects
Respiratory hospital admissions	Case	2,220	2,693	2,856	Ozone effects, PM2.5 effects, NO_2 effects*
Cardiovascular hospital admissions	Case	2,220	2,693	2,856	Ozone effects, PM2.5 effects
Infant mortality	Case	1,600,000	1,941,184	3,630,643	PM2.5 effects
COPD in adults	Case	53,600	65,030	242,043	PM2.5 effects
Bronchitis in children	Case	588	713	59	PM2.5 effects^, NO_2 effects*
Medication use and lower respiratory symptoms because of asthma	Case	42	51	59	PM2.5 effects
Working Days loss	Days	130	158	134	PM2.5 effects
Minor Restricted Activity Days	Days	42	51	46	PM2.5 effects, ozone effects
Restricted Activity Days	Days	92	112	134	PM2.5 effects

*Notes: * Effects included in CE Delft (2019) but not in EC (2018). ^Effects included in EC (2018) but not in CE Delft (2019); ** Only the lower bound estimates have been included, in accordance with the report that takes a cautious approach in estimating the benefits from air pollution. ^^ Converted to 2016 prices using Eurostat HCIP index for the EU28.*

We note here that the valuation framework seems to be relatively similar to both studies. For adult mortality impacts, that explain over 70% of the total damage costs, both studies use exactly the same value. The European Commission Handbook uses considerably larger values for infant mortality and COPD in adults than the Clean Air Outlook which may result in slightly higher damage cost estimates. However, the Clean Air Outlook uses larger values for the working days loss.

Overall we conclude that both frameworks are very similar with respect to impacts that have been included and valuation.

1.4. Studies of air pollution costs in individual Member States

There have also been a number of studies to estimate the costs of air pollution in individual Member States, and these are presented below for comparison.

Table 4: Overview of national studies that have estimated unit damage costs from air pollution for individual countries

	Belgium (Flanders)	Ireland	Netherlands	Germany	Denmark
Author	VITO (2010)*	EnvEcon (2015)**	CE Delft (2017)	UBA (2019)	Andersen et al. (2019)
Method	IPA (Needs adjusted)*	Econometrics	IPA (Needs adjusted)*	IPA (Needs adjusted)*	IPA
Types and dimensions of air pollution calculations					
Concentration of PM	Yes	Yes	Yes	Yes	Yes
Concentration of O_3	Yes	Yes	Yes	Yes	Yes
Concentration of NO_2	No	No	Yes	Yes	Yes
Concentration of toxics	Yes	No	Yes		
WHO (2013) CRFs?	No		Yes^	Yes^	Yes^
Sectoral aggregation	Transport, other (services, industry, electricity, households)		Some specific numbers for electricity or transport	Transport, industry, electricity generation, households	Transport, industry, other (incl. households, agriculture, shipping)
Differentiation	high/low chimneys Transport (rural, cities, motorways),	Average, rural and various city sizes	Low, Central, High values	City sizes, rural. Numbers for various vehicle types	Regions and population density
Mortality included?	Yes	Yes	Yes	Yes	Yes
Morbidity included?	Yes	Yes	Yes	Yes	Yes
IQ loss included?	No	No	Yes	No	No
Biodiversity included?	Yes	Yes	Yes	Yes	No

Ecosystem services	Crops	Unclear	Yes	Crops	No
Buildings/materials	Yes	No	Yes	Yes	No
Values (price level)	2009	Unclear	2015	2016	2016
PM2.5 (€/kg)	22-141	7.5	79.5	58.4	76.8
PM10 (€/kg)	17-125	n/a	44.6	41.2	NA
SO_2 (€/kg)	10	4.8	24.9	15.04	40.9
NOx (€/kg)	6.3	1	34.7	17.93	34.1
NH_3 (€/kg)		0.8	30.5	32.0	20.1
NMVOC (€/kg)	7.5	0.9	2.1	0.205	NA
CO_2 (€/t)	20	n/a	57-300	180-640	NA
Value of years of life lost (VOLY)	€ 44,379	Not given	€70,000^	€70,000^^	€ 149,637

** Needs adjusted means that the original NEEDS study is used as a starting point, but adjustments to these results have been made. ^Central values with a VOLY of €70'000 have been reported. In CE Delft (2017) two additional values have been calculated with a VOLY of €50'000 and €110'000 respectively. ^^Not given in the report but based on personal communication with the authors.*

In general the handbooks of Denmark, the Netherlands and Germany give comparable figures for most pollutants although the NOx valuation in Germany is about half of that in Denmark and the Netherlands., which may relate to the fact that chronic damage costs because of NO_2 were not taken into account in the study. The handbook of Denmark uses a higher VOLY but does not monetize biodiversity losses, which makes these values more difficult to compare to others. Ireland is clearly an outlier, which probably relates to the methods that have been applied in this research (econometric method instead of IPA). For Germany, the relatively high values for CO_2 valuation relate to the fact that the other studies have used abatement cost approaches, while Germany used a damage cost approach (with a zero or 1% discount rate which explains the variation).

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2. Annex 2: Extent of internalisation of air pollution and GHGs by Member State and sector

Table 5: Internalised costs, not internalised costs and costs which are exceeded by unadjusted revenues per sector (€ Million, 2016)

	Category	Energy	Industry	Households	Agriculture	Transport	Other	Total
EU-27	Internalised	8,380	31,502	137,173	7,726	32,575	63,299	317,157
	Not internalised	116,832	90,118	0	123,319	105,395	3,832	402,994
	Exceeded by revenue	0	0	36,502	0	0	0	0
Austria	Internalised	38	952	3,163	226	633	1,419	10,789
	Not internalised	1,053	2,929	0	3,248	897	0	3,769
	Exceeded by revenue	0	0	4,198	0	0	161	0
Belgium	Internalised	310	481	5,202	62	902	2,146	9,286
	Not internalised	1466	4999	0	4171	1129	0	11582
	Exceeded by revenue	0	0	36	0	0	146	0
Bulgaria	Internalised	93	150	159	36	898	18	1,353
	Not internalised	3,199	1,105	1,449	600	110	208	6,671
	Exceeded by revenue	0	0	0	0	0	0	0
Croatia	Internalised	12	165	712	84	333	152	1,688
	Not internalise	520	576	463	1,000	0	474	2,805

	d							
	Exceeded by revenue	0	0	0	0	228	0	0
Cyprus	Internalised	5	24	228	3	39	99	564
	Not internalised	465	165	0	82	5	16	566
	Exceeded by revenue	0	0	167	0	0	0	0
Czechia	Internalised	120	645	862	182	1,033	1,183	4,024
	Not internalised	6,476	3,158	2,691	2,673	419	349	15,767
	Exceeded by revenue	0	0	0	0	0	0	0
Denmark	Internalised	45	645	1,503	189	504	934	10,259
	Not internalised	1,221	384	0	2,532	25,589	0	23,288
	Exceeded by revenue	0	0	4,123	0	0	2,316	0
Estonia	Internalised	83	45	181	54	178	145	686
	Not internalised	1,329	282	38	200	187	11	2,047
	Exceeded by revenue	0	0	0	0	0	0	0
Finland	Internalised	496	824	916	141	689	707	6,639
	Not internalised	1,409	745	0	933	948	0	1,169
	Exceeded by revenue	0	0	2,443	0	0	422	0

France	Internalised	1,434	5,466	23,874	1,230	3,912	9,479	52,680
	Not internalised	2,716	9,873	0	20,833	6,476	2,991	35,604
	Exceeded by revenue	0	0	7,285	0	0	0	0
Germany	Internalised	2,097	6,634	30,335	1,587	5,927	11,829	63,666
	Not internalised	42,683	21,411	0	29,709	34,146	2,916	125,609
	Exceeded by revenue	0	0	5,257	0	0	0	0
Greece	Internalised	306	684	1,780	447	823	1,055	7,162
	Not internalised	3,389	1,636	0	806	892	0	4,656
	Exceeded by revenue	0	0	1,732	0	0	336	0
Hungary	Internalised	121	384	1,060	153	471	424	2,613
	Not internalised	1,463	1,167	2,785	2,900	536	1,303	10,153
	Exceeded by revenue	0	0	0	0	0	0	0
Ireland	Internalised	4	386	1,929	76	783	709	5,098
	Not internalised	1,373	656	0	2,932	881	74	4,705
	Exceeded by revenue	0	0	1,211	0	0	0	0
Italy	Internalised	618	6,542	21,914	1,257	3,955	8,716	60,547
	Not internalised	9,826	6,889	0	13,499	13,792	0	26,461

	Exceeded by revenue	0	0	12,264	0	0	5,281	0
Latvia	Internalised	48	67	209	48	138	136	645
	Not internalised	189	107	149	469	266	77	1,258
	Exceeded by revenue	0	0	0	0	0	0	0
Lithuania	Internalised	18	48	408	43	30	224	782
	Not internalised	227	641	362	814	1,440	0	3,473
	Exceeded by revenue	0	0	0	0	0	10	0
Luxembourg	Internalised	5	21	384	0	135	148	937
	Not internalised	61	294	0	482	1,419	63	2,075
	Exceeded by revenue	0	0	243	0	0	0	0
Malta	Internalised	33	5	32	2	24	26	275
	Not internalised	9	2	0	14	222	11	104
	Exceeded by revenue	0	0	154	0	0	0	0
Netherlands	Internalised	142	922	5,407	550	1,286	3,540	21,227
	Not internalised	5,484	5,697	0	7,311	5,686	0	14,797
	Exceeded by revenue	0	0	7,713	0	0	1,667	0
Poland	Internalised	173	1,549	4,432	545	2,885	2,627	12,210

	Not internalised	19,410	10,275	5,357	11,090	2,635	3,777	52,545
	Exceeded by revenue	0	0	0	0	0	0	0
Portugal	Internalised	42	321	1,537	122	695	1,211	4,967
	Not internalised	1,539	1,937	0	1,067	364	144	4,012
	Exceeded by revenue	0	0	1,039	0	0	0	0
Romania	Internalised	128	1,204	1,082	69	800	166	3,449
	Not internalised	3,754	2,835	3,484	3,869	1,487	1,830	17,260
	Exceeded by revenue	0	0	0	0	0	0	0
Slovakia	Internalised	29	128	434	58	424	419	1,491
	Not internalised	752	2,306	896	784	305	419	5,463
	Exceeded by revenue	0	0	0	0	0	0	0
Slovenia	Internalised	85	247	879	3	112	107	1,535
	Not internalised	511	238	0	707	32	466	1,850
	Exceeded by revenue	0	0	104	0	0	0	0
Spain	Internalised	1,288	2,408	9,543	268	3,801	2,897	23,198
	Not internalised	6,107	8,319	0	9,256	3,142	513	24,346
	Exceeded by	0	0	2,992	0	0	0	0

	revenue							
Sweden	Internalised	608	554	1,337	290	937	975	9,388
	Not internalised	203	1,492	0	1,336	2,615	0	959
	Exceeded by revenue	0	0	3,216	0	0	1,471	0

Table 6: External costs per sector and Member State (€ million)

	Energy	Industry	Households	Agriculture	Transport	Other	Total
EU-27	125,212	121,620	137,173	131,045	137,970	67,131	720,152
Austria	1,091	3,881	3,163	3,474	1,530	1,419	14,558
Belgium	1,776	5,480	5,202	4,233	2,031	2,146	20,867
Bulgaria	3,292	1,255	1,608	636	1,008	226	8,024
Croatia	532	741	1,176	1,085	333	626	4,492
Cyprus	470	188	228	85	44	115	1,130
Czechia	6,596	3,803	3,553	2,855	1,452	1,532	19,790
Denmark	1,265	1,029	1,503	2,722	26,093	934	33,547
Estonia	1,412	327	219	255	366	156	2,734
Finland	1,905	1,569	916	1,074	1,636	707	7,808
France	4,150	15,339	23,874	22,063	10,388	12,470	88,284
Germany	44,780	28,046	30,335	31,296	40,073	14,745	189,275
Greece	3,695	2,320	1,780	1,253	1,716	1,055	11,818
Hungary	1,583	1,551	3,844	3,053	1,007	1,728	12,766
Ireland	1,377	1,042	1,929	3,009	1,664	783	9,803
Italy	10,444	13,431	21,914	14,756	17,747	8,716	87,008
Latvia	238	173	358	517	404	213	1,904

Lithuania	245	689	770	857	1,470	224	4,255
Luxembourg	66	315	384	482	1,555	211	3,012
Malta	41	7	32	16	246	37	378
Netherlands	5,625	6,619	5,407	7,861	6,972	3,540	36,024
Poland	19,583	11,824	9,789	11,635	5,520	6,404	64,755
Portugal	1,581	2,258	1,537	1,189	1,059	1,355	8,979
Romania	3,882	4,039	4,567	3,939	2,287	1,996	20,710
Slovakia	781	2,434	1,329	843	729	838	6,954
Slovenia	596	485	879	709	144	572	3,386
Spain	7,396	10,727	9,543	9,524	6,944	3,410	47,544
Sweden	811	2,046	1,337	1,625	3,553	975	10,347

Table 7: Degree of internalisation per sector and Member State

	Energy	Industry	Households	Agriculture	Transport	Other	Total
EU-27	**7%**	**26%**	**127%**	**6%**	**24%**	**94%**	**44%**
Austria	3%	25%	233%	6%	41%	111%	74%
Belgium	17%	9%	101%	1%	44%	107%	44%
Bulgaria	3%	12%	10%	6%	89%	8%	17%
Croatia	2%	22%	61%	8%	169%	24%	38%
Cyprus	1%	13%	173%	3%	88%	86%	50%
Czechia	2%	17%	24%	6%	71%	77%	20%
Denmark	4%	63%	374%	7%	2%	348%	31%
Estonia	6%	14%	83%	21%	49%	93%	25%
Finland	26%	53%	367%	13%	42%	160%	85%
France	35%	36%	131%	6%	38%	76%	60%

Germany	5%	24%	117%	5%	15%	80%	34%
Greece	8%	29%	197%	36%	48%	132%	61%
Hungary	8%	25%	28%	5%	47%	25%	20%
Ireland	0%	37%	163%	3%	47%	91%	52%
Italy	6%	49%	156%	9%	22%	161%	70%
Latvia	20%	38%	58%	9%	34%	64%	34%
Lithuania	7%	7%	53%	5%	2%	105%	18%
Luxembourg	7%	7%	163%	0.1%	9%	70%	31%
Malta	79%	72%	588%	13%	10%	70%	73%
Netherlands	3%	14%	243%	7%	18%	147%	59%
Poland	1%	13%	45%	5%	52%	41%	19%
Portugal	3%	14%	168%	10%	66%	89%	55%
Romania	3%	30%	24%	2%	35%	8%	17%
Slovakia	4%	5%	33%	7%	58%	50%	21%
Slovenia	14%	51%	112%	0.4%	78%	19%	45%
Spain	17%	22%	131%	3%	55%	85%	49%
Sweden	75%	27%	341%	18%	26%	251%	91%

3. Annex 3: Review of available valuation studies for water pollution

3.1. Nitrogen emissions

The ‘impact pathway’ approach has in recent years been applied to water pollution by nitrogen. It aims to identify site- and catchment-specific benefits associated with abatement measures by linking economic and environmental data through consecutive modelling stages, allowing for monetization of end point effects. Analytically this methodology is site-specific, bottom-up and generates different results for different catchments.

Andersen et al. (2011) applied the impact pathway approach to six European countries (DK, NO, UK, CR, LU, IT) and estimated external costs of nitrogen for surface water quality, drinking water, ammonia and GHG. Keeler et al. (2016) estimate the external costs of nitrogen at up to USD 10/kgN for various US-Minnesota catchments, focusing on GHG, ammonia and drinking water, but leaving out surface water quality. They rely on an impact pathway approach for the health costs related to ammonia and drinking water.

Andersen et al. (2019) demonstrate the comprehensive datasets required for implementation of the impact pathway approach to estimate external costs of nitrogen leaching to surface waters. They establish dose-response relations to link the excess nitrogen (cf. the annual gross nitrogen balance) leaching to coastal water bodies and the implications for water quality, measured as sight-depth. A measure of sight-depth influences economic valuations of recreation benefits and waterfront property owners’ amenity benefits, as derived from contingent valuation studies. The ecological criteria for good coastal water quality frequently refer to the depth limit for seagrasses that in turn has been found to correlate closely with sight depth. Sight depth is thus a reasonable proxy, for which data availability is good. The amenity and recreation benefits reflect significant use values, but there are further ecosystem services available which are not included, e.g. fish stocks. Non-use values are also not included. These omissions are due to the difficulties in identifying adequate dose-response relations from scientific literature. The figures thus represent a conservative estimate of externalities.

The aggregate values identified are distributed across the initial applications and losses of fertilizer-N via the nitrogen-leaching simulation model NLES, which takes account of the fate over time of total N. The analysis is demonstrated for ten comparable coastal water bodies situated in the Baltic Sea and the North Sea, with external costs of eutrophication per kg of surplus fertiliser-N leaching found to range from €0.3-10 per kg surplus N (geometric mean: €1.94/kgN). The N-surplus at field level corresponds to the gross nitrogen balance. The external cost range rises to €2-11.5 per kgN when factoring in cascading health burdens of ammonia and drinking water contamination plus the GHG of nitrous oxides (at €24/tCO_2eq). When distributed over the downstream surplus N reaching water bodies, water quality costs per se range from €2.5-32 per kgN (geometric mean: €6.79 per kgN) (excluding GHG/DW/NH_3). The estimate range reflects differences in population densities and the variability in leaching according to the site conditions of soil, hydrology etc.

3.1.1. Preferred values for valuation

For drinking water we follow the World Bank and apply the dose-response function for bladder cancers derived from a larger cohort study. It applies to potable water sourced from surface waters, and to groundwater reservoirs adjusted with the nitrate pulse over a ten year period. The methodology was used for the external cost study of catchments in six European countries (CZ, DK, IT, LU, NO, UK) from which the results (Andersen et al., 2011) have been adjusted to correspond with the valuation metric for statistical life/life-years used in this study.

For surface waters the dose-response relations between N-surplus of agricultural soils and the N-leaching to water bodies and their quality at the coast in the study by Andersen et al. (2019) is applied to the coastal regions of EU27 at NUTS3 level (Eurostat, 2017), using the resulting geometrical mean of €1.94 per kg surplus N as the starting point. We adjust the estimate to reflect willingness-to-pay at income levels and relative prices as well as population densities of individual Member States. For the remaining agricultural soils located in non-coastal territories we assume a nitrogen retention rate of 50%, whereby their impact on surface water quality in the coastal areas is less pronounced. This methodology applies to the entire territories of landlocked Member States as related to downstream impacts at the principal coastline affected.

3.2. Phosphorus emissions

Although there is also a gross nutrient balance for phosphorus, we use here Eurostat's figures for the total amount of phosphorus applied in agriculture. Phosphorus triggers eutrophication in freshwaters, which has negative impacts on recreation and amenity values for residents, as discussed above for nitrogen.

Based on a similar approach as for nitrogen we offer an estimate of the externalities related to phosphorus fertilisers, derived from the results by Hansen et al. (2009) from the EXIOPOL project. The MyLake model (Saloranta and Andersen 2007) was used to simulate daily total phosphorus and chlorophyll a concentrations in various layers of a lake. Three different parameter and input data files are required to run a MyLake model application. These three files contain: 1) time series of meteorological variables and inflow properties, 2) lake morphometry and initial profiles, and 3) model parameter values. Daily total inflow to a lake was used together with daily simulated concentrations of total phosphorus (TP) in the main tributary.

This study finds a dose-response function of 0.131 ugP/litre per tonne phosphorus applied as fertilisers to the agricultural catchment area, which with a water flow of 5000 l/s suggests an annual leaching rate of 2%. Although phosphorus leaching differs from nitrogen by being more erratic and depending on sudden rainfalls, erosion etc., we consider this a reasonable estimate of the annual leaching rate over a longer time span. Hansen's dose-response relation for Secchi-depth is 0.0168 meter per ugP/litre, which for the catchment analysed produces an external cost of €4.19 per kg P-fertiliser applied. Similarly as for nitrogen, the valuation is based on studies identifying the impact of sight-depth on residents' recreational benefit via changes in waterfront property prices. Recreational benefits of non-residents and wider ecosystem services related to water quality of lakes are not included, due to the absence of scientific studies demonstrating how they can be linked to Secchi depth.

The catchment is situated in southern Norway, where lakes have relatively good visibility. Considering that the Secchi depth function is logarithmic and to reflect conditions in Europe more widely, we adjust the dose-response relation downwards with a factor of 10 and come to an external cost of €0.42 per kg P-fertiliser applied. In the absence of catchment specific modelling we consider this to constitute a lower-bound conservative estimate of the external costs. When updated from the study's price level of year 2000 to 2016 we come to €0.84 per kg P-fertiliser applied. We adjust this estimate from Norwegian conditions to reflect WTP at income levels and relative prices as well as population densities (as a proxy for residential densities) of individual Member States.

Mineral Phosphorus fertilisers have a content of cadmium, for which there are potential negative health effects (e.g. osteoporosis among women through food with cadmium traces).

The study of Pizzol and Thomsen (2014) modelled the cadmium soil deposits and plant uptake of cadmium, with the subsequent human intake, and derived an estimate for the external costs related to P-fertilisers due to accumulation of soil cadmium. The estimate is preference based, and is relevant for assessing the external costs of cadmium in the present study. Their results have been adjusted to be consistent with the 2016-valuation of statistical life in the costing of air pollution, whereby the external cost is €0.66 per gram cadmium applied. The EU limit value is 60 mg per tonne of phosphorus, whereby the external cost is €0.04 per kg P-fertiliser applied. We adjust this estimate from Danish conditions to reflect WTP at income levels and relative prices as well as population densities of individual Member States.

3.3. Preferred estimate values for valuation of nitrogen and phosphorus emissions

The table below shows our preferred estimates for these emissions. They can be applied to emissions from Eurostat.

Table 8: Preferred estimated values for valuation of nitrogen and phosphorus emissions (reference year 2016)

Member State	Gross nitrogen balance value (€/kgN surplus)	Phosphorus emissions value (€/kgP applied)
BE	6.00	4.35
BG	0.20	0.32
CZ	1.40	0.94
DK	2.33	2.02
DE	2.99	2.54
EE	0.45	0.24
IE	1.23	0.93
EL	0.77	0.73
ES	0.85	0.90
FR	1.75	1.22
HR	1.15	0.51
IT	1.89	2.13
CY	1.40	0.87
LV	0.16	0.23

LT	0.15	0.28
LU	3.72	3.10
HU	0.33	0.67
MT	2.72	2.16
NL	5.71	4.93
AT	0.88	1.19
PL	0.59	0.70
PT	0.82	1.00
RO	0.30	0.45
SI	0.58	0.91
SK	0.61	0.89
FI	0.16	0.21
SE	0.27	0.31

Notes: The table presents figures for total nitrogen and total phosphorus from the agriculture sector. The valuation technique used is the impact-pathway approach, considering the end points of eutrophication and human health.

Reference sources used for nitrogen are Andersen et al., 2011 and 2019. If using GNB/ha multiply with utilised agricultural area (UAA).

Reference sources used for phosphorus are Hansen et al, 2010 Pizzol and Thomsen 2014. If using P/ha multiply with UAA.

3.4. Discussion

Values for nitrogen excess load and phosphorus emissions can be found but it should be emphasized that some important ecosystem services are not included – for a simple thing as fish life. So far we have found no indications in literature of the specific dose-response to improved water quality (and also assuming that the relationship would be complex in terms of species, currents, catches, climate etc.). Thus the figures are illustrative for some external costs to water quality – but do not cover all external costs. More research is needed to clarify and add more impact pathways.

Nitrogen and phosphorus are also far from the only impacts from water pollution. Pesticides and heavy metals may be important drivers determining water quality.

Because of the incomplete picture the results below will need to be interpreted carefully.

3.5. References

Andersen et al. (2011) Monetary valuation with impact pathway analysis: Benefits of reducing nitrate leaching in European Catchments. International Review of Environmental and Resource Economics 5:199-244.

Andersen et al. (2019) Economic benefits of reducing agricultural N losses to coastal waters for seaside recreation and real estate value in Denmark. Marine Pollution Bulletin, 140:146-156.

Hansen et al. (2009) External costs of nutrients (N and P) – first estimates. Report of the EXIOPOL project

Keeler et al. (2016) The social costs of nitrogen. Science Advances 2(10)

Pizzol and Thomsen (2014) Comparative life cycle assessment of wastewater treatment in Denmark including sensitivity and uncertainty analysis. Journal of Cleaner Production 68(4): 25-35

Saloranta and Andersen (2007) MyLake - A multi-year lake simulation model code suitable for uncertainty and sensitivity analysis simulations. Ecological Modelling 207(1):45-60

4. Annex 4: Review of valuation studies for water scarcity

A wealth of literature exists on the measurement of environmental values associated with water, in Europe and elsewhere. However, this project contains a specific context that must be matched in the source literature for those values to be useful.

The context of relevance contains the following features:

- **Water scarcity:** where extraction of water resources has negative impacts on the environment (as opposed to pollution impacting on water quality, for example).
- **Environmental values:** the subject of the study must be the environmental impact of water scarcity - many studies measure the impact of scarcity on other extractive uses, such as agricultural or industrial users. This is not a measure of environmental value but instead an estimate of market value for consumptive use.
- **Marginal values:** to estimate a unit value of the environmental externality, the change in environmental impact must be the subject of the study. Some studies seek to measure the total value of an asset, such as a lake or river. To appropriately measure the impact of scarcity on a water bod the marginal, or change in, environmental value (and therefore water use) must be the focus of the study.
- **Estimates of water use:** to produce an estimate of the externality value in reproducible form, a unit value is required. As such, an estimate of the change in volume of water to the environment is required. Thus, the value per unit of water can be produced (e.g. €/m^3).

The number of studies that have been undertaken that focus on the impact of water extraction on associated environmental values of that water, in which a change in the volume of water is also estimated in the analysis, is very small. However, a number of studies from outside Europe were identified, and some in Europe.

It is important also to recognize that in most cases the values of focus in the study were not the full range of ecosystem services impacted by water scarcity, but instead some key values considered by the study authors to be of most interest. These are often preservation of endangered species and some cases recreation values such as fishing and swimming. As such, the estimates produced can be seen as conservative estimates of the full scale of environmental externality produced by water scarcity.

The table below outlines a number of studies conducted to estimate the value of some of the ecosystem services mentioned above (with a strong focus on non-use values related to environmental well-being, where available). These valuations represent the external cost that is incurred by the loss of the ecosystem services. As can be seen in the table, values differ significantly based on the valuation methods used, the ecosystem services accounted for, and the body of water studied.

However, they do provide an understanding of the range of values for environmental externalities produced by over-extraction. Each study has been undertaken in a different context, and a range of different methods have been used to calculate the results. Results are produced € in 2019 per kilolitre (€/m^3)[2], and any future values are discounted to the

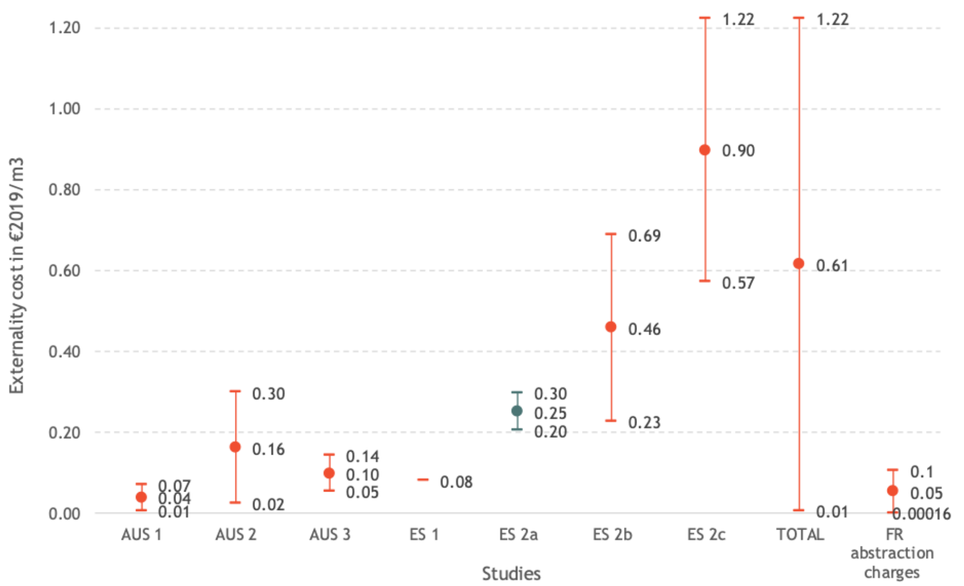
[2] The results were converted to 2019 Euros using HICP data from Eurostat ("prc_hicp_aind" dataset), considering only Eurozone countries. In cases where studies provided externality values in other currencies, the values were first converted to Euros in the given years using ECB exchange rate data (e.g.

present day (over a 30-year period) using a 4% real discount rate as per the Better Regulation Toolbox[3]. The three Australian studies and the first Spanish one produce this by taking the total estimated value for environmental externality and dividing this figure by the change in volume of water that produced it. In these contexts, the situation is one of over-extraction and the studies estimated the WTP of people for improvements to environmental condition, and the volume required to achieve that improved condition. This data is summarized in Figure 1 below.

The Spanish examples are imperfect for this purpose, as they in fact estimate the economic value of the water to productive users, should the state seek to purchase the water from the agriculture sector for environmental purposes. While it can be assumed that this value at least reflects the environmental value of the water should the state be willing to pay it, it is not a true reflection of the externality value.

In summary, externality values converted to Euros in 2019 range from €0.01/m^3 to as high as €1.22/m^3. The examples from Australia are more relevant estimates for the environmental externality on a unit basis than the Spanish examples, which measure surrogates. As such, we would suggest an externality charge with a maximum of **€0.30/m^3** (the maximum externality value identified in the Australian literature). This could be used as a guide for MS when considering MBIs to address over-extraction in their river basin areas. They could be applied to all units of water extracted from the resource, in an externality charge.

Figure 1: Estimated externality value per unit of over-extracted water, €/m^3



Note: For each study, the mean of the maximum and the minimum values is also presented. The methodologies and findings of the studies are presented in Table 9 below.

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https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-aud.en.html).

[3] https://ec.europa.eu/info/sites/info/files/file_import/better-regulation-toolbox-61_en_0.pdf

Table 9: Literature review and estimates of externality values

Pollution or impact	Reference	Scope	Value[4]	Unit	Ref. year	Valuation technique	End points considered	Applicable for	Suitable indicator for 4.2
Water scarcity	Akter et al. (2014). Integrated hydro-electrical and economic modelling of environmental flows: Macquarie Marshes, Australia.	Macquarie Marshes, Australia	0.01-0.07	€/m³	2014 (converted to 2019)	Benefit transfer of choice modelling, combined with hydro-ecological model	Water bird breeding and healthy vegetation	National framework, applied locally	€/m³
Water scarcity	TheCIE (2011). Economic benefits and costs of the proposed Basin Plan.	Murray-Darling Basin, Australia	0.02-0.30	€/m³	2010 (converted to 2019)	Ecological response analysis, combined with choice modelling from other studies	Fish conditions and macroinvertebrate conditions	National framework, applied locally	€/m³
Water scarcity	CSIRO (2012).Assessment of the ecological and economic benefits of environmental water in the Murray-Darling Basin.	Murray-Darling Basin, Australia	0.05-0.14	€/m³	2012 (converted to 2019)	Mix of stated and revealed preferences for a range of use and non-use benefits	Enhanced habitat ecosystem services, carbon sequestration, aesthetic appeal and avoided treatment costs	National framework, applied locally	€/m³
Water scarcity	Martinez-Paz and Perni (2011). Environmental cost of groundwater: a contingent valuation approach.	Gavilán Aquifer, Spain	0.08	€/m³	2011 (converted to 2019)	Contingent valuation estimating recreational and non-use benefits	Environmental status of a wetland supported by the aquifer	National framework, applied locally	€/m³
Water	Pérez-Blanco and	Segura	0.20-	€/m³	2007	Market value	Environmental flows	National	€/m³

[4] Own calculation based on data from the respective study in the table. The value represents externality (annual) values in annualized units, converted to 2020 Euros.

scarcity	Gutiérrez-Martín (2017). Buy me a river: Use of multi-attribute non-linear utility functions to address overcompensation in agricultural water buyback.	River Basin and Júcar River Basin, Spain	0.30		(converted to 2019)			framework, applied locally	
Water scarcity	Pérez-Blanco and Gutiérrez-Martín (2017). Buy me a river: Use of multi-attribute non-linear utility functions to address overcompensation in agricultural water buyback.	Segura River Basin, Spain	0.23-0.69	€/m^3	2017 (converted to 2019)	Shadow price estimate of economic agricultural value using the compensation variation method	Agricultural value	National framework, applied locally	€/m^3
Water scarcity	Pérez-Blanco and Gutiérrez-Martín (2017). Buy me a river: Use of multi-attribute non-linear utility functions to address overcompensation in agricultural water buyback.	Segura River Basin, Spain	0.57-1.22	€/m^3	2017 (converted to 2019)	Shadow price estimate of economic agricultural value using the foregone income method	Agricultural value	National framework, applied locally	€/m^3

5. Annex 5: Water scarcity case studies

1. Thessalia (or Thessaly) RBD, Greece	
Description of the river basin district	The Thessalia RBD can be found in Central Greece, where the country's main agricultural region is located. The total annual water demand in the RBD amounts to approximately 1.3 million m^3, with the majority of this demand coming from irrigation water (91%). The RBD encompasses 72 rivers, three lakes, seven coastal waters, and 32 groundwater bodies. Among them, four are heavily modified water bodies and four are artificial water bodies.[1] Numerous areas are protected, including seven areas that are designated for abstraction of drinking water, 67 for bathing, 16 for bird conservation, 13 for habitat conservation, two for UWWTP, and one due to its vulnerability to nitrates.[2] An assessment of RBDs notes that Thessalia has the highest percentage of natural surface water bodies in poor or bad ecological status across all 14 Greek RBDs (with 40% being classified as poor).[3] Groundwater bodies fared better, with nearly 70% deemed to have a good ecological status. Thessalia has been historically exposed to droughts, leading to a lack of soil moisture, increased evapotranspiration, vegetative stress, and a decline in run-offs, stream flows and groundwater table levels. [4] The District's water deficits are often supplemented by extended and intense abstractions of groundwater resources.[5] The main and most acute problems related to over-exploitation are found in granular groundwater systems and karstic aquifers throughout the RBD. This has led to salinization in numerous groundwater sources, ultimately affecting the quality of water and putting freshwater ecosystems at risk. Surface water is also over-exploited in the Pineios River Basin, as abstraction during the irrigation period overlaps with the low-flow period of the rivers. In some instances, this leads to extremely low or almost inexistent discharges in river bodies over the summer months. The RBMP for Thessalia did not report an estimate of environmental externalities associated with water scarcity.
Water pricing and internalisation of external costs	Across Greece, water supply services in cities are managed by companies called DEYAs, which operate as private enterprises but are owned by municipalities. Each DEYA determines its pricing policy on the basis of their expenses, which must be approved by the municipality council.[6] In a comparative study of the Greek context, Thessalia was found to have the lowest mean payable amount for a consumption basis of 15 m^3, amounting to €6.48.[7] The low price of water coupled with the lack of progressive rates in pricing for consumption is especially problematic in Thessalia, considering that the water balance is deficient in the region. The Joint Ministerial Decision (JMD) 135275/19.05.2017 is a recent national regulatory framework which defines 'resource cost' as the cost of alternative water uses in case a water system is over-used beyond its ability of natural replenishment. The cost is incurred when: a) a groundwater body is evaluated as 'bad' in terms of water quantity; and b) there is inadequate coverage of water needs for human use. The water management authority determines the price per cubic meter (€/m^3), which is paid by end users through tariffs relative to water use. This price is differentiated for types of water uses and ranges from €0.00001/m^3 to €0.0024/m^3 in Thessalia (see table below). The revenues collected through this charge go to a special fund dedicated to financing environmental protection activities.

	Groundwater pricing (resource cost) in €/m^3			
	Residential	Agriculture	Industrial	Livestock
Groundwater areas of the 'Pineios' RB	0.002	0.0024	0.002	0.002

Groundwater area 'Almyros- Pelion' RB	0.00001	0.00001	0.00001	0.00001

Source: Greek Special Secretariat for Water (2017), Management Plans of the River Basins of Thessalia River Basin District.

However, despite efforts to apply pricing measures, private irrigation systems remain uncontrolled and many illegal boreholes have been identified.[8] It is estimated that there are over 30,000 drillings across the RBD, most of which are unlicensed.[9]

Using the resource charges for the Pineios RB as proxies for the Thessalia RBD and groundwater abstraction volumes from the WISE Water Accounts database[10], the annual revenues that could have been collected over the period 2010-2015 were calculated, and compared to what would have been collected given an externality charge of €0.3/m^3:

- Given current resource costs (assumed constant across the period):
  - Agriculture, forestry, and fishing: €1.4-1.9 million;
  - Households: €0.003-0.004 million;
- Given a charge of €0.3/m^3 (assumed constant across the period):
  - Agriculture, forestry, and fishing: €177-238 million;
  - Households: €0.5-0.7 million.

We can conclude that given current resource charges and historical groundwater abstractions, less than 1% of external costs related to water scarcity are internalised in the RBD.[11]

2. Middle Apennines RBD, Italy

Description of the river basin district	The Middle Apennines RBD (also referred to as the Central Apennines RBD) is located in Central Italy and covers a surface of 42 506 km^2.[12] Over 9 million people live within the RBD,[13]among which almost 4 million live in the Lower Tiber, the sub-basin within which Rome is located.[14] In Central Italy, 41% of the land is forested, approximately 34% is covered by arable land, and close to 8% is occupied by settlements.[15] According to the WISE Water Accounts database, the total amount of water extracted from the RBD over the period 2010-2015 ranged from 3,000 hm^3/year to 3,600 hm^3/year.[16],[17] Seasonal water demand is dominated by the agricultural sector, which especially relies on large quantities of water during spring and summer. Meanwhile, the energy sector, mining and manufacturing, services and water collection, treatment and supply all use a substantially smaller amount of water and have a more constant water use. Across the RBD, precipitation rates have decreased by 2 billion m^3 in the last 50 years, and further reductions in rainfall are projected.[18],[19] The Middle Apennines RBD comprises 501 rivers, 38 lakes, six transitional bodies, 22 coastal bodies, and 133 groundwater bodies.[20]A number of areas are protected for various purposes – 253 are dedicated to drinking water purposes, 269 to bathing, 44 to bird conservation, 89 to fish conservation, and 328 to habitats conservation. In the Tiber sub-basin, specifically, the heavy and uncontrolled exploitation of both surface water and groundwater has had some negative effects on the flow of water, which is sometimes sustained by waste water returns.[21]Furthermore, groundwater bodies are often deemed "at risk" because of their poor chemical state, which is often associated with heavy withdrawals. This is also the case in coastal aquifers, due to the ingestion of sea water inland.[22] Water resources are consistently under stress in the RBD, with climate change and the increasing pressure posed by self-supply irrigation cited as explanatory factors.[23]In 2012, 16% of the RBD's surface water bodies were facing significant pressures derived from water abstraction, whilst 15% of groundwater bodies were deemed of 'poor' quantitative status.[24]

	The RBMP for Middle Apennines RBD did not report an estimate of environmental externalities associated with water scarcity.
Water pricing and internalisation of external costs	Water pricing is regulated by two main instruments: integrated service (IS) water charges and concession fees. The IS water charges are integrated tariffs that consist of the sum of the tariffs for water, sewer, and wastewater treatment plant services. This tariff varies according to water use and is constituted by a fixed annual fee (independent from consumption) or a variable fee depending on water consumption. The concession fee for public water use, on the other hand, is due annually and grants the exclusive right to access a specific quantity of water. The amount to pay for the concession fee is based on microeconomic analysis conducted by the Regions that take into account both the sector of use and the type of use. The charging method adopted for each fee depends on fixed parameters, variable parameters, or a combination of both. To quantify the concession fee for each user, the specific quantitative parameter (average flow rate expressed in l/sec, average nominal power expressed in kW or irrigated area expressed in hectares) must be multiplied by the related unitary value (€/ha, €/module, €/kW, €/m^3). If the result of the multiplication is less than the respective minimum concession fee, the latter is due. The framework of IS Water Charges and Water Concession Fees represents the water pricing policy to encourage the efficient use of the resource and to materialise the "polluter pays" principle.[25] The adoption of a new tariff method at the national level in 2015 for the integrated water service municipal water prices includes environmental costs and resource costs. This measure is expected to lead to a better cost recovery and to incentivize a more efficient use of water for water supply and waste water treatment services in the Middle Apennines RBD.[26] However, no evidence was found that this has been implemented.

Integrated services water charges					Concession fee				
Sector	Fixed fee		Variable fee						
	Min	Max	Min	Max	Value per ha	Value per module	Min value	Volumetric value	Power value
	€/yr	€/yr	€/m^3	€/m^3	€/ha	€/module	€/yr	€/m^3	€/kW
Household	14.75	121.76	0.72	8.80	n.a.	n.a.	n.a.	n.a.	n.a.
Agriculture	21.85	26.71	0.40 *	1.74 *	no info	no info	no info	no info	n.a.
Agriculture self-supply	n.a.	n.a.	n.a.	n.a.	0.52 - 0.95	27 - 96.7	15-30	0.11 - 0.15	n.a
Commercial	37.36	80.52	1.47	4.51	n.a.	n.a.	n.a.	n.a.	n.a
Touristic	37.36	0.00	1.40	2.88	n.a.	n.a.	n.a.	n.a.	n.a
Industry	37.36	0.00	1.35	4.07	n.a.	n.a.	no info	no info	n.a
Hydro-electric	no info	no info	no info	no info	n.a.	n.a.	258-300	n.a.	15.5 - 36.1
Other sectors	6.26	1,305.05	0.59	3.55	no info	no info	no info	no info	n.a

* Those values refer only to water tariff. The tariffs for sewer and wastewater treatment plant

	services were not included for the agriculture sector to compare much easier the SI water supply charges with the self-supply taxes. Source: MS expert IT, based on PGDAC.2 and regional annexes reporting the IS Water Charges for each ATO belonging to MARB. Given a lack of data and knowledge of an updated pricing system, which includes environmental and resource costs, we assume that no such costs have been priced in in the period 2010-2015. Using abstraction volumes from the WISE Water Accounts database[27], the annual revenues that would have been collected given an externality charge of €0.3/m^3 were calculated: • Agriculture, forestry, and fishing: €348-539 million; • Electricity, gas, steam and air conditioning supply: €226-266 million; • Mining and quarrying, manufacturing and construction: €79-102 million; • Service industries: €2 million; • Water collection, treatment and supply: €201-211 million; • Households: €4 million. We can conclude that, based on the data available to this case study, external costs related to water scarcity are not internalised in the RBD, in the period studied.[28]

3. Black Sea Basin District, Bulgaria	
Description of the river basin district	The Black Sea RBD is located in the east of Bulgaria, covering 19,004 km^2 of land (14.9% of the country's territory) and 6,358 km^{2}of marine territory.[29]As of 2012, 1,130,429 people lived in the RBD, among which 76.5% lived in urban areas.[30]The area is roughly divided into mountainous terrain and lowlands. The economic activities are dominated by the services industry (60% of the region's gross added value), including the tourism industry. The industry sector is also well developed (33% of the region's gross added value), with the presence of 105 industrial sites across the RBD. The agriculture sector represents 7% of the gross added value.[31] The RBD encompasses 122 rivers, three lakes, 15 transitional bodies, 13 coastal bodies, and 40 groundwater bodies. A number of areas are protected for drinking water purposes (40), for bathing (89), for birds (25), for fish (106), for habitats (48), and for nitrates (2).[32]Furthermore, 7 out of 11 Bulgarian wetlands recognised as Ramsar sites are present on the territory of the RBD.[33]In several areas, water bodies are persistently in 'poor' condition, being influenced by the discharge of poorly treated or untreated wastewater from urban agglomerations.[34] Water is provided by six main supply channels: the public water supply, irrigation systems, independent abstraction, raw and waste water obtained from other water users, and reused water from industrial sources. The main water abstracting activity is the electricity, gas, steam and air conditioning supply, followed by agriculture, forestry and fishing. Across Bulgaria, a significantly larger amount of fresh surface water is abstracted, compared to groundwater. Zooming in on the RBD level, the industrial sector and firefighting services represent the major share of surface water abstracted. Groundwater, on the other hand, is the main source of drinking and household water supply – with 987 groundwater abstraction facilities installed across the RBD. Water is also extracted for irrigation and animal husbandry, industrial needs, and other activities such as mining and electricity production.[35] The WEI+ score of the RBD indicates that water resources are not currently under stress. However, the chemical status of groundwater bodies is problematic, with over 42% deemed to be in 'poor' chemical status.[36] Only two surface water bodies are subjected to water abstraction pressures, representing just over 1% of all surface water bodies. Nevertheless, the RBMP acknowledges that agriculture is a source of significant pressure on water quantity. In addition, the OECD notes that the RBD faces the greatest pressure in terms of water stress across Bulgaria because it has the lowest amount of water resources while facing an increase in tourism activities.[37] The RBMP for the Black Sea Basin District did not report an estimate of environmental externalities associated with water scarcity.

Water pricing and internalisation of external costs	Regarding water abstraction and use, prices charged per sector are identical across the whole country and River Basins Directorates are responsible for issuing permits and for controlling compliance with the requirements.[38] Permits are required for both groundwater and surface water abstraction, with the exception of groundwater abstraction of less than 10 m^3 from wells.[39] The fees paid by major sectors for direct use (i.e. without the added costs of going through water supply companies as intermediaries) depend on water source and water use per m^3. High values were set for independent drinking and household groundwater supply in order to stimulate the use of the public water supply.[40]

Purpose	Water abstraction from surface water bodies (€/m^3)		Water abstraction from groundwater bodies (€/m^3)	
	2019	2021	2019	2021
Public drinking water supply	0.0102	0.0102	0.0102	0.0102
Own drinking water supply	0.0102	0.0153	0.0460	0.0562
Public water supply for irrigation	0.0007	0.0008	0.0066	0.0767
Own water supply for irrigation	0.0010	0.0012	0.0095	0.0117
Water supply for livestock	0.0031	0.0041	0.0307	0.0409
Water supply for aquaculture	0.0010	0.0015	0.0307	0.0409
Water used for cooling of machines during production	0.0002	0.0002	0.0004	0.0004
Water supply in industry	0.0230	0.0256	0.0409	0.0460

Source: Tariff for fees for water use, abstraction and discharge in force since 2017.[41]

Bulgaria has 64 water and sanitation service providers, 56 of which are state-owned. As of 2020, the average price for drinking water supply in the RBD was of approximately €0.92/m^3 regardless of the user type. In the agriculture sector, the cost of serviced water for irrigation is determined by the supplier based on the location of the area, with the price depending on the cost of water supply and the maintenance of related infrastructure. The price is calculated based on the delivered water volume and the price per unit area.[42] These charges are to be paid in addition to the fixed price of irrigation systems.

Using the self-supply charges in the table above for the year 2021 (i.e. “own drinking water supply” and “own water supply for irrigation”) as proxy resource charges (differentiated for surface and groundwater) and abstraction volumes from the WISE Water Accounts database[43], the annual revenues that could have been collected over the period 2010-2015 were calculated, and compared to what would have been collected given an externality charge of €0.3/m^3:

- Given current resource costs (assumed constant across the period):
  - Agriculture, forestry, and fishing: €0.07-0.13 million;
  - Households: €0.007-0.008 million;
- Given a charge of €0.3/m^3 (assumed constant across the period):
  - Agriculture, forestry, and fishing: €15-30 million;
  - Households: €0.04 million.

	We can conclude that given current resource charges and historical groundwater abstractions, less than 1% of external costs related to water scarcity are internalised in the RBD in the agricultural sector, and close to 20% in the household sector.[44]

4. Júcar RBD, Spain

Description of the river basin district	The Júcar RBD, located in the central-eastern part of the Iberian-Peninsula, covers an area of approximately 43,000 km^2 and over 5 million inhabitants. The Basin District takes its name from the Júcar River, which flows 497 km from the high-altitude Montes Universales range to the Mediterranean Sea. The RBD is composed of nine water resource systems, the largest of which is the Júcar System. These systems encompass important socio-economic regions, such as Valencia and Albacete, in addition to ecological areas such several Ramsar wetland sites. Numerous natural river reserves are also present within the RBD, predominantly occurring within the northern regions of the basin, as well as multiple species and habitat protection zones and numerous special protection areas. Finally, the RBD's Natura 2000 network contains 92 Sites of Community Importance and 47 Special Protection Areas. [45] In particular, Albufera de Valencia is a natural space of incalculable wealth, which presents a great variety of habitats. This natural area has been included in the Catalogue of Wet Areas of the Valencian Community and in the List of Wetlands of International Importance and has been declared a Special Protection Area for Birds (ZEPA). However, it is considered to have a poor ecological state due to urban and industrial pressures. These pressures have negatively impacted the survival of the ecosystems associated with the lake and the marsh. The Park's lake is currently a hypertrophic system, as a consequence of excessive inputs of allochthonous organic matter and inorganic nutrients. The "Study for the Sustainable Development of the Albufera de Valencia" expressed the urgency with which the ecological quality of the system needs to be restored and the deficiencies in sanitation systems to be corrected. The RBD is characterized by common flood events during autumn periods and low-flow periods in summer, which often lead to recurrent and severe drought periods. The average availability of water resources has decreased significantly in the last 30 years.[46]Furthermore, climate change impacts are projected to expose the region to significant changes in precipitation and temperature, ultimately leading to reductions in hydrological inflows to rivers and groundwater recharge.[47] The majority of water sources exploited across the RBD originate from surface water (~50% of total demand) and groundwater (~45% of total demand), with a small proportion of demand met through reuse and desalination.[48] The total population which are dependent on the RBD represent a total water demand of approximately 502 hm^3/year, whereas the demand for irrigated agriculture is approximately 2,929 hm^3/year.[49]Furthermore, numerous industrial interests rely on the RBD – e.g. hydropower production and cooling for nuclear power plants. Water resources in the RBD are regularly recorded as under severe stress, due to droughts and water extractions. Overall, it is estimated that there is significant pressure on 33% of groundwater sources from extraction in the JRBD. [50],[51] The RBMP for Júcar did not report an estimate of environmental externalities associated with water scarcity.

Water pricing and internalisation of external costs

In Spain, water is the property of the central state, with the Ministry of Environment delegating water management tasks to River Basin Management Authorities – responsible for the management of the basins and the development of RBMPs to ensure that good ecological status is achieved in all water bodies. The management of droughts in the JRBD is governed by two multi-sector partnerships: the Júcar River Basin Partnership (JRBP) and the Permanent Drought Commission. The JRBP was created in 1936 to bring together the major sectors of water users, central administration bodies related to water, and provincial and local stakeholders. The Partnership is responsible for water infrastructure development within the RBD, in addition to being responsible for establishing environmental objectives, economic recovery of costs, and integrated basin planning and management of the basin.

The main piece of water legislation in Spain is the 1985 Water Law. The legislation was introduced to shift the surface and groundwater ownership from private property to public. This Law was amended in 1999 in order to regulate water rights transfer contracts, attempting to overcome challenges in water resources management.[52] Furthermore, the 2001 Spanish Law of the National Hydrological Plan requires all River Basin Partnerships to develop Special Drought Plans (SDPs).

In regards to water pricing, revenues generated from water services are estimated below. Since water pricing is carried out through several instruments applied on a differing basis (€/ha, €/kW) aggregated tax revenue (€/m^3) values have been estimated dividing total annual revenue obtained for a specific water service by the volume of water delivered for that specific service in the same period. Only revenues for 2012 could be obtained.

Type of water services	Sector (type of water use)	Volume of delivered water (hm^3)	Revenue obtained with water tariffs and taxes (M€/year 2012)	Tax Revenue (€/m^3)
“En alta” (not-purified) supply of surface water	Urban*	240.1	1.2	0.005
	Agriculture/ Livestock	1,457.9	5.2	0.004
	Industry/energy**	0.0	0.0	n.a.
“En alta” (not-purified) supply of groundwater	Urban*	242.9	60.3	0.25
	Agriculture/Livestock	0.0	0.0	n.a.
	Industry/energy**	0.0	0.0	n.a.
“En baja” (purified) supply of urban water	Domestic	181.9	228.7	1.26
	Agriculture/ Livestock	0.0	0.0	n.a.
	Industry/energy connected with the urban network	49.8	66.9	1.34
Distribution of irrigation water	Agriculture/ Livestock	1,462.3	123.1	0.08
Self-supply	Domestic	0.0	0.0	n.a.

	Agriculture/ Livestock	1,095.6	270.5	0.25
	Industry/energy**	136,8	17.9	0.13
Reuse	Urban (gardens irrigation)	0.0	0.0	n.a.
	Agriculture/ Livestock	77.3	0.0	0.00
	Industry (golf)/energy**	0.5	0.0	0.00
Desalination	Urban*	2.6	0.0	0.00
	Agriculture/ Livestock	0.0	0.0	n.a.
	Industry/energy**	0.9	0,0	0.00
Waste water collection and purification in public network	Urban*	361.0	166.5	0.46
	Agriculture/ Livestock	0.0	0,0	n.a.
	Industry/energy**	105.6	48.7	0.46

*Note: Includes industries connected to the public network and ** includes industries not connected to the public network.*

Despite the availability of data depicting the revenues generated by water services, there is no indication of resource/environmental costs included in pricing within the Júcar RBD.[53]

There is no indication of environmental or resource costs included in water pricing. However, using abstraction volumes from the WISE Water Accounts database[54], the annual revenues that would have been collected given an externality charge of €0.3/m^3 were calculated:

- Agriculture, forestry, and fishing: €985-1,158 million;
- Electricity, gas, steam and air conditioning supply: €28-33 million;
- Mining and quarrying, manufacturing and construction: €5-6 million;
- Service industries: €121-125 million;
- Water collection, treatment and supply: €201-211 million;
- Households: €2 million.

We can conclude that external costs related to water scarcity are not internalised in the RBD, in the period studied.[55]

5. Weser RBD, Germany

Description of the river basin district	The Weser RBD, in the north-western part of Germany, covers an area of 49,063 km² and includes five sub-basins.[56] Around 9 million people reside in the RBD, which overlaps seven of the country's federal states: Lower Saxony (60% of the RBD's total area), Hesse, North Rhine Westphalia, Thuringia, Saxony-Anhalt, Bremen, and Bavaria.[57] The RBD comprises 1,380 rivers, 27 lakes, one transitional body, six coastal bodies, and 144 groundwater bodies. A number of aquatic areas are protected, including 157 for drinking, 207 for bathing, 149 for bird protection, 620 for habitat protection, and

26 due to their vulnerability to nitrates.[58] Almost all of the groundwater bodies are linked to groundwater-dependent land ecosystems. In addition, the RBD encompasses 504 water-dependent areas for Flora, Fauna and Habitats (FFH), as well as 90 water-dependent bird protection areas. Some of these areas belong to both categories.[59]

Germany is highly industrialised, intensively farmed and densely populated, and so is the Weser RBD.[60] Approximately 2.2 million hectares (i.e. about 47% of the area) is dedicated to agriculture.[61] The region's average population density is of 194 inhabitants/km², slightly below the German average of 233/km². The area is also used for electricity generation, accounting for about 0.4% of the country's total electricity generation. There are approximately 248 thermal power plants across the RBD, which add up to a total installed capacity of about 5.6 GW.[62] In addition, its potential to generate hydropower is largely exhausted, as a number of plants have been built.[63]

Water provision is predominantly autonomous in the industry sector, with the public water supply only playing a subordinate role. Around 99% of the total self-supplied water in the RBD is used by the manufacturing industry, and a large proportion of this water is used for cooling purposes.[64] The public water supply withdraws around 570 million m³ of water across the RBD, mostly from groundwater sources.[65] In 2013, over 5,089 million m³ were abstracted outside of the public supply system by the three main economic sectors.[66] The electricity and gas, and mining and manufacturing sectors dominate water abstraction. Notably, in the agriculture sector, an increasing need for irrigation water is expected due to growing demands for food and biomass, as well as to alleviate added pressures from climate change.[67] Approximately 477 public water supply companies provide drinking water to the region's inhabitants, representing a connection rate of 99.6%. Most of this water is abstracted from groundwater sources (79%).[68]

As of 2012, none of the water bodies of the RBD were reported to suffer from significant pressures due to water abstraction.[69] The RBMP only records freshwater withdrawal quantities greater than 50 L/s, therefore monitoring only a few withdrawals by large industrial companies. Furthermore, the Plan notes that current data does not indicate that the withdrawals have a significant negative impact on biological quality components. Groundwater recharge hovers between 50 and 400 mm per year in large part of the RBD, although low recharge rates occur frequently in areas which are heavily populated or have high groundwater levels. While the RBMP does not identify water scarcity as an issue, its analysis of long-term climatic and hydrometeorological parameters notes that low water periods are likely to occur more frequently in summer.[70] In contrast to the Plan's optimistic assessment, the RBD's WEI+ score indicates that water resources have continuously been under stress between 2012 and 2015, often jumping to severe stress.

Water pricing and internalisation of external costs

Stemming from a federal court case in 1995, water withdrawal fees are set by federal states with the aim of ensuring the internalisation of environmental and resource costs – i.e. to prevent the overexploitation of scarce water resources and prevent pressure on aquatic ecosystems. Such fees now exist in three out of the seven states in which the Weser RBD is located. In the three states, compensation payments to farmers are financed from the water abstraction fees in order to compensate for land use restrictions to protect endangered groundwater resources.[71]

Tax name according to national classification	Base	Tariff, unit
Bremen water abstraction charge	Abstraction of groundwater for public water supply	€0.05 per m^3
	Abstraction of groundwater for groundwater drawdown or cooling purposes	€0.025 per m^3
	Abstraction of groundwater for	€0.005 per m^3

		irrigation purposes	
		Abstraction of groundwater for fish farming	€0.0025 per m^3
		Abstraction of groundwater for other purposes	€0.06 per m^3
		Abstraction of surface water	€0.005 per m^3 for annual consumption <=500 million m^3; €0.003 per m^3 for annual consumption >500 million m^3
	Lower Saxony water abstraction charge	Abstraction for public water supply	€0.075 per m^3
		Abstraction for sprinkler and flood irrigation	€0.007 per m^3
		Abstraction of groundwater for cooling or dewatering purposes	€0.037 per m^3
		Abstraction of groundwater for fish farming	€0.004 per m^3
		Abstraction of groundwater for other purposes	€0.09 per m^3
		Abstraction of surface water for cooling purposes	€0.013 per m^3
		Abstraction of surface water for other purposes	€0.03 per m^3
		Abstraction of surface water for sprinkler irrigation and flood irrigation purposes or for sand and gravel processing	€0.005 per m^3
		Abstraction of surface water for other purposes	€0.04 per m^3
	Saxony-Anhalt water abstraction charge	Abstraction for public water supply	€0.05 per m^3
		Abstraction of groundwater for cooling purposes	€0.02 per m^3
		Abstraction of groundwater for sprinkler irrigation and flood irrigation purposes	€0.02 per m^3
		Abstraction of groundwater for fish farming	€0.0025 per m^3
		Abstraction of groundwater for other purposes	€0.07 per m^3
		Abstraction of surface water for cooling purposes	€0.01 per m^3

	Abstraction of surface water for sprinkler irrigation and flood irrigation purposes	€0.005 per m^3
	Abstraction of surface water for other purposes	€0.04 per m^3

Source: MS Expert Germany; RBMP (2016)[72]

As municipalities are usually responsible for water supply, both the Local Rates Acts and municipal regulations of the federal states determine the framework for calculating water service charges. The state abstraction tax is passed on to households and the industry sector in addition to these fees, but the agriculture sector is exempted from paying charges for water abstraction in five federal states, some of which are of relevance the Weser RBD.[73] The price of drinking water varies across states and municipalities, but, in 2013, the average price of drinking water in the RBD was €1.72/m^3.[74] The annual basic fee for households, which is independent of consumption, was, on average, €51.52.[75]

In Germany, some resource (abstraction) charges exist, as indicated in the table above. The charges from Bremen, Lower Saxony, and Saxony-Anhalt were used to calculate average charges, differentiated by sector and source. These average charges were used as proxy externality charges for the whole RBD. Using the latter and abstraction volumes from the WISE Water Accounts database[76], the annual revenues that could have been collected over the period 2010-2015 were calculated, and compared to what would have been collected given an externality charge of €0.3/m^3:

- Given current (average) abstraction costs (assumed constant across the period):
    - Agriculture, forestry, and fishing: €0.5-0.7 million;
    - Electricity, gas, steam and air conditioning supply: €29-38 million;
    - Mining and quarrying, manufacturing and construction: €33-40 million;
    - Service industries: €0.5 million;
    - Water collection, treatment and supply: €26-31 million;
    - Households: €0.1 million
- Given a charge of €0.3/m^3 (assumed constant across the period):
    - Agriculture, forestry, and fishing: €21-31 million;
    - Electricity, gas, steam and air conditioning supply: €745-1,000 million;
    - Mining and quarrying, manufacturing and construction: €281-343 million;
    - Service industries: €4 million;
    - Water collection, treatment and supply: €132-159 million;
    - Households: €0.5-0.6 million

We can conclude that given current (average) abstraction charges and historical groundwater abstractions, between 2% to 19% of external costs related to water scarcity are internalised in the RBD, depending on the sector.[77]

Notes

[1] Ministry of Environment, Energy and Climate Change (2014) Management Plan of the River Basins of Thessalia River Basin District: Summary. Available here

[2] European Commission (2018) Report on the implementation of the Water Framework Directive River Basin

Management Plans – Greece. Available here.

[3] Ibid

[4] Dalezios and Eslamian (2018) Water scarcity management: part 2: satellite-based composite drought analysis. Available here.

[5] Ministry of Environment, Energy and Climate Change (2014) Management Plan of the River Basins of Thessalia River Basin District: Summary. Available here.

[6] Koundouri and Gonzales Davila (2015) Implementing the European Water Framework Directive in Greece: an integrated socio-economic approach and remaining obstacles. In Routledge Handbook pg Water Economics and Institutions (chapter 22). Available here.

[7] The highest mean payable amount for the same consumption was of 19,05€, in the South Aegean region

[8] Dercas (2019) Agricultural Water Management in Greece. In *Water Resources Management in Balkan Countries* (Chapter 16). Springer Water.

[9] Ministry of Environment, Energy and Climate Change (2014) Management Plan of the River Basins of Thessalia River Basin District: Summary. Available here

[10] EEA (2019), WISE Water Accounts database for Europe. Available here.

[11] This estimate is subject to various assumptions. The most important assumption being that external costs in the RBD are valued at €0.3/m^3. For a more accurate estimate, further assessments need to quantify the external costs unique to the RBD.

[12] District Basin Authority of the Central Apennines (2020). Available here.

[13] EEA (2019) Water exploitation index plus (WEI+) for river basin districts (1990-2015). Available here.

[14] Tiber River Basin Authority (2010) Il piano di gestione del distretto idrografico dell'appennino centrale. Available here.

[15] Marchetti et al. (2016) The Italian Land Use Inventory for assessing land use changes in Italy during last decades. Available here.

[16] EEA (2019), WISE Water Accounts database for Europe.

[17] The amount of water extracted includes water extracted from the following sources: groundwater, rivers, lakes, and artificial reservoirs.

[18] Cesari and Pelillo (2010), Ewa 6th Brussels Conference: Implementing the River Basin Management Plans. Available here.

[19] UNESCO (2012), Facing the Challenges: The United Nations World Water Development Report 4, Volume 3. Available here.

[20] EC (2012) Report on the implementation of the Water Framework Directive River Basin Management Plans – Italy. Available here.

[21] UNESCO (2012) Facing the Challenges: The United Nations World Water Development Report 4, Volume 3. Available here.

[22] Tiber River Basin Authority (2010) Il piano di gestione del distretto idrografico dell'appennino centrale. Available here.

[23] Massarutto (2015), Water Pricing in Italy: Beyond Cost Recovery, in *Water Pricing Experiences and Innovations* (Chapter 11). Available here.

[24] EC (2012) Report on the implementation of the Water Framework Directive River Basin Management Plans – Italy. Available here.

[25] Tiber River Basin Authority (2015) A6 - Economic summary of the Tiber River Basin Authority PGDAC.2 first update. Available here.

[26] EC (2016) Peer Review Report: Tiber River Basin Authority, Italy. Available here.

[27] EEA (2019), WISE Water Accounts database for Europe. Available here.

[28] This estimate is subject to various assumptions. The most important assumption being that external costs in the RBD are valued at €0.3/m³. For a more accurate estimate, further assessments need to quantify the external costs unique to the RBD.

[29] EC (2012) Report on the Report on the implementation of the Water Framework Directive River Basin Management Plans – Bulgaria. Available here

Bulgaria Black Sea Region Basin Directorate (2016) River basin management plan in the Black Sea region for basin water management (2016-2021). Available here

[30] Bulgaria Black Sea Region Basin Directorate (2016) River basin management plan in the Black Sea region for basin water management (2016-2021). Available here.

[31] OECD (2018) Bulgaria Country Report. Available here; Bulgaria Black Sea Region Basin Directorate (2016) River basin management plan in the Black Sea region for basin water management (2016-2021). Available here; USDA (2016) Bulgaria. Available here.

[32] EC (2012) Report on the Report on the implementation of the Water Framework Directive River Basin Management Plans – Bulgaria. Available here.

[33] Bulgaria Black Sea Region Basin Directorate (2016) River basin management plan in the Black Sea region for basin water management (2016-2021). Available here.

[34] Assessment of the current state of water in the Black Sea region for 2018 Available here

[35] Bulgaria Black Sea Region Basin Directorate (2016) River basin management plan in the Black Sea region for basin water management (2016-2021). Available here.

[36] EC (2012) Report on the Report on the implementation of the Water Framework Directive River Basin Management Plans – Bulgaria. Available here.

[37] OECD (2018) Bulgaria Country Report. Available here

[38] Tuntova (n.d.) Water management in Bulgaria. Available here.

[39] Bulgaria Black Sea Region Basin Directorate (2016) River basin management plan in the Black Sea region for basin water management (2016-2021). Available here.

[40] Ibid

[41] http://www5.moew.government.bg/?wpfb_dl=17466 .

[42] Ibid

[43] EEA (2019), WISE Water Accounts database for Europe.

[44] This estimate is subject to various assumptions. The most important assumption being that external costs in the RBD are valued at €0.3/m³. For a more accurate estimate, further assessments need to quantify the external costs unique to the RBD.

[45] Ministerio de Agricultura, Alimentacion y Medio Ambiente (2015) Estudio Ambiental Estrategico- Plan Hidrologico de la demarcion hidrografica del jucar. Available here

[46] Carmona et al., 2017, Assessing the effectiveness of Multi-Sector Partnerships to manage droughts: The case of the Jucar river basin

[47] Carmona et al., 2017, Assessing the effectiveness of Multi-Sector Partnerships to manage droughts: The case of the Jucar river basin

[48] Ballesteros (2019) Drought planning in Spain: The Jucar River Basin Case. Available here

[49] Solera et al., (2017) Analysing hydropower production in stressed river basins within the SEEA-W approach: the Jucar River case

[50] Ballesteros (2019) Drought planning in Spain: The Jucar River Basin Case. Available at: here

[51] Ministerio de Agricultura, Alimentacion y Medio Ambiente (2014) Propuesta de proyecto de revision del plan hidrologico- Memoria, Anejo 7, Inventario de presiones. Available at: here

[52] Garrido and Llamas (2012) Water management in Spain: an example of changing paradigms. Available here

[53] WWF (2017) Recuperación de costes del agua. Diagnóstico de los segundos planes hidrológicos y propuesta de mejora, pg. 103. Available at: here

[54] EEA (2019), WISE Water Accounts database for Europe. Available here.

[55] This estimate is subject to various assumptions. The most important assumption being that external costs in the RBD are valued at €0.3/m^3. For a more accurate estimate, further assessments need to quantify the external costs unique to the RBD.

[56] EC (2012) Report on the Implementation of the Water Framework Directive (2000/60/EC) River Basin Management Plans – Germany. Available here.

[57] Flussgebietsgemeinschaft Weser (2016) RBMP. Available here.

[58] EC (2012) Report on the Implementation of the Water Framework Directive (2000/60/EC) River Basin Management Plans – Germany. Available here.

[59] Flussgebietsgemeinschaft Weser (2016) RBMP. Available here.

[60] FGG (n.d.) Entwicklung von Wassernachfrage und Wassernutzungen. Available here.

[61] FGG (n.d.) Relevanz der Wassernutzungen. Available here.

[62] Flussgebietsgemeinschaft Weser (2016) RBMP. Available here.

[63] Hameln, Petershagen, Schlüssel-Burg, Landesbergen, Dörverden and Langwedel (32.2 MW of installed capacity) as well as a plant at the Hemelingen barrage (10 MW of installed capacity)

[64] Flussgebietsgemeinschaft Weser (2016) RBMP. Available here.

[65] FGG (n.d.) Entwicklung von Wassernachfrage und Wassernutzungen. Available here.

[66] Flussgebietsgemeinschaft Weser (2016) RBMP. Available here.

[67] FGG (n.d.) Entwicklung von Wassernachfrage und Wassernutzungen. Available here.

[68] Ibid

[69] EC (2012) Report on the Implementation of the Water Framework Directive (2000/60/EC) River Basin Management Plans – Germany. Available here.

[70] Ibid

[71] Flussgebietsgemeinschaft Weser (2016) RBMP. Available here.; MS expert Germany (2020). Not publicly available.

[72] Flussgebietsgemeinschaft Weser (2016) RBMP. Available here.

[73] Berbel et al. (2019) Analysis of irrigation water tariffs and taxes in Europe. In *Water Policy 21*(4). Available here.

[74] Flussgebietsgemeinschaft Weser (2016) RBMP. Available here.

[75] Ibid.

[76] EEA (2019), WISE Water Accounts database for Europe. Available here

We can conclude that given current resource charges and historical groundwater abstractions, less than 1% of external costs related to water scarcity are internalised in the RBD in the agricultural sector, and close to 20% in the household sector. Available here

[77] This estimate is subject to various assumptions. The most important assumption being that external costs in the RBD are valued at €0.3/m^3. For a more accurate estimate, further assessments need to quantify the external costs unique to the RBD.

6. Annex 6: Detailed modelling results

An overview of the selected market-based instruments (MBI) for the macroeconomic modelling is provided in the table below. The selected MBIs were chosen to ensure that the five thematic areas included in the study scope were covered, that they are representative of existing experience across the EU-27 and can be practically implemented, that they are relatively easy to model, and that they can help to support implementation of the EU environmental acquis whilst also having the potential to generate positive economic impacts. However it should be noted that the modelling is illustrative only and Member States of course remain free to select the MBIs that are most appropriate in their own national context.

Each individual MBI was modelled for a small group of Member States judged by the study team to be likely candidates for an instrument of that type – for instance, because they did not already have such a measure or suffered heavily from the pollution it was intended to tackle. As described in the main report, the complete list of measures was then modelled for all Member States, with revenue used to reduce labour taxes.

A key limitation of the scenario design is that it is stylised; it is not based on a detailed assessment of existing environmental taxes and problems in all EU MS. It should also be noted that of the 10 MBIs examined, three are charges rather than taxes (pay-as-you throw, water consumption charge and forest felling charge), but for the modelling analysis they were treated the same as taxes that raise revenues to national government.

Table 10: Summary of selected market-based instruments (MBI)

Thematic area	Market-based instrument (MBI)	Member State(s)
Air pollution	NOx tax	• Austria • Germany • Netherlands
	Indirect tax on domestic biomass fuel and coal	• Bulgaria • Hungary • Poland • Slovakia
Waste, resources, and circular economy	Landfill tax	• Cyprus • Greece • Lithuania
	Pay-As-You-Throw	• Cyprus • Estonia • Greece • Latvia • Malta • Romania • Slovakia
Water quality & marine litter	Pesticide tax	• Austria • Belgium • Luxemburg • Slovenia • Sweden
	Fertiliser levy	• Czech Republic

		• Denmark • Estonia • France
	Waste water pollution taxes	• Ireland • Romania
Water stress & availability	Water consumption charge	• Bulgaria • Cyprus • Czech Republic • Germany • Greece • Italy • Malta • Poland • Portugal • Spain
Biodiversity & land-use management	Intensive agriculture tax	• France • Ireland • Netherlands • Portugal
	Forest felling charge	• Latvia

6.1. Scenario overview

For each MBI, three scenarios are simulated: a scenario without revenue recycling (i.e. where revenues are used to pay down government debt), a second scenario with revenue recycling via a reduction in income taxation, and a third scenario with a bespoke use of revenues (i.e. it varies by MBI). Results for each scenario are compared to the E3ME baseline to provide an indication of macroeconomic impacts of the selected instruments, following a conventional difference-to-baseline approach.

6.1.1. Baseline

The E3ME baseline used for scenario comparison is consistent with the future trends published by the European Commission[5] and does not include any of the MBI / Member State combinations under study. In other words, the baseline assumes that MS do not introduce any further environmental taxes in addition to the ones that are already in place.

The E3ME baseline currently does not take into account the ongoing COVID-19 pandemic, yet because the time horizon for the scenarios is 2030 and because the exercise follows a conventional relative difference-to-baseline approach, results from the modelling exercise can still be considered as indicative outcomes. There is however one caveat with regard to the backdrop of the drastic price development triggered by the recent events. The economic repercussions of the pandemic include shocks to raw material and energy prices through supply constraints (price goes up) and reductions in demand (price falls). If these large price shocks persist to 2030 then by adding a fixed tax

[5] *EU Reference Scenario 2016: Energy, transport and GHG emissions Trends to 2050*, European Commission and *The 2012 Ageing Report: Economic and budgetary projections for the 27 EU Member States (2010-2060)*, European Commission.

amount to the baseline without adjusting for the price shocks, then the magnitude of relative changes in scenario results will differ. It is therefore important to bear this in mind in this section when interpreting results, and to treat them as indicative of the direction and order of size of the impacts only. The economic impacts of COVID-19 are expected to be severe, leading to unemployment and more spare productive capacity in the EU economy. An environmental tax reform, as demonstrated in this study, can be used as part of a green stimulus package to create jobs, boost investment, and thus mitigate the negative economic impacts and at the same time provide environmental benefits.

6.1.2. Policy scenarios

In the policy scenarios, the MBI internalises the externality (costs) caused by environmental damages, but cost increases are passed through to product prices of affected industries. The magnitude of the cost pass-through is determined by the parameters in the price formation equations in E3ME, estimated using sectoral-level time series data. Final consumer prices are ultimately affected by policy costs in the supply chain. As a result, the MBI has two key economic effects: 1) reduced industry competitiveness and 2) reduced real household disposable income. More information on the impact mechanism for each instrument is provided below.

If an MBI generates additional revenues, many different options are available to government to spend the revenues on other policies to tackle specific issues or to lower other forms of taxation, and these decision matter for macroeconomic outcomes. If, for example, the revenues are used to reduce other existing distortional taxes, economic efficiency may be improved further, boosting GDP and/or employment. Positive impacts of such income tax revenue recycling can outweigh the negative impacts of environmental taxation and, in some cases, produce overall net positive outcomes in GDP and jobs.

To comprehensively assess the dynamics determining macroeconomic outcomes for each MBI, including the sensitivity to government decisions around potential revenue use, the following scenario variants have been simulated:

- **MBI + debt reduction:** For each instrument, a scenario without revenue recycling is simulated assuming net tax revenues and resulting budget surpluses are used to reduce government debt, instead of being recycled back into the economy through a tax reduction or an increase in government spending[6].
- **MBI + income tax reduction:** For each instrument, a scenario is simulated assuming net tax revenues are used to reduce income taxation: total revenues from each policy are used to adjust average tax rates for income tax to help offset any reduction in real incomes due to higher prices. Income taxes are levied directly on real incomes, thus a reduction in tax rates has a proportional impact on aggregate real incomes.
- **MBI + bespoke revenue recycling:** For each instrument, a scenario is simulated with bespoke revenue recycling assumptions, based on recommendations from the study team's thematic experts (e.g. providing subsidies for RES technologies, lowering social security contributions, agriculture investments, etc.).

The results should be seen as indicative of an MBI's macroeconomic impact under varying conditions. In both theory and practice, however, many other revenue use options are available to policy makers to address specific problems or reduce other forms of taxation.

[6] The economic impacts of budget deficit improvement are not captured in this study.

6.2. Scenario assumptions

The following subsections provide an overview of the key assumptions for each of the selected instruments. Scenario inputs were provided by the expert leading the research on the respective theme, covering details of the MBI's coverage, tax rates or total expected revenues and bespoke revenue recycling mechanism. In addition, the following subsections provide an overview of the generalised impact mechanism for each instrument.

6.2.1. NOx tax

Design features

This scenario is based on the introduction of a NOx tax in Austria, Germany and Netherlands. The tax is applied to NOx emissions from fuel combustion (coal, oil and gas), accounting for around three quarters of overall NOx emissions. The main sources of NOx emissions from fuel combustion are road transport, power generation, and a small amount from combustion in industry. The NOx tax is introduced from 2020 onwards in the three Member States. The rates are given in the table below and are assumed to increase with inflation up to 2030.

Table 11: NOx tax rates

Member State	Effective rate (€/kg NOx)
Austria	28.7
Germany	25.2
Netherlands	18.2

In the scenario with bespoke revenue recycling, all revenues collected from the NOx tax are used to subsidise the investment costs of renewable energy (mainly wind and solar).

Impact mechanism

A NOx tax has similar effects to a tax on fuel consumption since these emissions are associated with fuel combustion. In the electricity generation and supply sector, higher costs from the air pollution tax result in higher electricity prices for firms and households. Households and industries also face higher costs when using fuel for road transport and other purposes. The net GDP impacts can still be positive if the reduction in fuel imports and investment prompted by the NOx tax outweigh the negative impacts of cost increases.

When the tax revenues are used to subsidise renewable energy in the electricity generation and supply sector (scenario variant with bespoke revenue recycling option), the costs of generating electricity from renewable energy sources will decrease. This creates wider benefits through higher renewable investment as well as lower electricity prices.

When the tax revenues are used to lower income taxes for all households (scenario variant with income tax reductions), this leads to a general increase in disposable incomes. This is in turn leads to higher consumer spending, potentially driving GDP and employment upwards.

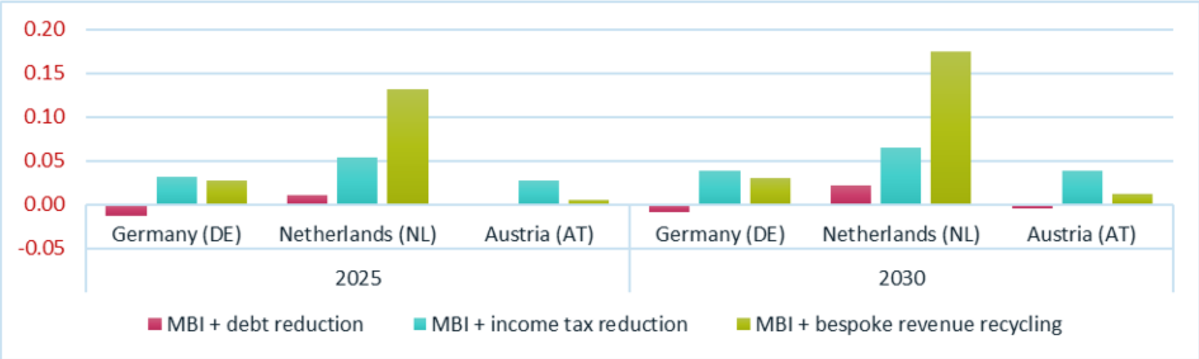
This generalised impact mechanism is the same for all MBI + income tax reduction scenario variants and is this not repeated for each instrument in the following subsections.

Modelling results for a NOx tax

Impact on GDP and employment

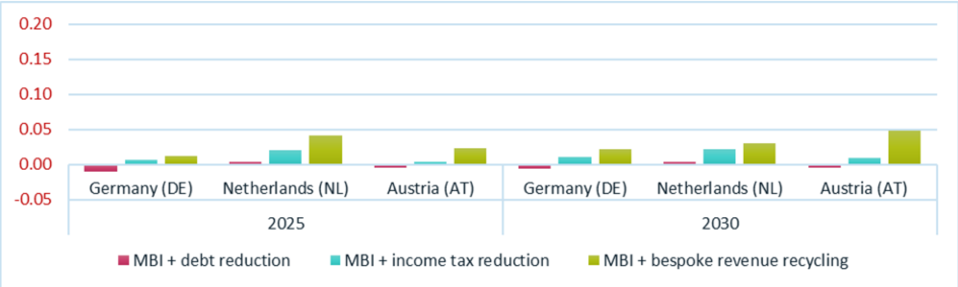
The model results show almost no net effects from the NOx tax in the MBI + debt reduction scenario. However, in the two other scenario variants, the model projects net positive effects on GDP and employment as a result of reduced electricity prices and higher investment in the electricity generation & supply sector. The pattern is the same in all countries yet most pronounced in the Netherlands. In the scenario with bespoke revenue recycling, the positive GDP result in the Netherlands is driven by the investment in new power generation technologies. In contrast to the other two countries, this country is still reliant on gas power generation (the main source of NOx emissions). This effect is smaller than in the scenario in which revenues are invested into the power sector (i.e. scenario with bespoke revenue recycling), because the additional investment in RES and the resulting fall in electricity prices has a more direct effect on GDP compared to the employment, consumer spending and investment resulting from reduced income taxation over time. In Germany and Austria, using the revenues to reduce income taxation yields larger net economic effects.

Figure 2: NOx tax - change in GDP (% difference to the baseline)



By itself, the NOx tax would have little to no net effect on total employment. However, when the NOx tax is combined with investment in renewable energy, this generates additional employment in some sectors (e.g. renewables related) and reduces employment in other sectors (e.g. fossil fuel related), leading to a very small net increase in employment relative to the baseline. When the NOx tax is combined with income tax reductions, the changes to employment are distributed over multiple economic sectors rather than concentrated in the power sector. This leads to a positive yet lower net employment effect compared to the scenario with investment in renewable energy (i.e. MBI + bespoke revenue recycling).

Figure 3: NOx tax - Change in total employment (% difference to the baseline)



Impact on sector output and employment

The largest effect from the NOx tax on sector output is seen in ‘utilities’, which includes the electricity generation and supply sector. This effect is mainly driven by a reduction in electricity demand from higher electricity prices as a result of the NOx tax. In the scenario with income tax reductions, sectors that emit less NOx benefit most from lower income taxes.

However, when revenues are used to subsidise investment in renewable energy (mainly wind and solar), the negative effect on output in utilities is largely mitigated. The subsidies make renewable energy systems (RES) technologies cheaper to investors, resulting in higher investment of renewable technologies. Moreover, these subsidies are passed through to electricity prices, benefiting consumers and industries. Mining, which includes coal, oil and gas extraction, is in this case worse off due to stronger substitution of these energy sources for wind and solar. Other sectors benefit from lower electricity prices and investment in this scenario.

Table 12: NOx tax - Change in sector output in 2030 (% difference to the baseline)

Scenario	Agri	Mining	Utilities	Manufact	Construct	Transport	Services
Germany	-0.02	-0.01	-0.07	0.00	0.01	-0.03	-0.01
Germany*	0.01	-0.06	-0.04	0.03	0.08	0.02	0.02
Germany**	0.05	-0.01	-0.02	0.02	0.03	0.03	0.04
Netherlands	0.00	0.00	-0.04	0.04	0.03	0.00	0.02
Netherlands*	0.05	-0.03	0.10	0.26	0.23	0.08	0.15
Netherlands**	0.02	0.00	0.02	0.06	0.05	0.03	0.06
Austria	0.00	0.01	-0.09	0.00	0.00	-0.01	-0.01
Austria*	0.05	0.03	0.58	0.08	0.12	0.10	0.05
Austria**	0.02	0.02	-0.03	0.03	0.02	0.02	0.04

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

In terms of employment, the NOx tax induces a move away from biomass technology and thus marginally reduces employment in the agriculture sector. In the scenario with bespoke revenue recycling, this effect is strengthened by subsidies for solar and wind energy. Both the NOx tax and the subsidies for solar and wind energy also drive the positive employment effects in utilities (power supply). The results for the scenario with income tax reductions are similar to the results for the scenario with debt reduction; agriculture employment slightly decreases, while other sectors of the economy see a small increase in employment numbers.

Table 13: NOx tax - Change in sector employment in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Germany	-0.01	0.00	0.12	-0.01	-0.01	0.00	-0.01
Germany*	-0.07	0.00	1.24	-0.02	0.09	0.01	0.01
Germany**	-0.01	0.00	0.12	0.00	0.03	0.01	0.01
Netherlands	-0.01	0.00	0.22	0.02	0.00	0.02	0.00
Netherlands*	-0.13	-0.02	3.09	0.11	0.05	0.04	-0.01
Netherlands**	-0.02	0.00	0.22	0.04	0.01	0.03	0.02
Austria	-0.01	0.00	0.08	0.00	0.00	-0.01	-0.01
Austria*	-0.15	0.00	3.57	0.04	0.01	0.07	0.01
Austria**	-0.01	0.00	0.08	0.01	0.00	0.00	0.01

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on real income

The NOx tax would lead to very small changes in real income. In the scenario with debt reduction, the impact on real income is negative in Austria and Germany, while in the Netherlands the effect on real income is very close to zero. The change in real income is furthermore evenly distributed across income groups.

However, using revenues to facilitate lower income taxation results in positive real income effects. In Germany and Austria, real income increases more under these conditions than in the scenario with bespoke revenue recycling. An exception is the Netherlands, where additional income associated with RE investment is projected to have bigger impacts on real disposable income than a reduction in income taxation.

Table 14: NOx tax - Change in real income in 2030 (% difference to the baseline)

Scenario	All	Q1	Q2	Q3	Q4	Q5
Germany	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Germany*	0.03	0.04	0.04	0.03	0.02	0.01
Germany**	0.06	0.07	0.07	0.06	0.06	0.06
Netherlands	0.00	0.01	0.01	0.00	0.00	0.00
Netherlands*	0.15	0.16	0.16	0.15	0.15	0.15

Netherlands**	0.12	0.15	0.13	0.12	0.12	0.11
Austria	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Austria*	0.09	0.09	0.10	0.09	0.09	0.08
Austria**	0.10	0.12	0.11	0.10	0.10	0.10

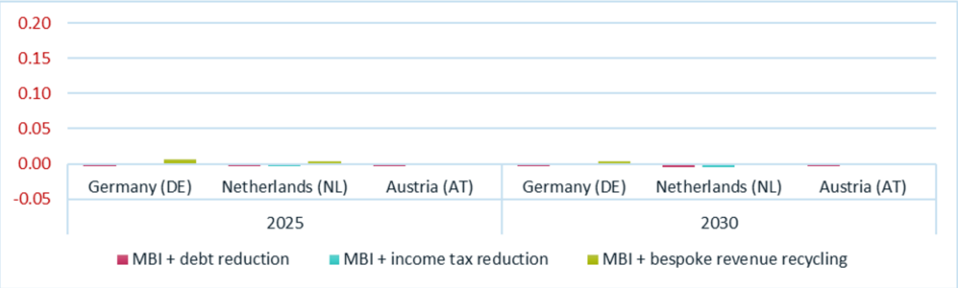
**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on trade

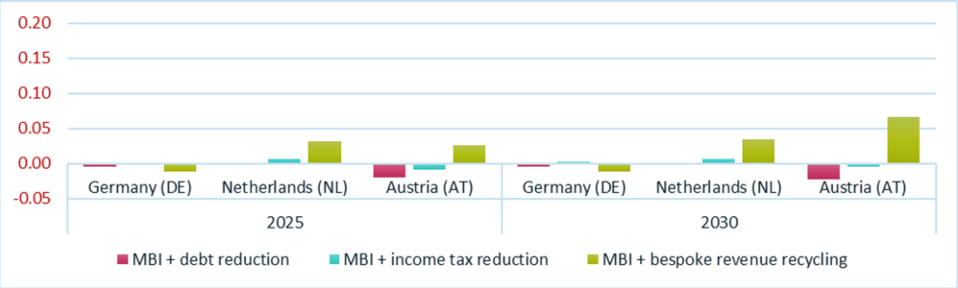
The NOx tax will have very small net effects on the competitiveness (i.e. trade balance) of the selected countries. The results suggest that overall exports will be slightly lower as a result of the NOx tax, yet the differences are only visible at the third decimal place for all scenario variants. Only Germany would see a (very small) increase in exports, mainly from RES related exports.

Figure 4: NOx tax - Change in exports (% relative to baseline)



In terms of imports, the net effects from a NOx tax are very small. The only notable impact is driven by a demand for components by the electricity generation and supply sector (Utilities) from abroad, in the scenario with bespoke revenue recycling for Austria and the Netherlands. The magnitude of changes in imports in these countries is larger than the magnitude of changes in exports.

Figure 5: NOx tax - Change in imports (% difference to the baseline)



To gauge the overall impact on trade, the table below identifies whether a scenario including a NOx tax will have a positive, negative, or neutral effect on each country's balance of trade. This table, along with similar ones prepared for all other MBIs, identifies a positive impact as a situation where the balance of trade (exports minus imports) grows compared to the baseline, and a negative impact as a situation where the balance of trace shrinks compared to the baseline. If the balance only slightly[7] grows or shrinks, this is considered as zero or marginal impact.

The overall effect on the balance of trade varies as, in general, exports and imports either both increase or decrease. Therefore, the effect would be determined by the magnitude of the change in absolute terms. Typically, the effect on the balance of trade is similar in the scenario with debt reduction and the scenario with income tax reductions.

In the case of Germany, for example, both imports and exports decrease by small amounts as a result from the MBI. These effects cancel each other out and the resulting effect on the balance of trade compared to the baseline is insignificant. However, increased real income in a scenario with reduced income tax results in a positive imports effect, leading to a negative balance of trade effect in Germany.

Table 15: NOx tax - Impact on the balance of trade (compared to the baseline)

Scenario	2025	2030
Germany	~	~
Germany*	+	+
Germany**	~	-
Netherlands	-	-
Netherlands*	-	-
Netherlands**	-	-
Austria	+	+
Austria*	-	-
Austria**	+	+

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

+positive impact, - negative impact, ~ no or marginal impact

6.2.2. Indirect tax on domestic biomass fuel and coal

Design features

This scenario is based on the introduction of an indirect tax on domestic biomass and coal use in Bulgaria, Hungary, Poland and Slovakia. As the name suggests, this tax is applied

[7] The percentage change between the balance of trade in the scenario and the trade balance in the baseline, in that year, is between +0.99% and -0.99%.

to household use of biomass and coal for heating and cooking. The tax rates are given in the table below. It is assumed that tax rates are fixed over time after they are first introduced in 2020.

Table 16: Indirect tax rates on domestic biomass and coal (€ per tonne)

Member State	1 - Pellets	2 - Other wood	3 - Coal	4 - Brown coal/lignite
Bulgaria	0.0184	0.1015	0.2744	0.2069
Hungary	0.0361	0.1996	0.5396	0.4068
Poland	0.0318	0.1759	0.4756	0.3585
Slovakia	0.0361	0.1996	0.5396	0.4068

In the scenario with bespoke revenue recycling, all revenues from the tax are used to provide lump sum payments back to households.

Impact mechanism

Households are faced with higher fuel costs as a result of a coal and biomass tax. This leads to a reduction in their real disposable income resulting in lower consumption and GDP. One of the key concerns from this tax is therefore its effect on income distribution since it is most likely to affect lower income households disproportionately.

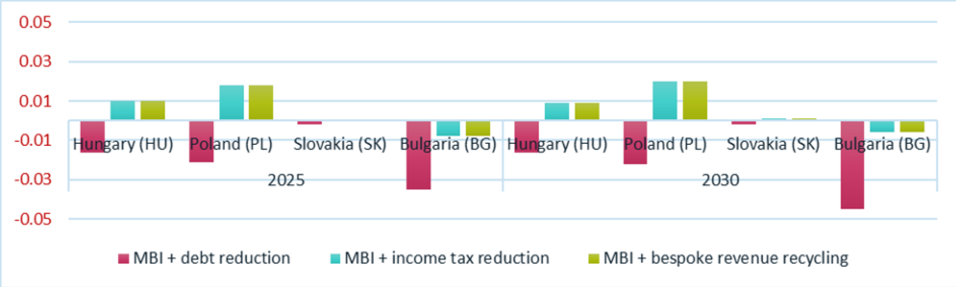
When tax revenues are used to provide lump sum payments across households (bespoke revenue recycling), this could help alleviate the negative distribution impacts as well as provide stimulus to the economy. A more targeted revenue recycling such as means-tested benefit payments would further improve distributional outcome, but is not modelled in this study.

Modelling results for a domestic biomass fuel tax

Impact on GDP and employment

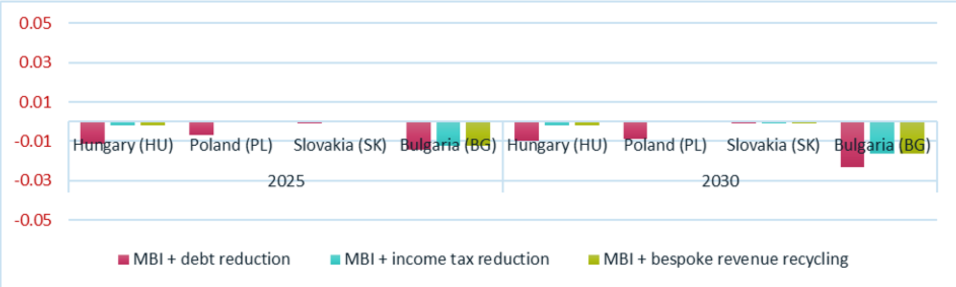
The results suggest that in the scenario with debt reduction, the tax could have a net negative effect on GDP and total employment. It should be noted, however, that in all countries the net effect on GDP remains very small. When revenue recycling is introduced either through reduced income taxation or lump sum payments to households, the negative effects on income are largely (i.e. Bulgaria) or completely (i.e. Hungary, Poland, Slovakia) offset. At macro-level, both lump sum payments and income tax revenue recycling method lead to similar effects; both methods increase disposable incomes, leading to higher consumption and GDP. The effects can also be observed in the net changes to real income (see next section on impact on real income).

Figure 6: Indirect tax on domestic biomass and coal - Change in GDP (% difference to the baseline)



In the scenario with debt reduction, the employment results mirror the GDP results, although the changes relative to the baseline are smaller in magnitude. In the other two scenarios, the positive income effects go hand in hand with negative employment effects for Hungary and Slovakia (in 2030). Wage increases mean that employment effects are smaller than GDP effects, or even negative.

Figure 7: Indirect tax on domestic biomass and coal - Change in total employment (% difference to the baseline)



Impact on sector output and employment

At sector level, the industries that see the largest negative effects are those that produce biomass fuel and coal, i.e. the agriculture and mining sectors. The effects are in the order of 0.00% to 0.05%, with the largest effects projected for Hungary. Due to the substitution of biomass and coal for other energy sources, such as electricity and renewables, most gains are observed in the utilities sector (which includes electricity generation & supply as well as gas). Output in construction, manufacturing, transport and services is slightly lower in response to reduced economic activity in the negatively affected sectors and reduced consumer spending overall.

When the tax revenue is recycled back into the economy through lump sum payments to households or income tax reductions, the negative effects are largely mitigated through additional spending on goods & services. However, the revenue recycling does not change the direct behavioural response to the higher prices for pellets, other wood, coal, brown coal and lignite. There may nonetheless be some small rebounds in demand for these products as additional income is used for spending on goods & services.

Table 17: Indirect tax on domestic biomass and coal - Change in sector output in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Hungary	-0.05	-0.02	0.07	-0.01	0.00	-0.01	-0.02
Hungary*	-0.02	0.01	0.09	0.00	0.01	0.01	0.01
Hungary**	-0.02	0.01	0.09	0.00	0.01	0.01	0.01

Poland	-0.03	0.00	0.01	-0.01	-0.01	-0.01	-0.02
Poland*	0.02	0.01	0.01	0.01	0.01	0.01	0.02
Poland**	0.02	0.01	0.01	0.01	0.01	0.01	0.02
Slovakia	0.00	0.01	0.02	0.00	0.00	0.00	0.00
Slovakia*	0.00	0.01	0.02	0.00	0.00	0.00	0.00
Slovakia**	0.00	0.01	0.02	0.00	0.00	0.00	0.00
Bulgaria	0.00	0.00	0.06	-0.03	-0.02	-0.01	-0.02
Bulgaria*	0.00	0.00	0.06	-0.01	-0.02	0.00	0.01
Bulgaria**	0.00	0.00	0.06	-0.01	-0.02	0.00	0.01

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

The tax would not have any major employment implications, as shown below. Changes are mostly concentrated in the agriculture and utilities sectors, mirroring the changes in sectoral output. Revenue recycling mitigates job losses in manufacturing, construction, transport and services, while the initial employment effects in agriculture and utilities remain unchanged (negative for the former, positive for the latter).

Table 18: Indirect tax on domestic biomass and coal - Change in sector employment in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Hungary	0.08	0.00	0.02	0.00	0.00	0.00	-0.01
Hungary*	0.08	0.00	0.02	0.00	0.00	0.00	0.00
Hungary**	0.08	0.00	0.02	0.00	0.00	0.00	0.00
Poland	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01
Poland*	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Poland**	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Slovakia	0.01	0.00	0.01	0.00	0.00	0.00	0.00
Slovakia*	0.01	0.00	0.01	0.00	0.00	0.00	0.00
Slovakia**	0.01	0.00	0.01	0.00	0.00	0.00	0.00
Bulgaria	-0.02	0.00	0.02	-0.01	-0.16	-0.01	-0.01

Bulgaria*	-0.02	0.00	0.02	-0.01	-0.12	0.00	-0.01
Bulgaria**	-0.02	0.00	0.02	-0.01	-0.12	0.00	-0.01

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on real income

In most countries, the tax affects the first income quintile most, thus suggesting the tax could have negative distributional effects. In Bulgaria, the negative effect is more concentrated in quintiles two, three and four, suggesting the use of biomass and coal for heating and cooking is more widespread. In Slovakia, the effects on real income are negligible (i.e. the effects are only visible at the third decimal place).

Revenue recycling in the form of lump sum payments to households or income tax reductions mitigates the negative effect on real incomes. The lump-sum payment produces better outcomes for lower income households, but overall the effect of the tax is still negative for the lower income groups, even with lump sum payments.

Table 19: Indirect tax on domestic biomass and coal - Change in real income in 2030 (% difference to the baseline)

Scenario	All	Q1	Q2	Q3	Q4	Q5
Hungary	-0.03	-1.73	-0.95	-0.31	-0.01	0.00
Hungary*	0.02	-1.65	-0.89	-0.26	0.04	0.04
Hungary**	0.02	-1.69	-0.90	-0.26	0.04	0.06
Poland	-0.06	-0.33	-0.28	-0.18	-0.07	0.00
Poland*	0.02	-0.21	-0.19	-0.10	0.01	0.07
Poland**	0.02	-0.27	-0.23	-0.12	0.01	0.10
Slovakia	0.00	0.00	0.00	0.00	0.00	0.00
Slovakia*	0.00	0.00	0.00	0.00	0.00	0.00
Slovakia**	0.00	0.00	0.00	0.00	0.00	0.00
Bulgaria	-0.06	-0.03	-0.11	-0.20	-0.17	-0.04
Bulgaria*	0.00	0.05	-0.03	-0.13	-0.10	0.03
Bulgaria**	0.00	0.04	-0.03	-0.13	-0.10	0.03

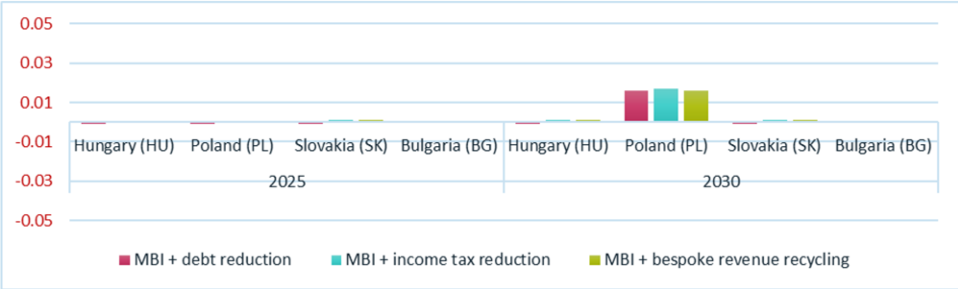
**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on trade

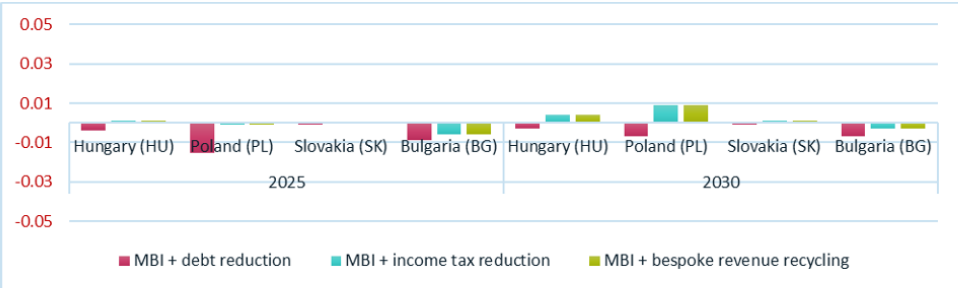
The tax on biomass and coal is projected to have very small net effects on the competitiveness (i.e. trade balance) of the selected countries. In Poland there are more pronounced impacts, and the tax would lead to higher exports overall, suggesting that some biomass and coal would be exported as domestic demand reduces. In the other countries, the changes are very small.

Figure 8: Indirect tax on domestic biomass and coal - Change in exports (% difference to the baseline)



In most countries, imports are slightly lower than in the baseline as a result of lower consumer spending. In the scenarios with bespoke revenue recycling and reduced income taxation, the impact on consumer spending is partly mitigated by the lump sum payments to households, which leads to higher demand for foreign goods and services.

Figure 9: Indirect tax on domestic biomass and coal - Change in imports (% difference to the baseline)



The net effect on the balance of trade is generally positive or neutral for all scenario variants. In the case of Hungary in the scenario with bespoke revenue recycling, the tax yields a neutral effect on the balance of trade in 2025 but a negative effect by 2030. This is partially driven by a higher increase in imports in 2030 than in 2025.

Table 20: Indirect tax on domestic biomass and coal - Impact on the balance of trade (compared to the baseline)

Scenario	2025	2030
Hungary	+	+
Hungary*	~	-
Hungary**	~	-
Poland	+	+
Poland*	+	+

Poland**	+	+
Slovakia	~	-
Slovakia*	~	~
Slovakia**	~	~
Bulgaria	+	+
Bulgaria*	+	+
Bulgaria**	+	+

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

+positive impact, - negative impact, ~ no or marginal impact

6.2.3. Pay-As-You-Throw

Design features

The Pay-As-You-Throw charge (PAYT) is modelled as if it were introduced in 2020 for seven countries: Cyprus, Estonia Greece, Latvia, Malta, Romania and Slovakia. The rates proposed by the thematic experts are given in the table below and taken as inputs for the scenario. The rates vary between regions but are assumed to be constant over time. The PAYT is applied to all types of waste generated by households and disposed via land.

Table 21: Pay-As-You-Throw rates

Member State	Effective rate (€/kg)
Cyprus	0.22
Greece	0.22
Estonia	0.22
Latvia	0.16
Malta	0.22
Romania	0.22
Slovakia	0.22

In the scenario with bespoke revenue recycling, 80% of revenues from the PAYT are recycled back into the economy. For the first five years, these revenues are used to invest in waste management facilities. After five years, revenues are used to reduce employer's social security contributions. The remaining 20% of revenues is assumed to be used for tax administration purposes throughout the projected period.

Impact mechanism

As a PAYT is only applicable to households, higher prices from the charge lead to a reduction in real incomes and consumption. This effect would lead to a reduction in GDP and employment and can further cause a reduction in real income.

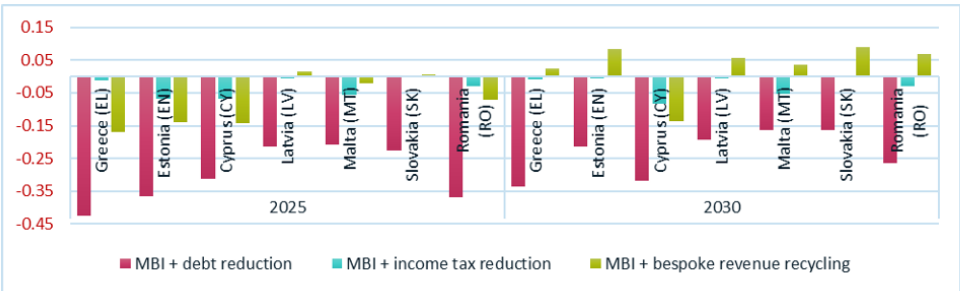
When the tax revenues are used to reduce tax rates (or increase investment) in other parts of the economy, these negative economic impacts could be offset.

Modelling results for PAYT

Impact on GDP and employment

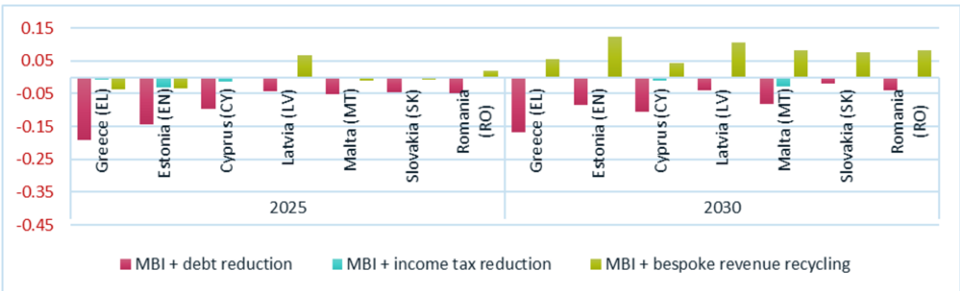
The scenario results suggest that a PAYT would have small net negative effects on GDP in the selected countries throughout the projected time period. However, when the tax revenues are recycled back into the economy, the negative effect is partially mitigated in 2025 and completely mitigated by 2030 except for one country (i.e. Cyprus). When revenues are recycled as income tax reductions, the net negative effects are mitigated but not to the same extent as in the scenario with bespoke revenue recycling (i.e. revenues are recycled as reductions to social security contributions towards the end of the decade).

Figure 10: Pay-As-You-Throw - Change in GDP (% difference to the baseline)



The same pattern is visible for total employment levels in the selected countries. The PAYT will have a small net negative effect on employment in all countries, in 2025 and 2030. However, revenue recycling mitigates the impact and even leads to very small positive net changes by 2030 in the scenario in which revenues are initially recycled as waste management investment and then as reduced employer social security contributions.

Figure 11: Pay-As-You-Throw - Change in total employment (% difference to the baseline)



Impact on sector output and employment

The results by sector suggest that the PAYT generates negative effects in a) the waste sector (i.e. sewerage & waste), b) in those sectors mostly affected when overall consumer spending is reduced, which varies from country to country, and c) in sectors producing a lot of waste (e.g. textiles). In the scenario with bespoke revenue recycling, positive effects are observed mainly in those sectors that benefit from the investment in waste management facilities (e.g. machinery & equipment, construction, architecture & engineering, and sewerage & waste), while the continued price increase drives up economic activity in repair sectors (e.g. repair of household goods). The scenario income tax reductions is expected to mitigate the negative output effects which occur when no revenues are recycled back into the economy (i.e. scenario with debt reduction). This is because the consumer spending reduction brought about by a PAYT is compensated by an increase in disposable income.

Table 22: Pay-As-You-Throw - Change in sector output in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Greece	-0.15	-0.14	-0.50	-0.26	-0.10	-0.38	-0.27
Greece*	-0.08	0.65	0.32	0.29	1.02	-0.16	-0.05
Greece**	-0.01	0.00	-0.11	-0.01	0.01	0.00	-0.01
Estonia	-0.34	-0.03	-0.18	-0.11	-0.03	-0.11	-0.18
Estonia*	0.06	0.06	0.22	0.15	0.41	0.02	0.04
Estonia**	0.05	0.00	-0.02	0.01	0.00	-0.01	0.01
Cyprus	-0.59	-0.02	-0.08	-0.51	-0.11	-0.31	-0.24
Cyprus*	-0.48	-0.03	-0.05	-0.25	0.75	-0.27	-0.14
Cyprus**	-0.40	-0.01	-0.02	-0.27	-0.03	-0.22	-0.08
Latvia	-0.03	-0.01	-0.07	-0.02	-0.05	-0.03	-0.19
Latvia*	0.00	0.12	0.05	0.13	0.63	0.02	0.03
Latvia**	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Malta	-0.20	0.00	0.00	-0.10	-0.05	0.00	-0.08
Malta*	-0.12	0.00	0.00	0.10	1.48	0.00	-0.03
Malta**	-0.01	0.00	0.00	0.00	-0.01	0.00	-0.03
Slovakia	0.00	-0.02	-0.08	-0.05	-0.06	-0.07	-0.16
Slovakia*	0.00	0.02	0.11	0.07	0.80	-0.04	0.01

Slovakia**	0.00	0.00	-0.01	0.00	0.00	0.00	0.00
Romania	-0.01	0.01	-0.06	-0.11	-0.07	-0.12	-0.22
Romania*	0.01	0.01	0.18	0.15	0.60	-0.03	-0.03
Romania**	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.02

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

The employment effects by sector are also driven by the employment intensities in the affected sectors, but generally mirror the changes in output observed in each country. The changes relative to the baseline are smaller in magnitude than the changes in output, however.

Table 23: Pay-As-You-Throw - Change in sector employment in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Greece	0.00	0.00	-0.02	-0.12	-0.10	-0.36	-0.19
Greece*	0.00	0.00	0.00	0.31	0.83	-0.15	-0.02
Greece**	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00
Estonia	-0.07	-0.01	-0.01	-0.10	0.00	-0.02	-0.10
Estonia*	0.55	0.00	0.00	0.12	0.42	0.06	0.08
Estonia**	0.18	0.00	0.00	-0.03	0.02	0.00	-0.01
Cyprus	0.15	0.00	0.00	-0.06	0.03	0.00	-0.14
Cyprus*	0.20	0.00	0.00	0.04	0.87	0.06	-0.04
Cyprus**	0.14	0.00	0.00	-0.04	0.15	0.00	-0.03
Latvia	-0.02	0.00	0.00	-0.01	0.06	0.00	-0.07
Latvia*	0.09	0.00	0.00	0.04	1.15	0.03	0.02
Latvia**	0.00	0.00	0.00	0.01	0.01	0.01	0.00
Malta	-0.03	0.00	-0.01	-0.05	-0.03	0.03	-0.10
Malta*	0.15	0.00	0.00	0.06	0.52	0.12	0.05
Malta**	0.01	0.00	0.00	0.00	-0.01	0.03	-0.04

Slovakia	0.01	0.00	-0.01	-0.03	0.00	-0.05	-0.02
Slovakia*	0.05	0.00	0.00	0.10	0.00	0.00	0.09
Slovakia**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Romania	0.00	0.00	-0.01	-0.02	-0.05	-0.05	-0.06
Romania*	0.00	0.00	0.01	0.12	0.47	0.02	0.08
Romania**	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on real income

The effects on real income, and real income by quintile, are driven by the direct effect on household spending from the tax and induced effects from lower consumption overall. Overall, the PAYT results in small negative effects on real incomes in the selected countries, in all scenario variants. In most countries, the effect in percentage terms is higher for upper quintiles, since these groups are likely to generate more waste. Only in Greece, the effect in percentage terms is largest for the lowest quintile, but the variance between the quintiles is minor.

A scenario in which revenues are recycled as income tax reductions results in a mitigation of the negative real income effect. However, in this scenario 2030 real income remains, in general, below the baseline. One exception is the case of Slovakia, where recycled revenues result in no changes relative to the baseline.

Table 24: Pay-As-You-Throw - Change in real income in 2030 (% difference to the baseline)

Scenario	All	Q1	Q2	Q3	Q4	Q5
Greece	-0.48	-0.48	-0.49	-0.47	-0.51	-0.47
Greece*	-0.28	-0.27	-0.28	-0.27	-0.31	-0.28
Greece**	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01
Estonia	-0.46	-0.43	-0.41	-0.43	-0.47	-0.49
Estonia*	-0.20	-0.17	-0.15	-0.16	-0.20	-0.23
Estonia**	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03
Cyprus	-0.40	-0.41	-0.40	-0.40	-0.41	-0.41
Cyprus*	-0.29	-0.31	-0.29	-0.29	-0.30	-0.29
Cyprus**	-0.09	-0.12	-0.11	-0.09	-0.09	-0.08

Latvia	-0.35	-0.31	-0.28	-0.31	-0.36	-0.39
Latvia*	-0.11	-0.07	-0.04	-0.06	-0.12	-0.15
Latvia**	-0.01	0.00	0.00	0.00	-0.01	-0.01
Malta	-0.25	-0.20	-0.19	-0.21	-0.25	-0.28
Malta*	-0.15	-0.11	-0.09	-0.10	-0.16	-0.18
Malta**	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Slovakia	-0.35	-0.32	-0.30	-0.32	-0.36	-0.38
Slovakia*	-0.20	-0.17	-0.14	-0.16	-0.20	-0.23
Slovakia**	0.00	0.00	0.00	0.00	0.00	0.00
Romania	-0.45	-0.39	-0.37	-0.40	-0.45	-0.49
Romania*	-0.23	-0.19	-0.14	-0.17	-0.23	-0.27
Romania**	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

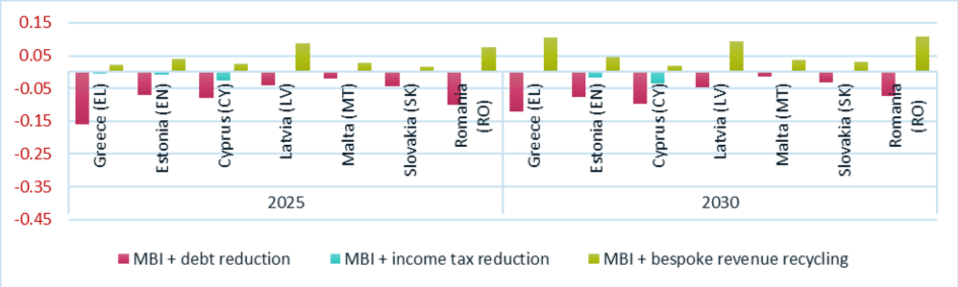
Impact on trade

A PAYT is projected to have a very small impact on the competitiveness (i.e. trade balance) of the selected countries. It should be noted that we assume that waste is managed domestically in the scenarios.

Figure 12: Pay-As-You-Throw - Change in exports (% difference to the baseline)

While the changes in exports in 2030 are close to zero or negative in the scenario with debt reduction and in the scenario with income tax reductions, the changes in exports in the scenario with bespoke revenue recycling (i.e. investments in waste management go up and social security contributions go down) are marginally positive in some countries (i.e. Greece, Latvia, Slovakia, Romania). This is because a reduction in employer's social security contributions generates savings in labour costs, making these countries more competitive. For the other countries (i.e. Cyprus and Malta), the impact is negative yet still close to zero in all scenario variants.

Figure 13: Pay-As-You-Throw - Change in imports (% difference to the baseline)



The changes in total imports are also very small, but with changing signs between the scenario with debt reduction and the scenario in which revenues are used to finance waste management investment and then to reduce social security contributions. The PAYT indirectly reduces demand for import goods and services, but when the revenue is reinvested in the economy this leads to a small increase in the import of investment-related goods and services. A scenario with reduced income taxation results in negligible import changes from the baseline.

6.2.4. Landfill tax

Design features

The scenarios assume that a landfill tax is introduced in 2020 for three countries: Cyprus, Greece and Lithuania. The applied tax rates are consistent with the instruments designed in Section 6 of this report and thus informed by the detailed analysis by instrument and country. The proposed tax rates are repeated in the table below. The rates vary between regions and over time.

Table 25: Landfill tax rates (€/tonne)

Member State	2020	2025	2030
Cyprus	30	55	70
Greece	35	60	70
Lithuania	30	55	70

The above landfill taxes are applied to all types of waste, including animal and vegetal waste, chemical waste, and mixed ordinary waste.

In the scenario with bespoke revenue recycling, it is assumed that 80% of revenues from the landfill tax are recycled back into the economy. For the first five years, these revenues are used to invest in waste management facilities. After five years, revenues are used to reduce employer’s social security contributions. The remaining 20% of tax revenues is assumed to be used for tax administration purposes throughout the period.

Impact mechanism

The cost of the tax is borne by both firms and households, leading to higher prices. Higher prices for firms lead to a loss of international competitiveness and a worsening of the balance of trade. For households, higher prices lead to a reduction in real incomes and consumption. Both effects would lead to a reduction in gross output and GDP if revenue from the tax was not recycled.

When the tax revenues generated from the landfill tax are used to reduce tax rates (or increase investment), then these negative economic impacts could be offset.

Modelling results for landfill tax

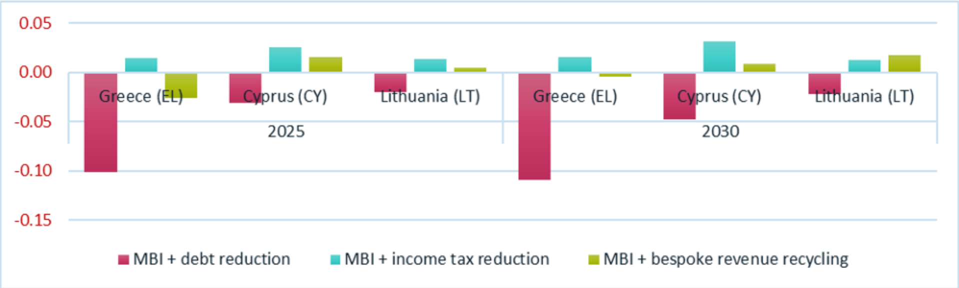
Impact on GDP and employment

The scenario results suggest that the landfill tax without recycling of revenuecould have a small net negative effect on GDP in the selected countries throughout the projected time period. This negative effect is driven by the higher prices faced by businesses and consumers, leading to a worsening of the balance of trade and a reduction in real incomes and consumption.

However, in the scenario in which the landfill tax revenues are used to increase investment in the waste sector and to reduce employers' social security payments, the direction of impact changes in all countries but Greece. In Cyprus and Lithuania, small net positive GDP and employment effects are driven by a boost to investment in waste management facilities and a reduction in the cost of employing additional workers. In Greece, the negative impact of the landfill tax becomes smaller with this revenue recycling.

The scenario with reduced income taxation results in a positive GDP effect in all countries, including Greece. In fact, reducing income taxes generally improves output to a larger extent than in the scenario with bespoke revenue recycling.

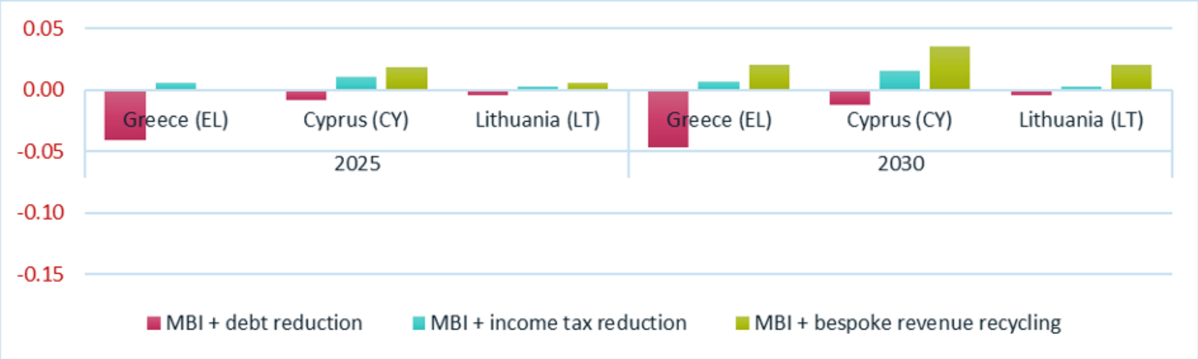
Figure 14: Landfill tax - Change in GDP (% difference to the baseline)



A similar pattern is visible for net changes in total employment levels in the selected countries. The landfill tax will have a small net negative effect on employment[8], but the combination with reduce employer's social security contributions or income taxes has a relatively stronger positive effect on total employment.

[8] The macro model does not distinguish between the labour intensities of the various different waste treatment methods and hence may rather reflect the impact of the discouragement on waste generation rather than the shift from landfilling to more environmentally friendly and also more labour-intensive waste treatment methods; this composition shift effect would render the overall effect less negative.

Figure 15: Landfill tax - Change in total employment (% difference to the baseline)



Impact on sector output and employment

Although the overall GDP and employment effects are similar across the selected countries, the effects by sector are more diverse as a result of different economic structures. Overall, those sectors most closely linked to the waste sector are most affected, due to the price increases caused by the landfill tax.

When the revenue is reinvested in the economy, sectoral improvements are mostly a function of where the revenue is spent (e.g. construction sector benefits from investment made by the waste sector) and patterns of consumer spending in the selected countries.

Table 26: Landfill tax - Change in sector output in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Greece	-0.05	-0.04	-0.16	-0.08	-0.03	-0.12	-0.09
Greece*	-0.03	0.17	0.07	0.07	0.28	-0.05	-0.02
Greece**	0.01	0.01	-0.01	0.01	0.01	0.02	0.01
Cyprus	-0.26	0.00	-0.02	-0.17	-0.02	-0.09	-0.04
Cyprus*	-0.22	-0.01	0.00	-0.10	0.23	-0.04	-0.01
Cyprus**	-0.21	0.00	0.01	-0.11	0.01	0.00	0.01
Lithuania	0.00	0.00	-0.03	-0.04	-0.01	-0.01	-0.01
Lithuania*	0.00	0.00	0.04	0.03	0.17	0.00	0.01
Lithuania**	0.00	0.00	0.01	0.02	0.01	0.01	0.01

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

The employment effects broadly mirror output effects but in smaller magnitudes.

Table 27: Landfill tax - Change in sector employment in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Greece	0.00	0.00	-0.01	-0.03	-0.03	-0.08	-0.06
Greece*	0.00	0.00	0.00	0.11	0.23	-0.02	0.00
Greece**	0.00	0.00	0.00	0.00	0.00	0.02	0.01
Cyprus	0.10	0.00	0.00	-0.02	-0.01	0.00	-0.02
Cyprus*	0.12	0.00	0.00	0.01	0.25	0.02	0.02
Cyprus**	0.10	0.00	0.00	-0.01	0.03	-0.01	0.01
Lithuania	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01
Lithuania*	0.00	0.00	0.00	0.03	0.11	0.01	0.01
Lithuania**	0.00	0.00	0.00	0.00	0.01	0.00	0.00

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on real income

The effects on real income, and real income by quintile, are driven by the price effects caused by the landfill tax, and existing consumer spending patterns in each country. Overall, the landfill tax without recycling of revenues will result in a small negative effect on real incomes in the selected countries. Only in Cyprus is the effect in percentage terms is largest for the lowest quintile, albeit still very small.

The scenario with income tax reductions results in an improvement, rather than a deterioration, in real income compared to the baseline. This implies that households are better off as the net effect on their disposable incomes is positive (i.e. their income tax reductions outweigh the higher waste management expenditure).

Table 28: Landfill tax - Change in real income in 2030 (% difference to the baseline)

Scenario	All	Q1	Q2	Q3	Q4	Q5
Greece	-0.16	-0.16	-0.16	-0.15	-0.16	-0.15
Greece*	-0.09	-0.09	-0.09	-0.09	-0.10	-0.09
Greece**	0.02	0.02	0.02	0.02	0.03	0.02
Cyprus	-0.08	-0.09	-0.08	-0.08	-0.08	-0.07

Cyprus*	-0.03	-0.05	-0.04	-0.03	-0.03	-0.03
Cyprus**	0.05	0.03	0.04	0.05	0.05	0.06
Lithuania	-0.03	-0.03	-0.03	-0.03	-0.04	-0.04
Lithuania*	0.00	0.00	0.01	0.01	0.00	-0.01
Lithuania**	0.03	0.02	0.02	0.02	0.03	0.03

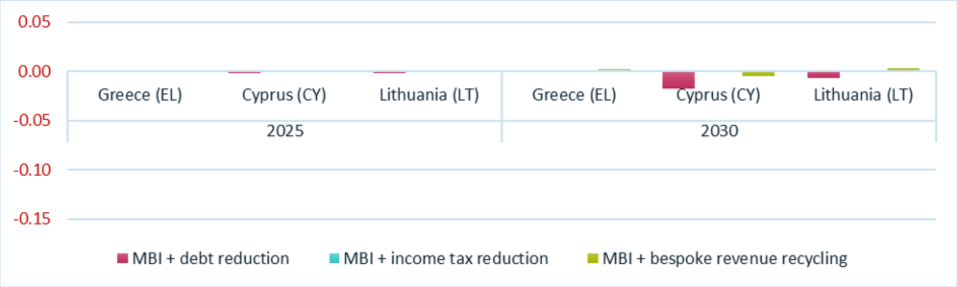
**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on trade

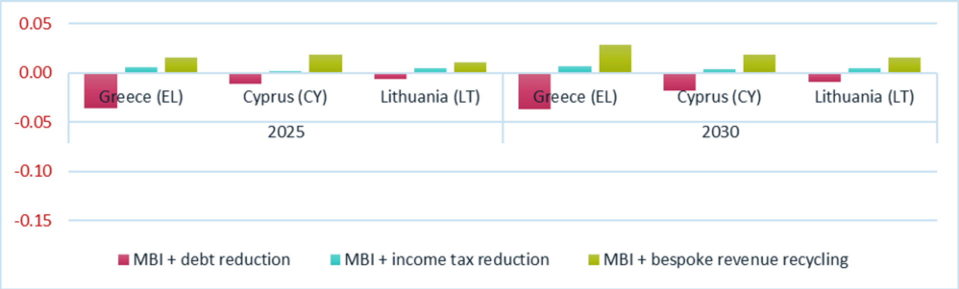
The landfill tax will have very small net effects on the competitiveness (i.e. trade balance) of the selected countries. It should be noted that we assume waste is managed domestically in the scenarios.

Figure 16: Landfill tax - Change in exports (% difference to the baseline)



The model does not project any change in total exports in Greece and very small negative changes for Cyprus and Lithuania in the scenario with debt reduction. In the other two scenario variants, the effects are even smaller overall but exports in Greece and Lithuania marginally increase compared to the baseline.

Figure 17: Landfill tax - Change in imports (% difference to the baseline)



Similarly, the changes in total imports are very small, but with changing signs between the scenario with debt reduction and the other two scenario variants. The landfill tax indirectly reduces demand for import goods and services, but when the revenue is reinvested in the economy (i.e. scenario with bespoke revenue recycling) this leads to a small increase in imports of foreign goods and services related to investment. The scenario with reduced income taxation leads to higher imports relative to the baseline but the net change is lower than in the scenario with bespoke revenue recycling.

A landfill tax will improve the balance of trade in the scenario with debt reduction for all countries analysed, due to lower imports. However, when revenues are recycled, the balance of trade worsens due to increased imports. Total exports remain mostly unaffected in all scenarios.

Table 29: Landfill tax - Impact on the balance of trade (compared to the baseline)

Scenario	2025	2030
Greece	+	+
Greece*	-	-
Greece**	-	-
Cyprus	+	+
Cyprus*	-	-
Cyprus**	-	-
Lithuania	+	+
Lithuania*	-	-
Lithuania**	-	-

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

+positive impact, - negative impact, ~ no or marginal impact

6.2.5. Pesticide tax

Design features

The pesticide tax is modelled as a tax on pesticide paid by the agriculture sector which purchases pesticide as an input to production. This tax is applied to five Member States: Austria, Belgium, Luxemburg, Slovenia and Sweden.

It should be noted again that E3ME is a macroeconomic model which cannot provide detailed estimates of various food prices as a result of pesticide tax on different types of crop. This detailed analysis requires a specialised land-use model. Instead, E3ME provides an estimate of the wider and secondary impacts on other sectors and on households from a general tax applied to the agriculture sector when purchasing inputs from the chemical sector (pesticides).

The pesticide tax rates are calculated from the estimated revenues from the tax and are shown in the table below.

Table 30: Pesticide tax revenues (€ million)

Member State	2020	2025	2030
Austria	741	531	320
Belgium	312	228	144
Luxemburg	34	24	13
Slovenia	52	40	28
Sweden	72	56	39

In the scenario with bespoke revenue recycling, all revenues from the pesticide tax are used to invest back into the agriculture sector.

Impact mechanism

The main impacts come from the agriculture industry, which passes on the costs to consumers, leading to higher domestic and export food prices. Households faced with higher food prices see their real disposable income fall while higher export prices cause negative competitiveness impacts. Domestic chemical companies, which produce pesticides, as well as imports of chemicals, are expected to see reduction in demand.

When the tax revenues are used to invest back into the agriculture sector, it may be possible to offset the negative economic impacts from a pesticide tax through economic stimulus and innovation (e.g. invest in new machineries) from the investment.

Modelling results for pesticide tax

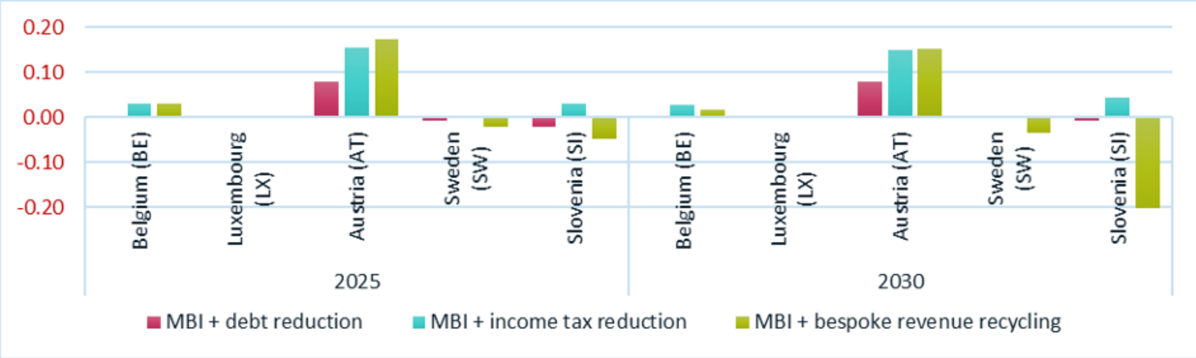
Impact on GDP and employment

When comparing the scenario with debt reduction to the baseline, a pesticide tax has no to very small net negative effects on GDP for all countries except Austria. In Austria, benefits from the reduction in chemical imports outweighs the negative effect from higher food prices. When the bespoke revenue recycling mechanism is introduced (i.e. investment the agriculture sector), the net positive GDP effect in Austria is bolstered and Belgium sees a relatively small net positive effect on GDP relative to the baseline.

Although still small in magnitude, the scenario with bespoke revenue recycling brings about a further reduction relative to the baseline to Slovenia's GDP. This is because investment boosts GDP in the early years, but these investments diminish over time as revenues from the tax decrease. The initial boost to investment leads to the adoption of new technologies in the agriculture sector. This makes the sector more competitive but comes at the expense of employment. As a result of technological innovation in the sector, employment decreases. The net reduction in GDP is primarily driven by a reduction in consumer spending caused by these job losses.

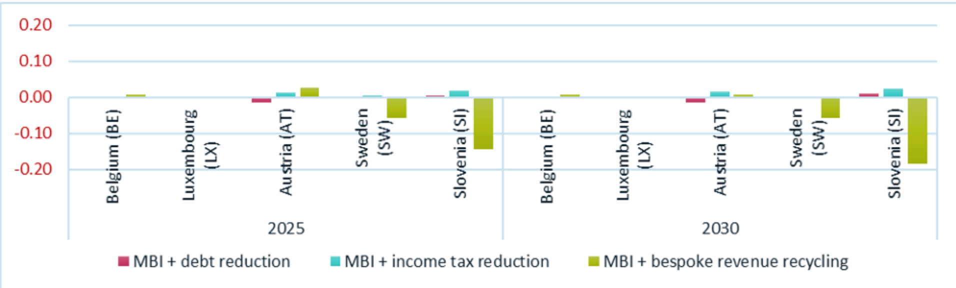
The scenario with reduced income taxation brings about higher GDP compared to the baseline in all countries except Luxembourg, where there is no change from the baseline. Notably, this scenario does not result in a negative net GDP impact in Slovenia. Further explanations can be found in the paragraphs on the sector employment results below.

Figure 18: Pesticide tax - Change in GDP (% difference to the baseline)



For Belgium and Luxembourg, the net changes in employment are close to zero for all scenarios. In the case of Austria, although GDP is positively affected, total employment is lower compared to the baseline in the scenario with debt reduction and higher compared to the baseline in the scenarios with income tax reduction and bespoke revenue recycling. In the case of Sweden and Slovenia, employment is slightly higher compared to the baseline in the scenarios with debt reduction and reduced income taxation, while total employment is lower than baseline in the scenario with bespoke revenue recycling (i.e. revenues are invested back into the agriculture sector).

Figure 19: Pesticide tax - Change in total employment (% difference to the baseline)



Impact on sector output and employment

Even though the pesticide tax is targeted to the agriculture sector, its effects are felt in multiple sectors of the economy. However, the magnitudes of the net changes by sector are not very large and, in general, the largest effects are in the agriculture sector itself. It is worth noting that, typically, agricultural economic output is lower than the baseline in the scenario with debt reduction and higher than the baseline when revenues are reinvested in the sector (i.e. bespoke revenue recycling). In fact, this holds true for most sectors in most countries for which a pesticide tax was modelled. It is also worth noting that reductions in the manufacturing sector are partially driven by a reduction in the chemicals sector, which produces pesticides. Since the chemicals sector is particularly affected by a pesticide tax, the sector-specific results have been isolated. These results show that reductions in the chemicals sector are highest in Austria and reach -2.8% compared to the baseline.

Table 31: Pesticide tax - Change in sector output in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Belgium	-0.04	-0.02	-0.05	-0.12	-0.01	-0.03	-0.02
Belgium*	0.23	-0.02	-0.05	-0.10	0.08	-0.02	-0.01
Belgium**	0.05	-0.02	-0.04	-0.10	0.00	-0.01	0.01
Luxembourg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Luxembourg*	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Luxembourg**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.02	-0.19	-0.20	-0.34	-0.03	-0.08	-0.05
Austria*	1.06	-0.17	-0.11	-0.25	0.19	-0.05	0.00
Austria**	0.06	-0.18	-0.10	-0.30	0.01	-0.04	0.04
Sweden	-0.03	0.00	0.00	0.00	0.00	0.00	0.00
Sweden*	-0.21	0.00	-0.03	0.00	0.00	-0.01	-0.02
Sweden**	-0.02	0.00	0.01	0.00	0.00	0.00	0.01
Slovenia	-0.50	0.00	0.01	-0.01	0.00	0.00	0.01
Slovenia*	0.26	0.06	-0.23	-0.05	0.10	-0.15	-0.28
Slovenia**	-0.47	0.00	0.06	0.01	0.02	0.04	0.07

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

A similar picture emerges for employment by sector in 2030 in the case of Belgium and Austria (see Table below). The largest changes to employment compared to the baseline are typically in the agriculture sector, with Belgium and Austria seeing larger net changes in agriculture employment in the scenario in which revenues are recycled into the agriculture sector. This is because economic activities and additional investment lead to higher demand for labour.

However, results for Sweden and Slovenia also show that agriculture employment is higher compared to the baseline in the scenario with debt reduction and in the scenario with income tax adjustments, while it is lower than baseline in the scenario in which revenues are recycled back into the agriculture sector. This is because agriculture investments have historically led to reduced employment associated with technological innovation. On the other hand, the demand for agricultural machinery can also induce job creation in other sectors.

In the scenario with bespoke revenue recycling, for some MS, higher employment in the manufacturing of motor vehicles and other transport equipment offsets lower employment levels relative to the baseline in the manufacturing of chemicals (pesticide) employment. Because some additional demand for machinery is met by imports, net job increases in manufacturing overall remain limited.

Table 32: Pesticide tax - Change in sector employment in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Belgium	0.02	0.00	-0.02	0.00	0.00	-0.01	0.00
Belgium*	1.13	0.00	-0.02	0.01	0.02	-0.01	0.00
Belgium**	0.02	0.00	-0.02	0.00	0.00	-0.01	0.00
Luxembourg	-0.13	0.00	0.00	0.00	0.00	0.00	0.00
Luxembourg*	-0.13	0.00	0.00	0.00	0.00	0.00	0.00
Luxembourg**	-0.13	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.30	0.00	-0.01	-0.06	0.00	-0.05	-0.02
Austria*	0.73	0.00	-0.01	-0.06	-0.01	-0.04	-0.01
Austria**	0.30	0.00	-0.01	-0.04	0.00	-0.03	0.02
Sweden	0.09	0.00	0.00	0.00	0.00	0.00	0.00
Sweden*	-2.85	0.00	0.00	0.01	-0.03	0.00	0.00
Sweden**	0.08	0.00	0.00	0.00	0.00	0.00	0.00
Slovenia	0.30	0.00	0.00	-0.02	-0.02	-0.01	0.00
Slovenia*	-3.25	0.00	-0.01	0.02	0.25	0.01	-0.05
Slovenia**	0.30	0.00	0.00	-0.01	-0.01	0.01	0.02

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on real income

A pesticide tax is expected to increase the agriculture sector's costs, which in turn is expected to lead to higher food prices. Therefore, real incomes are projected to be lower compared to the baseline in the scenario with debt reduction and the scenario with bespoke revenue recycling. With Austria as the exception, the reduction is larger when revenues are recycled into the agriculture sector. In fact, the steepest reduction to household income compared to the baseline is the case of Slovenia in the scenario with bespoke revenue recycling. This is brought about by comparatively steep reductions in agriculture and services employment demand, leading to lower wages and lower consumption, as well as the reduction in GDP relative to the baseline.

Table 33: Pesticide tax - Change in real income in 2030 (% difference to the baseline)

Scenario	All	Q1	Q2	Q3	Q4	Q5
Belgium	0.00	0.00	0.00	0.00	0.00	0.00
Belgium*	-0.01	-0.01	-0.01	-0.01	-0.01	0.00
Belgium**	0.04	0.05	0.05	0.04	0.04	0.04
Luxembourg	0.00	0.00	0.00	0.00	0.00	0.00
Luxembourg*	0.00	0.00	0.00	0.00	0.00	0.00
Luxembourg**	0.00	0.00	0.00	0.00	0.00	0.00
Austria	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Austria*	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01
Austria**	0.12	0.13	0.12	0.12	0.12	0.11
Sweden	0.00	0.00	-0.01	0.00	0.00	0.00
Sweden*	-0.03	-0.04	-0.04	-0.04	-0.04	-0.03
Sweden**	0.01	0.01	0.01	0.01	0.01	0.01
Slovenia	0.00	0.00	0.00	0.00	0.00	0.00
Slovenia*	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22
Slovenia**	0.11	0.09	0.09	0.10	0.12	0.13

**MBI + bespoke revenue recycling*

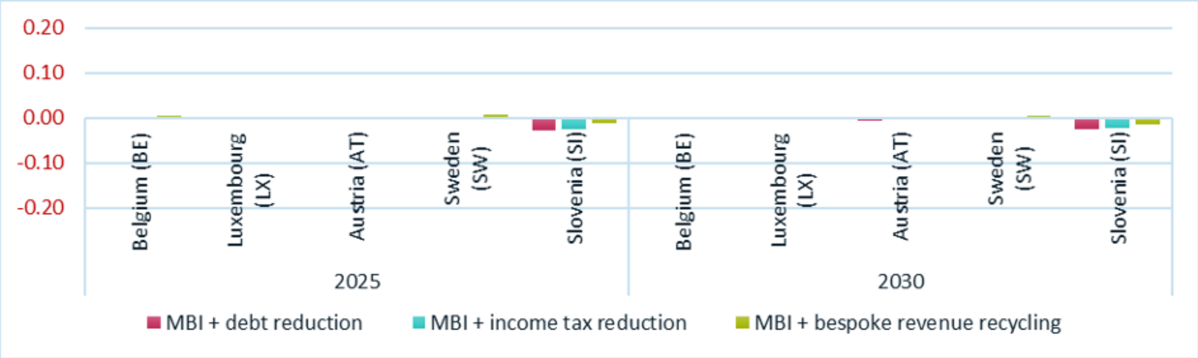
***MBI + income tax reduction*

When revenues are recycled back as income tax reductions, this results in net positive changes. In general, lower income taxes lead to a small increase in real income in all quintiles. This is because higher levels of disposable income counteract the impact of higher food prices. Furthermore, real income is boosted by a positive employment effect leading to increased wages and higher consumption.

Impact on trade

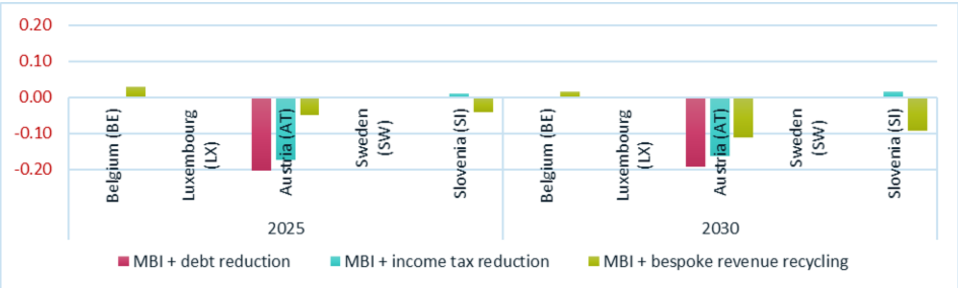
A pesticide tax is projected to have very small net effects on the competitiveness (i.e. trade balance) of the selected countries. Only in Slovenia, the pesticide tax leads to small but noticeable negative changes in exports for all scenario variants.

Figure 20: Pesticide tax - Change in exports (% difference to the baseline)



Similar to the impact on exports, the changes in total imports are very small. In the case of Belgium, investment in the agriculture sector leads to a small increase in imports, while in Slovenia this has the opposite effect. In Austria, imports are consistently projected to be considerably lower than baseline from the introduction of a pesticide tax and its effect on food prices. In the scenario with investment in the agriculture sector (i.e. MBI + bespoke revenue recycling), the decline in imports is partially mitigated.

Figure 21: Pesticide tax - Change in imports (% difference to the baseline)



The overall effect on the balance of trade varies. For Austria, the country with the largest projected reductions in imports relative to the baseline, the results suggest improvements in the balance of trade under all scenario variants. However, the changes Slovenia, and Sweden show opposite signs when comparing the scenario with revenue recycling into the agriculture sector to the two other scenario variants For Belgium, a small reduction in pesticide imports improves its trade balance but when revenues are recycled in the agriculture sector, imports of machinery and other goods and services cancel out this affect. Finally, the impact on Luxembourg's and Sweden's exports and imports are negligible, thus suggesting a neutral impact on the country's balance of trade.

Table 34: Pesticide tax - Impact on the balance of trade (compared to the baseline)

Scenario	2025	2030
Belgium	+	+
Belgium*	-	-
Belgium**	-	-
Luxembourg	~	~
Luxembourg*	~	~

Luxembourg**	~	~
Austria	+	+
Austria*	+	+
Austria**	+	+
Sweden	~	-
Sweden*	+	+
Sweden**	-	-
Slovenia	-	-
Slovenia*	+	+
Slovenia**	-	-

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

+positive impact, - negative impact, ~ no or marginal impact

6.2.6. Fertiliser levy

Design features

Similar to the pesticide tax, the fertiliser levy is modelled as a levy on fertiliser paid by the agriculture sector, which uses fertiliser as input to their production. This MBI is applicable to four EU Member States: Czech Republic, Denmark, Estonia and France.

As mentioned in the description of modelling assumptions for the pesticide tax, E3ME cannot provide a detailed estimate of various food prices as a result of fertiliser levy applied to different types of crop (this requires a land-use model). In this study, E3ME is used to provide an estimate of wider impacts on other sectors and on households from a general levy applied to the agriculture sector when purchasing inputs from the chemical sector (which produces fertiliser). The fertiliser levy rates are calculated from expected revenues from levies, in line with the expectation propose in the main report. The revenues are shown in the table below.

Table 35: Fertiliser levy revenues (€ million)

Member State	2020	2025	2030
Czech Republic	467	398	283
Denmark	483	360	155
Estonia	24	23	21
France	3657	2972	1832

In the scenario with bespoke revenue recycling, all revenues from this levy are used to invest back into the agriculture sector.

Impact mechanism

Similar to a pesticide tax the main impacts from a fertiliser levy without revenue recycling come from the agriculture industry, which passes on the costs leading to higher domestic and export food prices. Households faced with higher food prices see their real disposable income fall while a higher export price causes negative competitiveness impacts. Domestic chemical companies, which produce fertilisers, as well as imports of chemicals, are expected to see a reduction in demand.

When the tax revenues are used to invest back into the agriculture sector, it may be possible to mitigate the negative economic impacts from the pesticide tax through an economic stimulus effect and innovation from the investment (for example, new machinery leading to an increase in demand for the engineering sector and a higher productivity of agricultural activities).

Modelling results for fertiliser levy

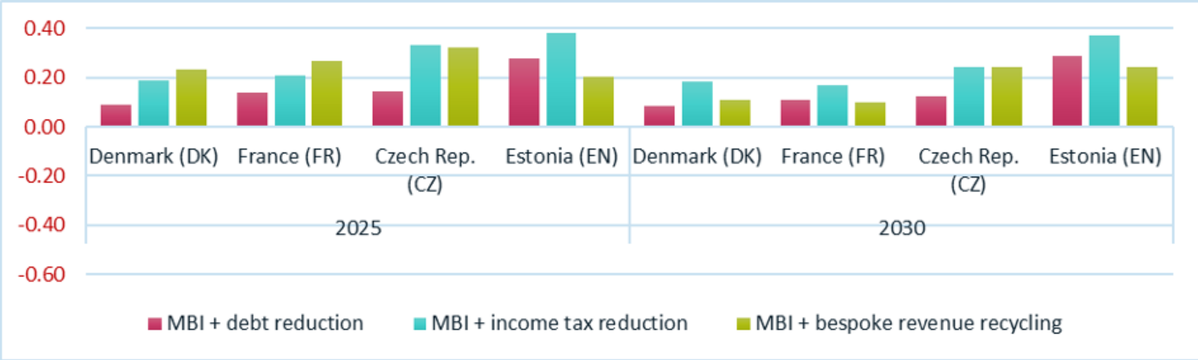
Impact on GDP and employment

The fertiliser levy brings about a small net increase in GDP relative to the baseline, in each country analysed and in each scenario. Although the levy reduces real income, consumption and exports as a result of higher agriculture prices, the reduction in chemical imports outweighs the negative effects. Furthermore, since fertiliser levies are implemented in four EU countries, it is possible that producers absorb the cost increase without passing it on to final agriculture prices in order to remain competitive. This helps to minimise negative impacts to households and domestic industries.

The increase in GDP is typically higher in the scenario with bespoke revenue recycling (i.e. agriculture investment), as these revenues are used to finance investments that drive up GDP. The increase in GDP in the scenario with bespoke revenue recycling is larger in 2025 than in 2030 because the amount of revenue collected, and thereby invested in the agriculture sector, is higher in 2025.

Furthermore, the scenario with income tax reductions shows the largest increase in 2030 GDP compared to the baseline as the reduction in real income brought about by higher agriculture prices is offset by an increase in real income as a result of lower income taxes.

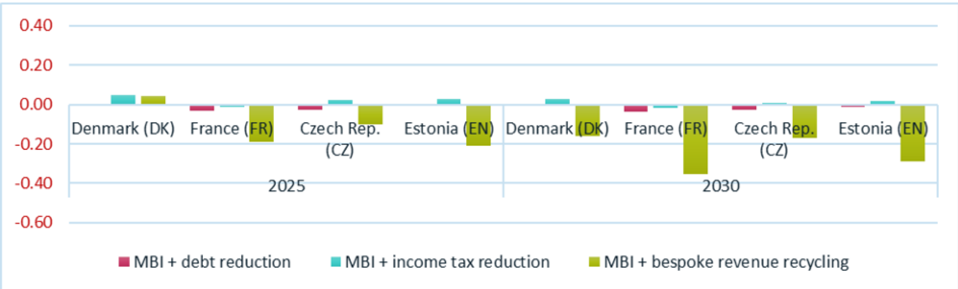
Figure 22: Fertiliser levy - Change in GDP (% difference to the baseline)



In terms of employment, the scenario with debt reduction typically shows a very small net negative employment effect. This is due to the higher prices borne by households, leading to lower consumption, leading to lower demand, and therefore lower employment compared to the baseline. In contrast, the scenario with lower income taxes results in small net positive employment effects in 2025 and 2030 (except for France's very small relative employment loss).

While the GDP results are driven mainly by a reduction in chemical imports, the employment results reflect the general reduction in demand for other goods and services as a result of higher agriculture product prices. However, the reduction in employment is much larger in the scenario with bespoke revenue recycling. This is because increased investment in the agriculture sector has historically led to technological innovation and a shift from labour to capital-intensive processes. However, the largest decrease in 2030 total employment is in France with -0.35% less employment than in the baseline, a relatively small decrease.

Figure 23: Fertiliser levy - Change in total employment (% difference to the baseline)



Impact on sector output and employment

Similar to a pesticide tax, a fertiliser levy targeted to the agriculture sector leads to higher prices for consumers, which affects demand in different sectors of the economy. However, as in the case of a pesticide tax, the largest impact is typically felt in the agriculture sector itself.

For all countries except Estonia, a fertiliser levy combined with investment into the agriculture sector brings about higher agriculture economic output relative to the baseline in 2030. In the case of Estonia, an increase in crop production output (+0.5%) and fisheries output (+0.5%) is offset by a decrease in forestry economic output (-1.1%) in the bespoke revenue recycling scenario. Moreover, although a fertiliser levy typically leads to lower levels of manufacturing output compared to the baseline as a result of lower chemical manufacturing output, this reduction is partly alleviated by the revenue recycling through a higher level of investment in agriculture equipment. This leads to improvements in the output of sectors such as the manufacturing of motor vehicles, electronic equipment, and machinery. Furthermore, increased economic output in the repairs and installation sector (which falls under the manufacturing broad category) is also observed in the bespoke revenue recycling scenario.

The scenario with income tax reductions yields similar yet slightly higher positive results compared with the scenario in which revenues are used to pay off government debt. This is due to higher consumption which results from higher real income. In some instances, the MBI combined with income tax reductions brings about a positive output effect in sectors that see a negative 2030 output effect when revenues are used for debt reduction.

Table 36: Fertiliser levy - Change in sector output in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Denmark	0.09	-0.01	-0.01	-0.09	-0.01	-0.01	-0.01
Denmark*	0.45	0.00	-0.01	0.03	0.09	0.00	-0.01
Denmark**	0.29	0.00	0.13	-0.02	0.05	0.01	0.09
France	0.06	-0.75	-0.11	-0.77	-0.11	-0.22	-0.10
France*	1.20	-0.78	-0.15	-0.59	-0.14	-0.26	-0.13
France**	0.12	-0.74	-0.07	-0.72	-0.10	-0.14	-0.05
Czech Rep.	-0.23	-0.01	-0.04	-0.09	-0.03	-0.05	-0.03
Czech Rep.*	2.73	-0.07	-0.01	0.08	0.15	0.01	0.03
Czech Rep.**	-0.14	-0.02	0.06	-0.04	-0.01	0.01	0.07
Estonia	0.28	0.03	0.03	0.10	-0.01	0.02	0.03
Estonia*	-0.19	0.03	-0.05	0.10	0.05	-0.03	-0.05
Estonia**	0.44	0.04	0.09	0.15	0.00	0.05	0.10

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

In terms of employment, the largest changes are observed in the agriculture sector and in the scenario with bespoke revenue recycling. Given that the amount of revenues collected from a fertiliser levy is much larger than the revenues collected from a pesticide tax, by scenario design this leads to a large flow of investment into the agriculture sector. As the investment leads to improved technology and a shift from labour to capital-intensive agriculture processes, this results in significant reductions in 2030 sectoral employment, relative to the baseline. Although the net changes in agriculture employment are comparatively large, it is worth noting that the total employment reductions compared to the baseline are comparatively small. This is because in the scenario with bespoke revenue recycling, the reduction in the agriculture sector is largely compensated by small gains in employment in the much larger services and construction sectors. The scenario with income tax reductions typically shows a positive 2030 services employment effect compared to the baseline, as a result of increased consumer spending overall. This is the core driver of overall positive total employment effects.

Table 37: Fertiliser levy - Change in sector employment in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Denmark	-0.03	0.00	0.00	0.07	0.01	-0.01	-0.01
Denmark*	-9.29	0.00	0.01	-0.10	0.09	0.02	0.02
Denmark**	-0.21	0.00	0.01	-0.04	0.05	0.02	0.04
France	0.20	0.00	0.00	-0.34	0.01	-0.09	-0.01
France*	-15.18	0.00	0.00	-0.12	-0.15	-0.08	0.00
France**	0.16	0.00	0.00	-0.30	0.01	-0.06	0.01
Czech Rep.	-0.82	0.00	0.00	-0.02	-0.01	-0.02	0.00
Czech Rep.*	-10.50	0.00	0.00	0.09	0.22	0.00	0.03
Czech Rep.**	-0.79	0.00	0.00	0.02	0.01	0.01	0.03
Estonia	-1.26	0.02	0.01	0.01	0.00	0.01	0.03
Estonia*	-10.49	0.01	0.00	-0.09	0.05	0.03	0.01
Estonia**	-1.14	0.02	0.01	0.04	0.00	0.02	0.07

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on real income

The fertiliser levy is in most scenarios and countries projected to reduce household real income relative to the baseline. Although the extent of cost pass through to food prices is often limited due to the level of competition in the agriculture and food sector, some of the cost increase from a fertiliser levy is passed on to consumers through increased food prices (the extent of the pass-through is reflected in the sector specific cost-price elasticity estimated from historical data). In the case of Denmark and Estonia in the scenario with debt reduction, the negative impacts happened in the early years. By 2030 all household quintiles see an improvement in real income compared to the baseline as the agriculture sector moves away from using fertiliser, reducing input costs.

When collected revenues are recycled back into the agriculture sector, the effect on real income in all household groupings is negative compared to the baseline or worse than in the scenario with debt reduction. This is because in the scenario with bespoke revenue recycling (i.e. agriculture investment), the increased investment expenditure in the agriculture sector provide stimulus in the short term, but in the long-term lead to labour savings technologies in the agriculture sector. Having said that, in the case of Denmark, households are better off relative to the baseline in the scenario with bespoke revenue recycling. This implies that a large investment in the Danish agriculture sector leads to reductions in production costs and indirectly leads to improvements in the income of households, especially lower income households.

The scenario with a combination of the MBI and income tax reductions is projected to bring about even higher upward changes in 2030 real income in all countries and all quintiles.

Table 38: Fertiliser levy - Change in real income in 2030 (% difference to the baseline)

Scenario	All	Q1	Q2	Q3	Q4	Q5
Denmark	0.01	0.01	0.01	0.01	0.01	0.01
Denmark*	0.06	0.07	0.07	0.06	0.06	0.06
Denmark**	0.15	0.18	0.16	0.15	0.16	0.15
France	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
France*	-0.22	-0.21	-0.22	-0.22	-0.22	-0.22
France**	0.07	0.08	0.07	0.07	0.07	0.06
Czech Rep.	-0.02	-0.01	-0.01	-0.01	-0.02	-0.03
Czech Rep.*	-0.04	-0.03	-0.03	-0.04	-0.04	-0.05
Czech Rep.**	0.26	0.25	0.26	0.26	0.26	0.27
Estonia	0.12	0.17	0.15	0.14	0.12	0.09
Estonia*	-0.08	-0.05	-0.06	-0.07	-0.08	-0.09
Estonia**	0.30	0.33	0.31	0.30	0.29	0.28

**MBI + bespoke revenue recycling*

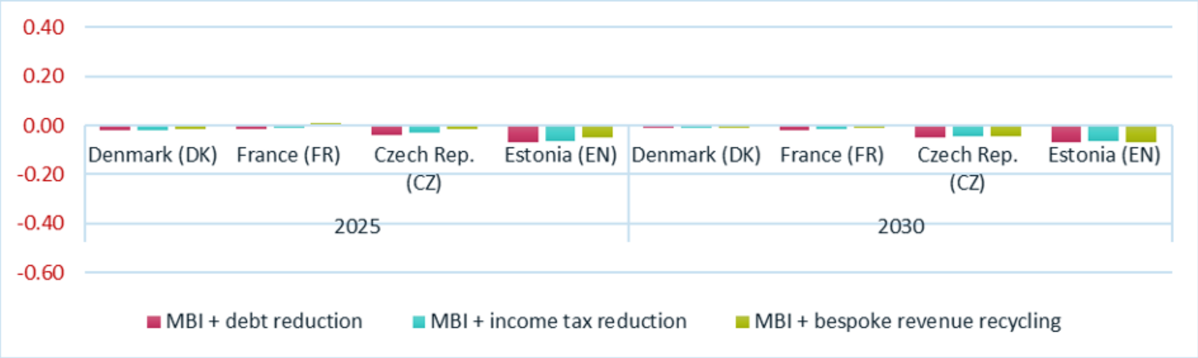
***MBI + income tax reduction*

Impact on trade

Overall, positive GDP effects are helped by a small improvement in the trade balance of the selected countries, i.e. imports (mainly of chemical which falls by around 4-5%) fall more strongly than exports (agriculture products falls by approximately 0.5%).

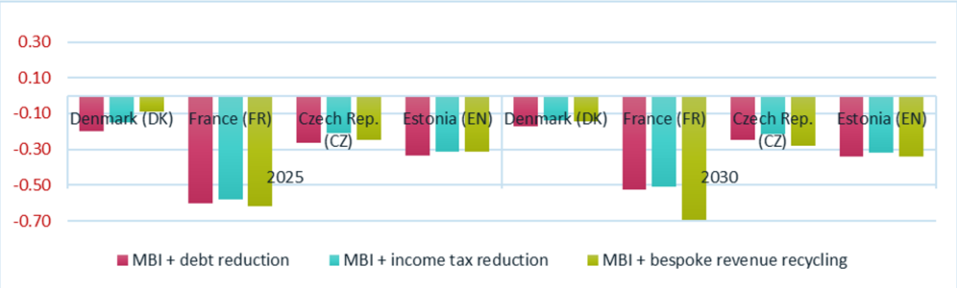
Export levels decrease marginally as a result of higher agriculture prices making the sector less competitive, in all scenarios and countries (with the exception of the scenario with bespoke revenue recycling in France).

Figure 24: Fertiliser levy - Change in exports (% difference to the baseline)



Total imports also decrease relative to the baseline when introducing a fertiliser levy. This is partially driven by a lower demand for imported chemical products. Modelling results show limited degrees of agriculture import substitution, suggesting a relatively inelastic demand for domestic agriculture products.

Figure 25: Fertiliser levy - Change in imports (% difference to the baseline)



The overall effect on the balance of trade is positive throughout. This implies that the reduction in imports brought about by a fertiliser levy supersedes the reduction in exports.

Table 39: Fertiliser levy - Impact on the balance of trade (compared to the baseline)

Scenario	2025	2030
Denmark	+	+
Denmark*	+	+
Denmark**	+	+
France	+	+
France*	+	+
France**	+	+
Czech Rep.	+	+

Czech Rep.*	+	+
Czech Rep.**	+	+
Estonia	+	+
Estonia*	+	+
Estonia**	+	+

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

+positive impact, - negative impact, ~ no or marginal impact

6.2.7. Waste water pollution tax

Design features

This scenario is based on waste water pollution taxes in Ireland and Romania. The rate varies by pollutant and country. The tax rates are modelled as additional cost to industries that discharge effluents such as the chemical, electricity, textiles, and food manufacturing sectors as well as households that discharge waste water. The expected revenues from the taxes are given in the table below.

Table 40: Expected revenues from waste water pollution taxes (€ million)

Member State	2020	2025	2030
Ireland	181	157	132
Romania	106	103	100

In the scenario with bespoke revenue recycling, revenues from the waste water pollution tax are used to reduce employers' social security contribution tax rates (i.e. reduction in labour tax).

Impact mechanism

The negative impacts from taxing waste water pollution without recycling the revenue come from higher costs to industries that discharge effluents. It can lead to an inflationary effect for the whole economy, which erodes real incomes and harms competitiveness. Households also lose out from the charges that they must pay directly, hence a reduction in overall consumer spending is expected. However, it should be noted that the modelling only looks at impacts of taxation on emitting sectors. In practice, there may be cost reductions associated with a reduction in water treatment costs which may offset the tax increase.

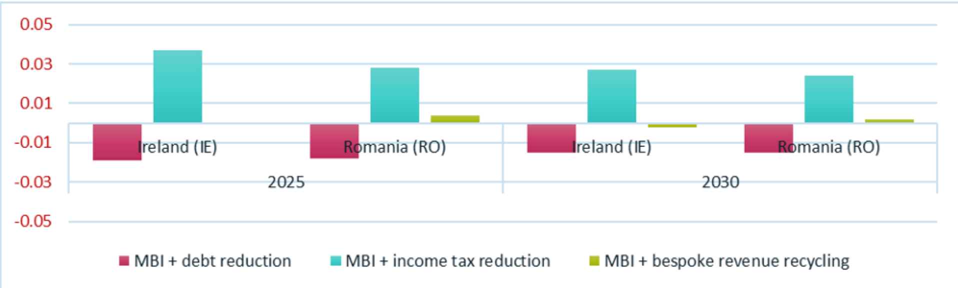
When tax revenues are used to reduce social security contribution tax lowers labour costs to firms, this can lead to higher employment demand. This in turn can lead to smaller negative impacts, or in some cases to small net positive GDP and jobs impacts.

Modelling results for a waste water tax

Impact on GDP and employment

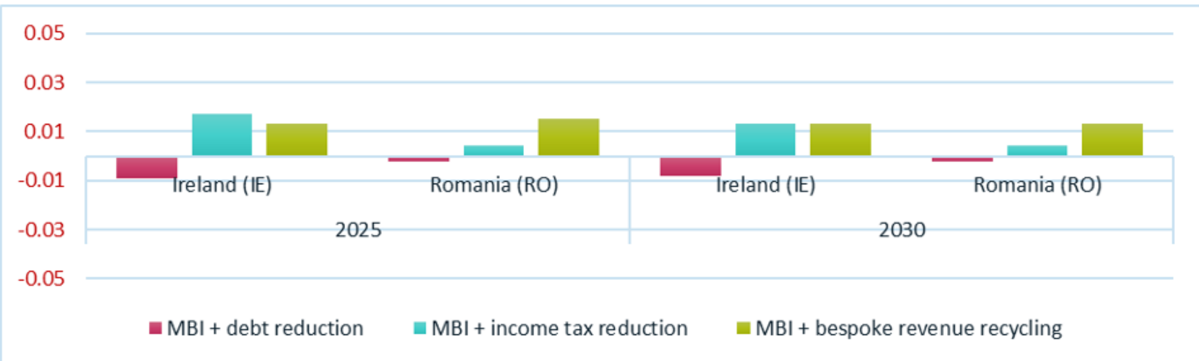
In the scenario with debt reduction, waste water pollution taxes bring about small reductions to GDP relative to the baseline in both countries. This is due to an increase in the costs to firms, which indirectly affects households through higher prices, as well as a direct increase in costs for households that discharge waste water themselves. This brings about reductions in real income and therefore reductions in consumption. However, the model does not take account of cost savings due to cleaner water (resulting in a reduction in water tariffs). When revenues are recycled to reduce social security contributions, the reduction in GDP is mostly mitigated in the case of Ireland and changes sign in Romania. Furthermore, revenues recycled to reduce income tax result in an increase in 2025 and 2030 GDP relative to the baseline. Therefore, this scenario brings about the largest overall net positive economic effect in terms of GDP.

Figure 26: Waste water pollution tax - Change in GDP (% difference to the baseline)



Without a reduction in social security contributions or income taxes, higher costs to firms and households lead to lower employment because of lower consumer spending. However, in the scenario with bespoke revenue recycling, the revenues collected are used to reduce firms' labour costs by reducing social security contributions. This leads to higher employment demand relative to the baseline. Higher employment drives up real wages, which drives up consumer spending and GDP. Similarly, when revenues are instead used to lower income taxes, this also leads to an increase in employment relative to the baseline.

Figure 27: Waste water pollution tax - Change in total employment (% difference to the baseline)



Impact on sector output and employment

The impact of waste water pollution taxes on sector output is typically a very small reduction in 2030 output compared to the baseline. The results show that in the scenario with debt reduction, the reduction to sectoral output compared to the baseline is larger than in the scenario in which revenues are recycled to lower social security contributions. When revenues are recycled to lower income taxation, a very small positive output effect is achieved as a result of higher disposable income leading to higher consumption and, therefore, higher demand for goods and services.

Table 41: Waste water pollution tax - Change in sector output (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Ireland	-0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01
Ireland*	0.00	0.00	0.00	0.00	-0.01	0.00	0.00
Ireland**	0.01	0.00	0.01	0.01	0.01	0.02	0.02
Romania	0.00	0.00	0.00	-0.01	0.00	-0.01	-0.01
Romania*	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Romania**	0.00	0.00	0.01	0.01	0.01	0.01	0.02

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

In the scenarios with income tax reductions and bespoke revenue recycling, lower reductions in output occur because overall employment increases. An increase in employment leads to higher consumer spending and therefore higher sectoral output. Having said that, the effects of waste water pollution taxes on sectoral employment are small, with a small increase relative to the baseline in manufacturing, construction, and services.

Table 42: Waste water pollution tax - Change in sector employment in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Ireland	0.00	0.00	0.00	-0.01	0.00	-0.03	-0.01
Ireland*	-0.02	0.00	0.00	0.01	0.07	0.00	0.01
Ireland**	0.00	0.00	0.00	0.01	-0.01	0.05	0.02
Romania	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Romania*	0.00	0.00	0.00	0.02	0.03	0.01	0.02
Romania**	0.00	0.00	0.00	0.00	0.00	0.00	0.01

**MBI + bespoke revenue recycling   **MBI + income tax reduction*

Impact on real income

Waste water pollution taxes cause a small reduction in household real incomes (in the scenario with debt reduction). This is because the tax affects both households and firms which increase prices to cover the cost of the taxes levied. Since lower income households have less disposable income, the price increase leads to slightly higher percentage reductions in real income for lower earning households. However, when the tax revenues are recycled back to firms in the form of lower social security contributions, this reduces labour costs and creates additional demand for employment. Higher employment demand leads to higher income. When revenues are used to reduce income taxation, a higher real income effect is seen in both Ireland and Romania. This effect is highest in the upper income quintile, which benefits most from the reduction in income taxes.

Table 43: Waste water pollution tax - Change in real income in 2030 (% difference to the baseline)

Scenario	All	Q1	Q2	Q3	Q4	Q5
Ireland	-0.04	-0.05	-0.04	-0.04	-0.04	-0.04
Ireland*	0.01	-0.01	0.00	0.01	0.01	0.01
Ireland**	0.07	0.05	0.06	0.07	0.07	0.08
Romania	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
Romania*	0.00	0.00	0.00	0.01	0.00	0.00
Romania**	0.04	0.03	0.03	0.03	0.04	0.05

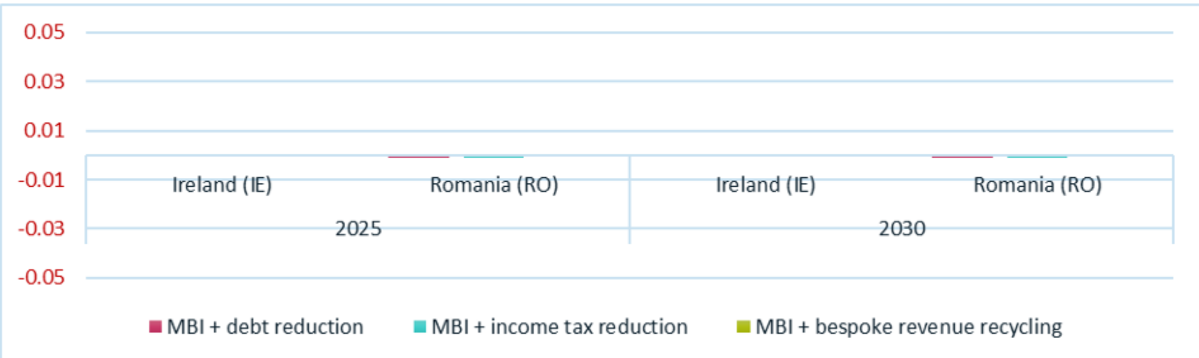
**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on trade

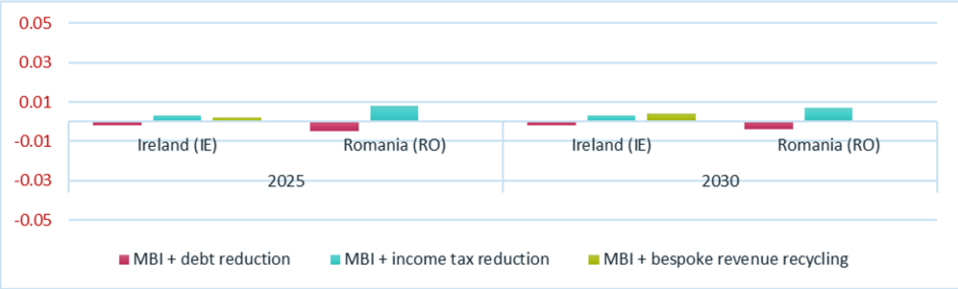
Total exports remain at baseline levels or slightly lower than baseline in all scenario variants.

Figure 28: Waste water pollution tax - Change in exports (% difference to the baseline)



Small effects on imports are observable. Whereas imports are slightly lower than baseline in the scenario with debt reduction, total imports are slightly higher than baseline in the scenario with an income tax reduction.

Figure 29: Waste water pollution tax - Change in imports (% difference to the baseline)



In the case of Ireland, this results in a neutral effect when comparing to the balance of trade to the baseline. A small decrease in Romania's imports trumps a an even smaller decrease in exports, leading to small balance of trade improvements in the scenario with debt reduction. However, higher imports in the scenario with revenue recycling via income taxation bring about a negative balance of trade impact in both Member States.

Table 44: Waste water pollution tax - Impact on the balance of trade (compared to the baseline)

Scenario	2025	2030
Ireland	~	~
Ireland*	-	-
Ireland**	-	-
Romania	+	+
Romania*	~	+
Romania**	-	-

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

+positive impact, - negative impact, ~ no or marginal impact

Overall, the impact on trade is very small and the effect of the changes on the balance of trade is minor.

6.2.8. Water consumption charge

Design features

This scenario is based on the assumed introduction of water externality pricing in ten EU Member States: Bulgaria, Cyprus, Czech Republic, Germany, Greece, Italy, Malta, Poland, Portugal and Spain. Since it is difficult to estimate the externality cost of water, which could also vary significantly depending on usage and area, we assumed a simple average charge rate of 4% on the existing water price across the ten member states from 2020 onward.

The sparsity of the available data meant that it is not possible to estimate econometric equations for water consumption in E3ME. Based on the available applied econometric literature, an industrial water demand price elasticity of -0.25 and a household water demand price elasticity of between -0.5 and -0.1 is assumed.

In the scenario with bespoke revenue recycling, revenues are invested in water infrastructure in line with the ‘water pays for water’ principle.

Impact mechanism

The charge is applied directly to consumers and businesses, resulting in a loss of real income and higher costs to industries (see Figure 7.10). As with the wastewater tax, the simulations only cover impacts of a water consumption charge. In practice, there may be a cost reduction associated with a reduction of external costs which may offset the additional water charge.

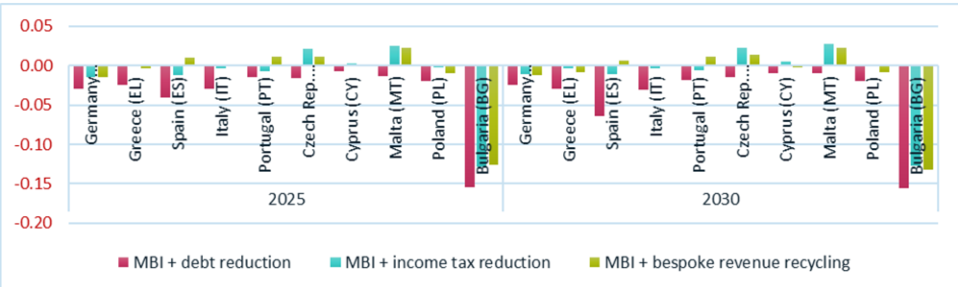
When the tax revenues are invested in water infrastructure, these negative GDP and employment effects can be mitigated from the boost to investment in the water supply industry.

Modelling results for a water consumption charge

Impact on GDP and employment

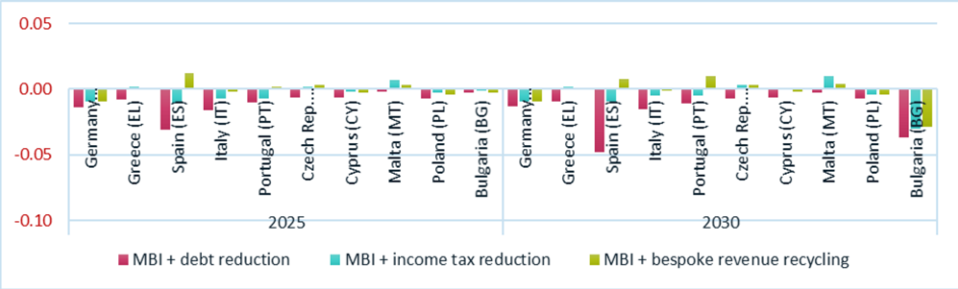
A water consumption charge impacts both households and firms. Due to the additional costs resulting directly from the charge and resulting prices, real income diminishes, and consumption is reduced. This leads to a reduction in GDP relative to the baseline in all countries in the scenarios with debt reduction. However, when the revenues of a water consumption charge are utilised to bolster investment levels in the water supply industry or to reduce income taxes, the reductions to GDP compared to the baseline are either mitigated or lead to net positive effects on GDP.

Figure 30: Water consumption charge - Change in GDP (% difference to the baseline)



Similarly, total employment is slightly lower compared to the baseline for all ten countries in the scenario with debt reduction. However, scenarios with revenue recycling leads to small net positive effects on total employment in Member States such as the Czech Republic and Malta for both revenue recycling variants.

Figure 31: Water consumption charge - Change in total employment (% difference to the baseline)



Impact on sector output and employment

In all three scenarios, the utilities sector is the worst affected sector due to lower water consumption leading to lower economic output in the water supply sector. When revenues are used to invest in water infrastructure, the effect on output in the utilities sector remains unchanged. This implies that if revenues are indeed recycled into water related infrastructure and management, this can lead to higher productivity in water provision as well as environmental benefits.

All other economic sectors typically show a very small negative effect on sectoral output in the scenario without revenue recycling. This effect is either mitigated or turned into an improvement in economic output relative to the baseline in a scenario which includes revenue recycling into water infrastructure. In fact, due to increased expenditure on water infrastructure, the construction sector's economic output increases compared to the baseline in nine out of the ten countries analysed. A similar increase in manufacturing economic output compared to the baseline is found in nine out of the ten countries. This is driven by increased economic activity in the electronics, electrical equipment, and machinery economic sectors. Similarly, the MBI combined with revenue recycling via income tax reductions more often than not results in improved output relative to baseline for economic sectors other than utilities. In most countries analysed, the agriculture and services sectors see increased output through increased consumer spending from the reduction in income taxes.

Table 45: Water consumption charge - Change in sector output in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Germany	0.01	-0.01	-0.23	-0.01	-0.02	-0.01	-0.02
Germany*	0.01	0.00	-0.23	0.01	0.01	0.00	-0.01
Germany**	0.03	0.00	-0.22	0.00	-0.01	0.01	0.00
Greece	-0.01	-0.01	-0.46	-0.01	-0.01	-0.02	-0.02
Greece*	0.00	0.02	-0.45	0.04	0.03	0.00	-0.01
Greece**	0.01	0.00	-0.43	0.01	0.00	0.02	0.00

Spain	-0.05	0.00	-0.36	-0.06	-0.04	-0.04	-0.05
Spain*	0.03	-0.02	-0.28	0.06	0.05	0.02	0.00
Spain**	0.03	0.01	-0.31	-0.01	-0.01	0.00	-0.01
Italy	0.00	-0.02	-0.25	-0.03	-0.01	-0.02	-0.02
Italy*	0.00	-0.02	-0.19	0.05	0.05	0.00	0.00
Italy**	0.01	-0.02	-0.21	0.00	0.00	0.00	0.00
Portugal	-0.04	-0.01	-0.24	-0.02	-0.01	-0.01	-0.01
Portugal*	0.01	0.02	-0.21	0.08	0.06	0.01	0.00
Portugal**	0.03	-0.01	-0.23	0.00	-0.01	0.00	0.00
Czech Rep.	0.00	0.01	-0.12	-0.01	-0.01	-0.01	-0.02
Czech Rep.*	-0.01	-0.01	-0.10	0.03	0.04	0.01	0.01
Czech Rep.**	0.02	0.01	-0.09	0.01	0.00	0.02	0.02
Cyprus	0.01	0.00	-0.10	0.00	-0.01	-0.01	-0.01
Cyprus*	0.02	0.00	-0.10	0.01	0.02	0.00	0.00
Cyprus**	0.02	0.00	-0.10	0.02	0.01	0.00	0.00
Malta	-0.01	0.00	0.00	-0.01	-0.03	0.00	0.00
Malta*	-0.01	0.00	0.00	0.01	0.19	0.00	0.00
Malta**	0.06	0.00	0.00	0.00	0.01	0.00	0.01
Poland	-0.01	-0.03	-0.06	-0.01	-0.01	-0.01	-0.02
Poland*	0.00	-0.15	-0.06	0.01	0.01	0.00	-0.01
Poland**	0.01	-0.03	-0.06	0.01	0.00	0.00	0.00
Bulgaria	0.00	-0.01	-0.15	-0.24	-0.29	-0.02	-0.07
Bulgaria*	0.00	-0.01	-0.14	-0.19	-0.24	-0.02	-0.06
Bulgaria**	0.00	-0.01	-0.15	-0.23	-0.29	-0.02	-0.05

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

In terms of employment by sector, the net changes are close to zero. It is worth noting that although the countries analysed can expect some reduction in water consumption and therefore a reduction in the utility sector's economic output compared to baseline, the utility sector's employment levels broadly remain at baseline levels in all scenarios.

It is also interesting to note that higher investment in water infrastructure brings about positive employment effects in eight countries' construction sectors and seven countries' manufacturing sectors. These sectors produce 'investment goods' required for investments made in other industries. With regards to higher employment in the manufacturing sector, this is driven by additional employment demand in the electronics, electrical equipment, and repair and installation sectors as a result of higher economic output relative to the baseline.

In the scenario with revenue recycling via income tax reductions, the effects on sectoral employment are negligible. Relative to the bespoke revenue recycling scenario, reducing income taxation shifts the positive employment effects from manufacturing to services sectors, which tend to be associated with consumer demand.

Table 46: Water consumption charge - Change in sector employment in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Germany	0.00	0.00	0.00	-0.01	-0.05	-0.01	-0.01
Germany*	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01
Germany**	0.00	0.00	0.00	-0.01	-0.04	0.00	-0.01
Greece	0.00	0.00	-0.01	-0.01	-0.01	0.00	-0.01
Greece*	0.00	0.00	-0.01	0.03	0.02	0.00	-0.01
Greece**	0.00	0.00	-0.01	0.00	0.00	0.02	0.00
Spain	0.01	0.00	-0.01	-0.06	-0.05	-0.04	-0.05
Spain*	0.01	0.00	0.00	0.03	0.02	0.03	0.00
Spain**	0.01	0.00	0.00	-0.02	-0.03	0.00	-0.01
Italy	-0.07	0.00	0.00	-0.01	-0.03	-0.01	-0.01
Italy*	-0.07	0.00	0.00	0.02	0.03	0.00	-0.01
Italy**	-0.07	0.00	0.00	0.00	-0.02	0.00	0.00
Portugal	0.00	0.00	0.00	-0.01	-0.02	0.00	-0.01
Portugal*	0.00	0.00	0.00	0.03	0.04	0.00	0.01
Portugal**	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01

Czech Rep.	0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.01
Czech Rep.*	-0.01	0.00	0.00	0.01	0.02	0.00	0.00
Czech Rep.**	0.02	0.00	0.00	0.00	-0.01	0.00	0.01
Cyprus	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
Cyprus*	0.00	0.00	0.00	0.00	0.02	0.01	-0.01
Cyprus**	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Malta	0.00	0.00	0.00	0.00	-0.01	0.00	0.00
Malta*	0.00	0.00	0.00	-0.01	0.06	0.00	0.00
Malta**	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Poland	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Poland*	0.00	0.00	0.00	0.00	0.01	-0.01	-0.01
Poland**	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01
Bulgaria	-0.01	0.00	0.00	-0.08	-0.18	-0.01	-0.02
Bulgaria*	-0.01	0.00	0.00	-0.06	-0.14	0.00	-0.02
Bulgaria**	-0.01	0.00	0.00	-0.07	-0.15	-0.01	-0.01

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on real income

The results suggest that a water consumption charge reduces household real income in most scenarios and countries, for all income quintiles. This is because this charge affects household income both directly, through higher utility bills, and indirectly, through higher prices imposed by firms facing the same charge. In most countries, lower income quintiles are most affected by a water consumption charge. Having said that, higher income households are relatively more affected in Germany and Spain since water consumption patterns vary between countries.

Although the effect on real income is still negative for all households in the scenario with income tax reductions and the scenario with bespoke revenue recycling, the effect is somewhat mitigated. This can be explained by overall higher employment levels compared to the baseline in many of the countries analysed in the case where revenues are being recycled into water infrastructure investments, and by increased disposable income in the scenario with recycling via income taxation. In fact, in the scenario with recycling via income taxation, real income is projected to improve in six out of the ten MS analysed. However, the highest change in real income is enjoyed by higher income households.

Table 47: Water consumption charge - Change in real income in 2030 (% difference to the baseline)

Scenario	All	Q1	Q2	Q3	Q4	Q5
Germany	-0.04	-0.01	-0.03	-0.04	-0.04	-0.04
Germany*	-0.04	-0.01	-0.02	-0.03	-0.04	-0.04
Germany**	-0.02	0.01	0.00	-0.02	-0.02	-0.02
Greece	-0.04	-0.05	-0.04	-0.04	-0.04	-0.04
Greece*	-0.04	-0.04	-0.03	-0.04	-0.03	-0.03
Greece**	0.00	-0.01	0.00	-0.01	0.00	0.00
Spain	-0.08	-0.07	-0.07	-0.08	-0.08	-0.09
Spain*	-0.04	-0.03	-0.04	-0.04	-0.04	-0.06
Spain**	-0.01	0.00	0.00	-0.01	-0.01	-0.03
Italy	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
Italy*	-0.03	-0.04	-0.03	-0.03	-0.03	-0.03
Italy**	0.00	0.00	0.00	-0.01	0.00	0.00
Portugal	-0.02	-0.03	-0.03	-0.03	-0.02	-0.02
Portugal*	-0.01	-0.02	-0.02	-0.01	-0.01	-0.01
Portugal**	0.03	0.03	0.03	0.03	0.04	0.04
Czech Rep.	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02
Czech Rep.*	-0.01	-0.01	-0.01	-0.02	-0.01	-0.01
Czech Rep.**	0.05	0.05	0.05	0.05	0.06	0.06
Cyprus	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01
Cyprus*	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01
Cyprus**	0.01	0.00	0.01	0.01	0.01	0.01
Malta	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01
Malta*	-0.01	-0.02	-0.02	-0.01	-0.01	-0.01

Malta**	0.06	0.04	0.04	0.05	0.06	0.07
Poland	-0.03	-0.05	-0.05	-0.05	-0.04	-0.02
Poland*	-0.03	-0.04	-0.05	-0.04	-0.03	-0.01
Poland**	0.00	-0.02	-0.03	-0.02	0.00	0.03
Bulgaria	-0.06	-0.06	-0.06	-0.06	-0.06	-0.05
Bulgaria*	-0.05	-0.05	-0.05	-0.06	-0.05	-0.05
Bulgaria**	-0.01	-0.01	-0.01	-0.01	-0.01	0.00

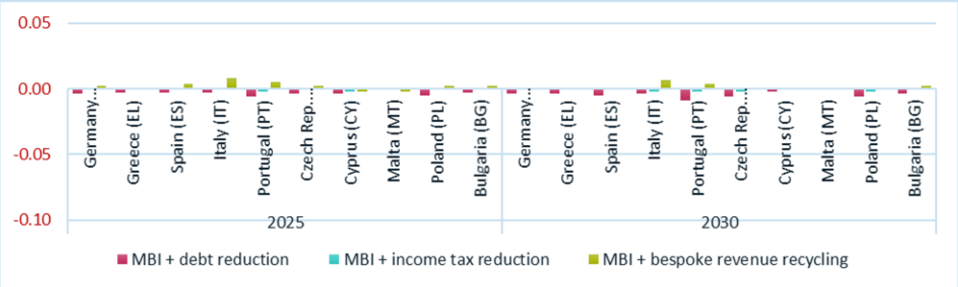
**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on trade

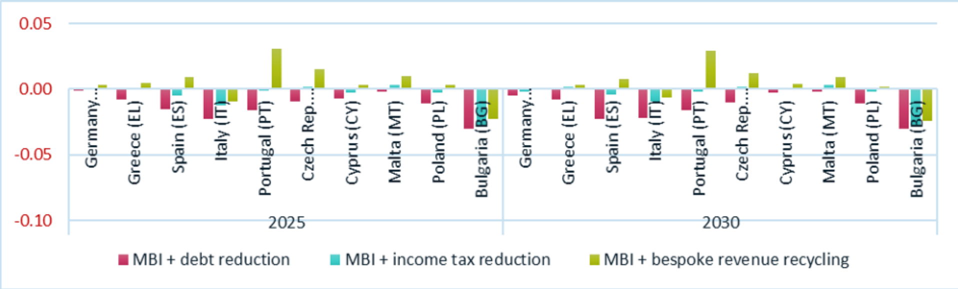
Differences to baseline are close to zero, suggesting a minor impact on exports from a water consumption charge. In the scenario with debt reduction, total exports are marginally lower compared to the baseline in all countries except Malta (which remains unchanged compared to the baseline). In the scenario with bespoke revenue recycling (i.e. investment water infrastructure projects), exports are marginally higher compared to the baseline in most countries. Exports are marginally lower compared to the baseline in a scenario where revenues are recycled via income taxation, but the change in exports is still not as large as that experienced in a scenario with debt reduction.

Figure 32: Water consumption charge - Change in exports (% difference to the baseline)



In all MS analysed, the small reductions in exports are paired with small reductions in imports compared to the baseline in the scenario with debt reduction. The results suggest that the reduction in imports is nonetheless larger than the reduction in exports in relative terms (except for Germany). Although the MBI in combination with reduced income taxation shows a negligible effect on imports, the scenario with investments in water infrastructure (i.e. bespoke revenue recycling) results in a comparatively large increase in import. This is because many investment goods, such as machinery and equipment, are imported to the country.

Figure 33: Water consumption charge - Change in imports (% difference to the baseline)



The overall net effect on the balance of trade varies. For some MS, the impact is neutral but most results show an improvement in the balance of trade when implementing a water consumption charge without recycling revenues and a deterioration in the balance of trade when implementing the charge alongside income tax reductions or investments in water infrastructure. In many MS where both imports and exports increase, the effect of higher imports supersedes the effect of higher exports under a scenario with revenue recycling.

Table 48: Water consumption charge - Impact on the balance of trade (compared to the baseline)

Scenario	2025	2030
Germany	-	~
Germany*	~	~
Germany**	-	~
Greece	+	+
Greece*	-	-
Greece**	-	-
Spain	+	+
Spain*	-	-
Spain**	+	+
Italy	+	+
Italy*	+	+
Italy**	+	+
Portugal	+	+
Portugal*	-	-
Portugal**	-	-

Czech Rep.	+	+
Czech Rep.*	-	-
Czech Rep.**	-	-
Cyprus	+	+
Cyprus*	-	-
Cyprus**	+	-
Malta	~	+
Malta*	-	-
Malta**	-	-
Poland	+	+
Poland*	-	-
Poland**	+	-
Bulgaria	+	+
Bulgaria*	+	+
Bulgaria**	+	+

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

+positive impact, - negative impact, ~ no or marginal impact

6.2.9. Intensive agriculture tax

Design features

This MBI is an assumed tax on the agriculture sector in three EU Member States: France, Ireland and Portugal. In order to model the impacts on land-use and food prices from intensive agriculture tax accurately, a land-use model is required. Instead, as a macroeconomic model, E3ME can be used to estimate wider macroeconomic and jobs impacts from a general taxation on the agriculture sector.

Since E3ME does not have a detailed land and livestock classification, it is not possible to enter tax rates on intensive agriculture directly into the model. Agriculture tax rates are estimated from expected intensive agriculture tax revenues derived from tax rate per livestock unit (LSU) and the estimated livestock unit subjected to this tax. This information is taken from the proposed design presented in Section 5 and Section 6. The tax rates, number of LSU affected, and expected revenues are given in the table below. The higher tax rates for France and Portugal reflect the fact that coupled payments exist for livestock in these Member States meaning that a higher tax rate is needed to achieve a given reduction in livestock.

Table 49: Intensive agriculture tax - tax rates and revenues

Member State	Tax rate (€/LSU)	LSU subject to tax	Expected revenues (€ million)
France	70	2600000	182
Ireland	20	1800000	36
Portugal	70	230000	16.1

In the scenario with bespoke revenue recycling, tax revenues are used to invest back into the agriculture sector.

Impact mechanism

The main impacts of a tax without revenue recycling are incurred in the agriculture industry, which passes on the costs leading to higher domestic and export food prices. Households faced with higher food prices see their real disposable income fall while higher export prices cause negative competitiveness impacts.

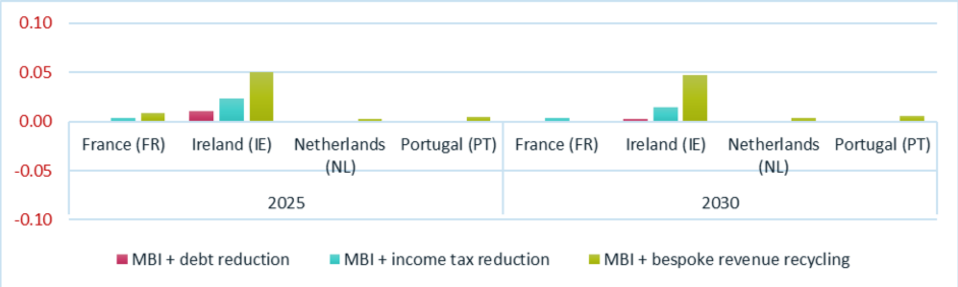
When tax revenues are invested back into the agriculture sector, it may be possible to mitigate potential negative economic impacts from the intensive agriculture tax through economic stimulus and innovation (e.g. investment in new machinery) from investment.

Modelling results for an intensive agriculture tax

Impact on GDP and employment

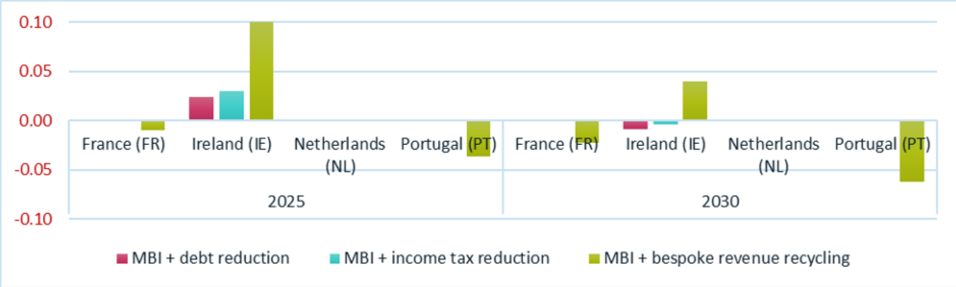
The results from the modelling suggest that the intensive agriculture tax would not have a significant macroeconomic impact. However, when the revenues are reinvested into the agriculture sector or recycled as income tax reductions, the measure could lead to very small net positive effects on GDP, particularly in Ireland.

Figure 34: Intensive agriculture tax - Change in GDP (% difference to the baseline)



In terms of employment, the model projects very small negative effects in France and Portugal in the scenario with bespoke revenue recycling. This is because investments in the agriculture sector tend to lead to the adoption of new technologies, with less labour required as a result. There are some cases where investment leads to higher demand for labour in the sector (e.g. to operate new machines) and through secondary employment impacts from investment shocks. This can be seen in the employment results for Ireland.

Figure 35: Intensive agriculture tax - Change in total employment (% difference to the baseline)



Impact on sector output and employment

The tax leads to small negative effects on output in the agriculture sector, while output in other aggregate sectors remain broadly unchanged in the scenario with debt reduction and in the scenario with income tax reductions. Within the aggregate agriculture sector, the results are driven by negative changes in crop production, which includes livestock farming and fishing.

The MBI combined with recycling of the tax revenues back into the agriculture sector leads to higher output in the agriculture sector relative to the baseline in all countries except Portugal. The investment in technology by the agriculture sectors leads to small positive effects in other sectors, mostly those related to the supply of machinery & equipment, electrical equipment, transport equipment and motor vehicles to the agriculture sector. In Ireland, the effects on other sectors from increased levels of investment and employment in the agriculture sector drive positive changes in other sectors more than in the other countries.

Table 50: Intensive agriculture tax - Change in sector output in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
France	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
France*	0.09	0.00	0.00	0.02	0.01	0.00	0.00
France**	-0.01	0.00	0.00	0.00	0.00	0.01	0.00
Ireland	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Ireland*	0.04	0.01	0.01	0.02	0.07	0.03	0.03
Ireland**	0.00	0.00	0.00	0.00	0.01	0.01	0.01
Netherlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands*	0.06	0.00	0.01	0.00	0.00	0.00	0.00
Netherlands**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	-0.02	0.00	0.00	0.00	0.00	0.00	0.00
Portugal*	-0.04	0.01	0.00	0.01	0.02	0.00	0.00

Portugal**	-0.02	0.00	0.00	0.00	0.00	0.00	0.00

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

In terms of employment, the effect of the MBI in combination with investment in the agriculture sector leads to lower agriculture employment relative to the baseline as a result of technological innovation. The induced effects on other sectors are very small, but those sectors providing equipment and technologies to the agriculture sector see small positive changes. In Ireland, the investment in the agriculture sector creates higher output accompanied by higher demand for labour. This may reflect the Irish agricultural sector's increasing export orientation over time, achieved by sustained investments.

Table 51: Intensive agriculture tax - Change in sector employment in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
France	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
France*	-1.11	0.00	0.00	0.02	-0.01	0.00	0.00
France**	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	-0.10	0.00	0.00	0.01	-0.06	0.00	0.00
Ireland*	0.86	0.00	0.00	0.03	-0.12	-0.05	0.01
Ireland**	-0.11	0.00	0.00	0.01	-0.06	0.02	0.01
Netherlands	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands*	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
Portugal*	-0.68	0.00	0.00	0.00	0.02	0.00	0.00
Portugal**	-0.01	0.00	0.00	0.00	0.00	0.00	0.00

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on real income

Overall, the tax would lead to reductions in real income for all income groups in the scenario with debt reduction and in the scenario with bespoke revenue recycling. The negative effects on real incomes are driven by the increase in food prices for households, and the loss of jobs in agriculture. In the bespoke revenue recycling scenario, real incomes fall as a result of technological innovation in France, the Netherlands and Portugal. Contrary to this is the case of Ireland, where the stimulus leads to more jobs and income. On the other hand, the scenario with income tax reductions results in a small improvement in real income compared to the baseline, for all countries except the Netherlands.

Table 52: Intensive agriculture tax - Changes in real income in 2030 (% difference to the baseline)

Scenario	All	Q1	Q2	Q3	Q4	Q5
France	-0.001	-0.002	-0.001	-0.001	-0.001	-0.001
France*	-0.014	-0.014	-0.014	-0.014	-0.014	-0.013
France**	0.009	0.010	0.010	0.009	0.010	0.009
Ireland	0.003	0.003	0.003	0.003	0.003	0.003
Ireland*	0.063	0.057	0.063	0.063	0.062	0.060
Ireland**	0.033	0.028	0.030	0.031	0.032	0.035
Netherlands	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
Netherlands*	0.000	0.000	0.000	0.000	0.000	0.000
Netherlands**	-0.001	-0.002	-0.002	-0.001	-0.001	-0.001
Portugal	-0.002	-0.003	-0.002	-0.002	-0.002	-0.002
Portugal*	-0.009	-0.010	-0.010	-0.009	-0.009	-0.008
Portugal**	0.008	0.007	0.008	0.007	0.008	0.008

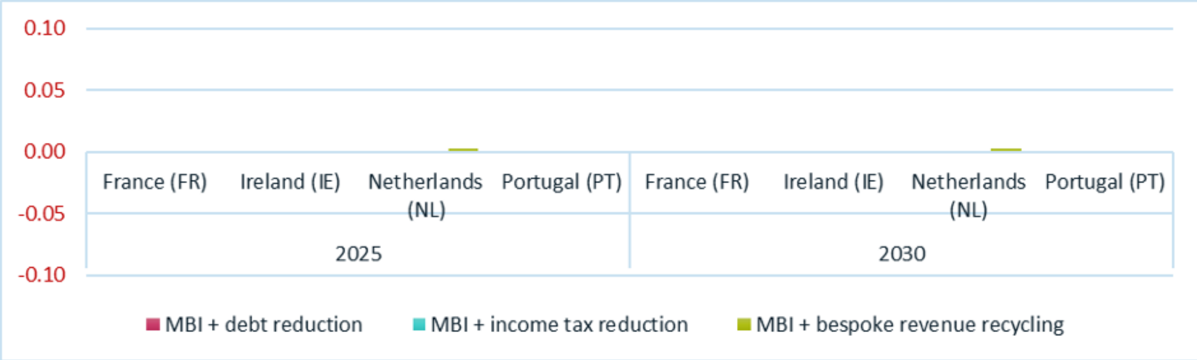
**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on trade

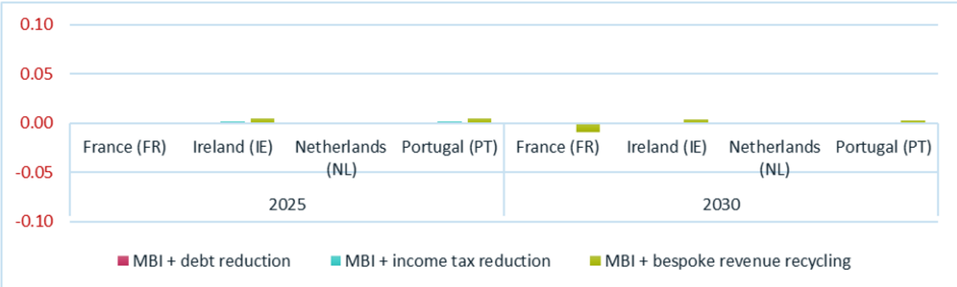
The effect on total imports from the intensive agriculture tax is projected to be minimal, as shown in the figure below. Changes are only visible at the three-decimal point.

Figure 36: Intensive agriculture tax - Change in exports (% difference to the baseline)



At the same time, the tax leads to small increases in imports relative to the baseline, as shown in the figure below. Only in France the tax would lead to a small reduction in imports relative to the baseline.

Figure 37: Intensive agriculture tax - Change in imports (% difference to the baseline)



The overall effect on the balance of trade in the scenario with debt reduction is neutral. The only exception is Portugal due to an increase in imports in 2025 and a reduction in exports in 2030. On the other hand, results for France and Netherlands show that a scenario with revenue recycling into agriculture improves the balance of trade, and results for Ireland and Portugal show a deterioration in the balance of trade when compared to the baseline. In general, the effect of revenue recycling through reduced income taxation results in a neutral or negative impact on the balance of trade.

Table 53: Intensive agriculture tax - Impact on the balance of trade (compared to the baseline)

Scenario	2025	2030
France	~	~
France*	+	+
France**	-	-
Ireland	~	~
Ireland*	-	-
Ireland**	-	~

Netherlands	~	~
Netherlands*	+	+
Netherlands**	~	~
Portugal	-	-
Portugal*	-	-
Portugal**	-	-

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

+positive impact, - negative impact, ~ no or marginal impact

6.2.10. Forest felling charge

Design features

This MBI is modelled as a forest felling charge in Latvia paid by the timber industry. The rate is fixed at €2,850 per hectare and there are 65,000 hectares of land in Latvia subject to the tax.

In the scenario with bespoke revenue recycling, revenues are used toward public spending on nature conservation.

Impact mechanism

As this is a tax on the forestry sector, without revenue recycling, there will be additional costs to the Latvian timber industry which lead to a loss of competitiveness. Although households are not paying for the forest felling charge directly, they may be worse off due to higher prices for fuel wood or wood used in construction.

When the revenues are used to increase public spending, these negative impacts can be mitigated, and positive impacts may even be possible.

Modelling results for a forest felling charge

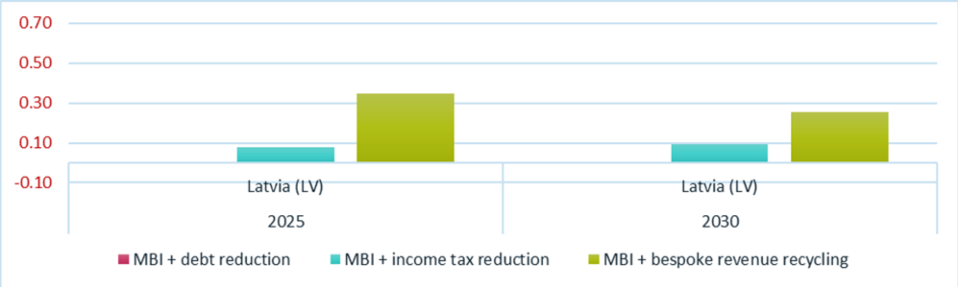
Impact on GDP and employment

The model projects a small net negative effect on GDP in the scenario with debt reduction. When the revenues are used to increase public spending, this leads to a net positive effect on GDP of around +0.55% by 2030. Alternatively, GDP is projected to be around 0.4% higher in 2030 compared to the baseline in the scenario with income tax reductions

Figure 38: Forest felling charge - Change in GDP (% difference to the baseline)

The net effect on employment mirrors the effect on GDP, but the changes are smaller. Employment is projected to increase by around +0.25% relative to the baseline in the scenario with bespoke revenue recycling and by +0.1% in the scenario with reduced income taxation.

Figure 39: Forest felling charge - Change in total employment (% difference to the baseline)



Impact on sector output and employment

Minor negative effects are projected for the forestry sector (part of agriculture in the table below), while higher prices for wood lead to small benefits in sectors providing alternatives to wood. When the revenue is used for public spending (i.e. MBI + bespoke revenue recycling), the reallocation of funds within the economy leads to net benefits across all aggregate sectors. It should be noted that the E3ME model does not cover biodiversity and therefore cannot model the benefit of revenue recycling though nature conservation spending. The economic benefits of recycling revenue this way are smaller compared to general public spending and investment which goes toward construction projects, spending on health and education, and so on. The MBI in combination with income tax reductions also results in improved sector output compared to the baseline, but this effect is smaller than the positive effect brought about by increased public spending in the bespoke revenue recycling scenario.

Table 54: Forest felling charge - Change in sector output in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Latvia	-0.04	0.00	0.22	-0.03	0.00	-0.01	-0.04
Latvia*	0.03	0.49	0.34	0.35	2.99	0.14	0.42
Latvia**	0.00	0.03	0.41	0.03	0.11	0.07	0.42

**MBI + bespoke revenue recycling **MBI + income tax reduction*

In terms of employment, the forest felling charge would lead to lower employment relative to the baseline in the forestry sector (a part of agriculture) and manufacturing (wood and timber manufacturing). When revenues are recycled via public spending or income tax reductions, output increases in the services and agriculture sector. Specifically, when revenues from the MBI are used to bolster public spending, employment in the construction sector increases significantly compared to the baseline.

Table 55: Forest felling charge - Change in sector employment in 2030 (% difference to the baseline)

Scenario	Agri.	Mining	Utilities	Manufact.	Construct.	Transport	Services
Latvia	0.01	0.00	0.01	-0.02	0.04	0.00	-0.01
Latvia*	0.08	0.00	0.01	0.09	1.93	0.03	0.17
Latvia**	0.04	0.00	0.01	0.01	-0.04	0.02	0.15

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on real income

In the scenario with debt reduction, real incomes are projected to be lower than real incomes in the baseline. When the revenues are recycled via public spending or income tax reductions, real incomes are projected to be higher than the baseline.

For all scenarios, the effects are least favourable in the lowest income group, suggesting the tax could have a regressive distributional effect. As reported in the table below, in the scenario with debt reduction, there is an income loss across the board but this loss is much more pronounced in the lowest quintiles. The income gain in the scenario with bespoke revenue recycling is somewhat lower in the lowest quintiles. When revenues are used to reduce income taxes, real incomes increase in all income quintiles, with higher income households seeing the largest increase compared to the baseline.

Table 56: Forest felling charge - Change in real income in 2030 (% difference to the baseline)

Scenario	All	Q1	Q2	Q3	Q4	Q5
Latvia	-0.06	-0.09	-0.08	-0.07	-0.07	-0.05
Latvia*	0.29	0.25	0.28	0.29	0.29	0.31
Latvia**	0.90	0.75	0.69	0.77	0.92	1.03

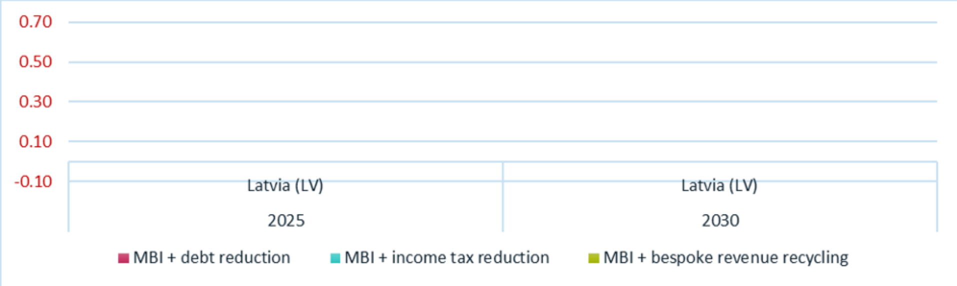
**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

Impact on trade

The effect on total exports from the forest felling charge is projected to be minimal, as shown in the figure below. Changes are only visible at the three-decimal point.

Figure 40: Forest felling charge - Change in exports (% difference to the baseline)



A positive effect on total imports from the forest felling charge is projected, mainly due to an increase in prices for domestic wood leading to higher demand for imported wood relative to the baseline. In the scenario with income tax reductions and the scenario with bespoke revenue recycling, a further increase in imports is driven by higher consumer spending relative to the baseline.

Figure 41: Forest felling charge - Change in imports (% difference to the baseline)

The changes in imports are of greater magnitude than the changes in exports, thus having a small negative effect on Latvia's trade balance overall. This result applies to all scenario variants.

Table 57: Forest felling charge - Impact on the balance of trade (compared to the baseline)

Scenario	2025	2030
Latvia	-	-
Latvia*	-	-
Latvia**	-	-

**MBI + bespoke revenue recycling*

***MBI + income tax reduction*

+positive impact, - negative impact, ~ no or marginal impact

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