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A) Project Overview

1 Executive Summary – German

Der Klimawandel ist eine der großen Herausforderungen für die Menschheit. Um den Klimawandel zu begrenzen, ist eine Transformation des globalen Energiesystems in Richtung Nachhaltigkeit mit drastisch reduzierten Treibhausgasemissionen erforderlich. Die Palette der politischen Instrumente, die zu einer Reduktion der Treibhausgasemissionen beitragen sollen, umfasst Standards sowie marktbasierte Ansätze wie Energie- oder CO_2 Steuern und Emissionshandelssysteme. Entsprechend der ökonomischen Theorie sind marktbasierte Ansätze vorteilhaft, da sie die Einhaltung der Ziele unter den geringsten Kosten für die Gesellschaft gewährleisten, indem sie Flexibilität bei der Wahl der Emissionsreduktionsmaßnahmen und deren Zeitpunkt bieten. In der EU werden CO_2 Emissionen aus Industrie und Energieversorgung im Rahmen des EU-Emissionshandelssystems (EU ETS) reguliert. Für die Regulierung der Emissionen von privaten Haushalten, Verkehr und anderen kleinen Emittenten gibt es hingegen keine EU-weite Strategie. Die Mitgliedsstaaten sind dafür verantwortlich, die Emissionen in diesen Sektoren zu reduzieren. Schlüsselinstrumente hierfür sind Energie- oder Emissionssteuern. Während Energie seit Jahrzehnten in allen Mitgliedstaaten besteuert wird, wurden CO_2 Steuern erst seit kurzem und nur in einigen wenigen Ländern eingeführt.

Das CATs Projekt analysierte die Besteuerung von Energie und CO_2 aus verschiedenen Blickwinkeln, einschließlich theoretischer (ökonomischer und juristischer) Aspekte, (quantitativer und qualitativer) empirischer Evidenz für die EU sowie der Modellsimulationen einer Reihe von Steuerszenarien für Österreich.

Eine umfangreiche Literaturrecherche bildet den Ausgangspunkt für die weitere Forschung im Projekt. Die ökonomische Literatur zu Energie- und CO_2 Steuern wird in Hinblick auf theoretische Empfehlungen zur optimalen Gestaltung von CO_2 Steuern sowie zur Vermeidung möglicher negativer Wettbewerbs- und Verteilungseffekte gescreent. Darüber hinaus wird analysiert, welche Rolle unterschiedlichen rechtlichen Konzepten (z.B. Steuern, Gebühren, Engelte und Abgaben) in diesem Zusammenhang zukommt. Ein weiterer Arbeitsschritt umfasst die Bewertung von Umsetzungsfragen und Hindernissen für die Einführung einer CO_2 Steuer auf EU- und Mitgliedsstaatenebene. Aus der Literaturrecherche werden auch Kriterien für die Bewertung von CO_2 Steuern abgeleitet. Diese umfassen quantitative Aspekte (z.B. Steuersätze nach Energieträger und Sektor, CO_2 Komponente der Energiesteuern, Anteil der Steuereinnahmen am BIP / an den Gesamtsteuereinnahmen, Entwicklung der Energieflüsse und der CO_2 Emissionen) sowie qualitative Aspekte (z.B. Steuerbefreiungen, Verwendung von Steuereinnahmen, Verwaltungskosten, Beteiligung von Interessengruppen bei der Einführung von CO_2 Steuern) und werden zur Analyse der Energie- und CO_2 Steuern in den EU-Mitgliedstaaten herangezogen. Die quantitativen Kriterien werden für alle Mitgliedstaaten erstellt, während sich die qualitative Beurteilung auf die Länder mit den ambitioniertesten CO_2 Steuern (Schweden, Finnland, Dänemark) konzentriert.

Das WIFO-DYNK[AUT]-Modell (WIFO Dynamic New Keynesian Model) wird verwendet, um CO_2 Steuerszenarien für Österreich zu simulieren. Das Modell beschreibt die Verflechtungen zwischen 62 Branchen und der Endnachfrage (z.B. privater Konsum, Investitionen, öffentliche Ausgaben). Es differenziert zudem fünf Haushaltseinkommensgruppen und modelliert die Energienachfrage explizit. Neben den üblichen makroökonomischen Indikatoren (BIP, Wertschöpfung und Beschäftigung) und den Auswirkungen auf die CO_2 Emissionen werden eine Reihe von Indikatoren berechnet, die in der Literatur verwendet werden, um Verteilungswirkungen abzuschätzen. Im CATs Projekt wurde das Modul mit Daten zu Haushaltseinkommensgruppen ergänzt (EU-SILC, Konsumerhebung) und das Modul für den Personenverkehr erweitert, um die Nachfrage nach Mobilität in physischen Einheiten darzustellen. Die detaillierte Modellierung des privaten Konsums ermöglicht eine Simulation von Energie- und CO_2 Steuern, in der sowohl Fragen der Technologiewahl als auch der Einkommensverteilung berücksichtigt werden. Die simulierten Szenarien zielen darauf ab, eine angemessene Bandbreite von Steuersatz- und Einnahmenrecyclingvarianten abzubilden. Der Schwerpunkt der Szenarien liegt auf energiebedingten CO_2 Emissionen, die in non-ETS Sektoren erzeugt werden. Drei zusätzliche Szenarien werden modelliert: (1) die ergänzende Einführung eines Mindestpreis ('floor price') für ETS-Sektoren; (2) eine Erhöhung der Kfz-Zulassungssteuer (NoVA); und (3) Politikszenarien bis 2030.

Auf EU-Ebene wurden in Richtlinie 2003/96/EG Mindeststeuersätze für Energiesteuern festgelegt. Versuche, diese Steuersätze an die ambitionierten mittel- und langfristigen Ziele der EU-Klimapolitik anzupassen, sind jedoch aufgrund der Einstimmigkeitsanforderung in Steuerfragen fehlgeschlagen. Somit ist die EU-Richtlinie nicht ausreichend, um die langfristigen Emissionsreduktionsziele zu erreichen. Die Energiesteuersätze (sowie die (impliziten) CO_2 Steuersätze) unterscheiden sich weiterhin stark zwischen den Mitgliedstaaten. Explizite CO_2 Steuern wurden bisher nur in etwa einem Drittel der Mitgliedstaaten eingeführt. Angesichts der erforderlichen Einstimmigkeit scheint eine Einigung über eine Einführung EU-weiter CO_2 Steuern unerreichbar. Daher sind Maßnahmen zur Begrenzung der Treibhausgasemissionen auf nationaler Ebene erforderlich, insbesondere in den non-ETS Sektoren. Steuerliche Maßnahmen wie die Energie- und Kohlenstoffbesteuerung können dazu beitragen, klimapolitische Ziele zu erreichen, indem die Externalität bepreist wird.

Auch die CATs Modellsimulationen für Österreich zeigen, dass CO_2 Steuern dazu beitragen können, die Treibhausgasemissionen zu reduzieren. Die Ergebnisse einer einnahmenneutralen Einführung von CO_2 Steuern zeigen in der Regel deutliche Auswirkungen auf die Emissionen (Reduktionen von 3-10% (1,2-3,7 Mt CO_2) gegenüber dem Basisjahr), insbesondere im Verkehrs- und Dienstleistungssektor (Reduktionen von bis zu 14% (1,5 Mt CO_2) bzw. 20% (0,4 Mt CO_2)). Die Auswirkungen auf das BIP sind dagegen moderat negativ ohne Rückvergütungen (max. -2,2% bzw. -6,9 Mrd. €) bis leicht positiv mit Rückvergütungen (max. +0,3% bzw. +1,1 Mrd. €). Es ist daher anzumerken, dass das Recycling zusätzlicher Steuereinnahmen ein zentraler Aspekt ist, um negative Auswirkungen auf das BIP, die Einkommensverteilung (Regressivität), Beschäftigung und die Wettbewerbsfähigkeit zu mildern.

Die Notwendigkeit struktureller Veränderungen im österreichischen Steuersystem wurde von internationalen Organisationen immer wieder betont. Die Einführung einer CO_2 Steuer würde eine Verlagerung der Steuerlast z.B. von Arbeit zu negativen Umwelteffekten bedeuten. Dies kann neben der Reduktion der Treibhausgasemissionen auch positive Wertschöpfungs- und Beschäftigungseffekte (doppelte Dividende) generieren. Eine ambitionierte Klimapolitik kann darüber hinaus Forschung und Innovation stimulieren und erleichtert die strukturellen Veränderungen, die für eine tiefe Dekarbonisierung erforderlich sind. Evidenz aus anderen EU-Mitgliedstaaten, die bereits umfassende ökologische Steuerreformen durchgeführt haben, zeigen, dass ein breiter gesellschaftlicher und politischer Konsens sowie die Einbeziehung langfristiger klimapolitischer Ziele in alle Politikbereichen eine Voraussetzung für die erfolgreiche Implementierung von CO_2 Steuern sind.

Die Forschung im CATs Projekt ergänzt die Literatur durch (i) einen detaillierten Review der ökonomischen und juristischen Aspekte von CO_2-Steuern, (ii) empirische Analysen von Energie- und CO_2 Besteuerung in der EU, sowie (iii) eine umfassende makroökonomische Modellanalyse der Effekte von CO_2 Steuern in Österreich.

In zukünftigen Projekten könnte die Analyse der sozialen Auswirkungen umweltpolitischer fiskalischer Maßnahmen weiter ausgebaut werden, indem das DYNK-Modell mit einem Mikrosimulationsmodell verknüpft wird. Darüber hinaus wurden im Rahmen des CATs-Projekts die Auswirkungen von CO_2 Steuern auf die Effizienz des Kapitalstocks (durch Investitionen in kohlenstoffarme Technologien) noch nicht detailliert genug bewertet; es ist jedoch wahrscheinlich, dass CO_2 Steuern mittel- und langfristig Anreize für Investitionen in kohlenstoffarme oder CO_2 neutrale Technologien setzen. Dies sollte in zukünftigen Studien in Kombination mit technisch-ökonomischen Bottom-up-Modellen bewertet werden.

2 Executive Summary

Climate change is one of the big challenges humanity is facing. A transition of the global energy system towards sustainability with dramatically reduced greenhouse gas (GHG) emissions is required in order to limit climate change. The range of policy instruments for effectuating emission reductions includes performance standards, technology standards as well as market-based approaches like energy or carbon taxes and emissions trading systems. Economic literature argues in favour of market-based instruments since they ensure compliance at the least cost to society by offering flexibility in the choice of abatement measures and their timing. In the EU, CO_2 emissions from industry and energy supply are regulated under the EU Emission Trading Scheme (EU ETS). To control emissions from private households, transport and other small sources, in contrast, no comprehensive EU policy strategy is in place. Instead these sectors are regulated on Member State level. Key instruments for this purpose are energy or emission taxes. While energy has been taxed in all Member States for decades, carbon taxes have only been introduced rather recently and only in a few countries. The introduction of carbon taxation should be given more emphasis as an option to curb emissions from the non-ETS sectors, and particularly from transport, in Austria.

The CATs project analysed the issue of energy and carbon taxation from different points of view, including theoretical (economic and legal) aspects, empirical evidence for the EU (quantitative and qualitative) as well as model simulations for a range of taxation scenarios for Austria.

An extensive literature review constituted the starting point for the research in this project. The economic literature on energy and carbon taxes was surveyed with respect to theoretical recommendations regarding the optimal design of carbon taxes, as well as potential competitiveness and distribution effects. In addition, the implications of different legal concepts (i.e. taxes, fees, charges and levies) were analysed. A literature review was conducted in order to assess implementation issues and barriers for introducing a carbon tax at EU and Member State level.

Criteria for the assessment of carbon taxes were developed based on the literature review. They cover quantitative aspects (e.g. tax rates by energy source and sector, CO_2 component, shares of tax revenues in GDP / total tax revenues, estimated extent of tax exemptions, development of energy flows and CO_2 emissions) as well as qualitative aspects (e.g. kind of tax exemptions, use of tax revenues, legal competencies, administration costs, stakeholder involvement) and were used to evaluate existing energy and carbon taxes in EU Member States. The quantitative criteria were compiled for all Member States while the qualitative appraisal focuses on the countries with the most ambitious carbon taxes (i.e. Sweden, Finland and Denmark).

The WIFO-DYNK[AUT] (Dynamic New Keynesian) model was used to assess a range of carbon tax scenarios for Austria. The model traces the inter-linkages between 62 industries and final users (e.g. private consumption, gross fixed capital formation, public consumption). It further explicitly differentiates between five household income groups and models energy consumption. In the CATs project, the model has been specifically updated with household income data for Austria, and the module for (private) passenger transport was expanded in order to represent the demand for mobility in physical units. This permits a more detailed representation of the energy price effects on mobility. Furthermore, the model was also adjusted to allow for a more consistent approach of integrating CO_2 price effects in the model. This enables the implementation of energy / CO_2 taxation with specific designs that takes into account issues of technology choice as well as of income distribution. Beside standard macroeconomic indicators (GDP, value added, and employment) and CO_2 emission impacts, results on a common range of indicators used in the literature to assess distributive impacts were provided, i.e. tax burden relative to income and expenditure as well as changes in income and expenditure across household income groups. The scenarios aimed at covering a reasonable range of tax rate variants and tax recycling schemes. The main focus of the scenarios was on energy-related CO_2 emissions generated in non-ETS sectors, i.e. mostly CO_2 emissions from private households, transport and service sectors. Three additional scenarios were provided: (1) a floor price for ETS sectors; (2) an increase in the vehicle registration tax (NoVA); and (3) policy scenarios until 2030. On EU level, minimum energy tax rates have been defined in Directive 2003/96/EC but attempts to adapt these tax rates to reflect the climate policy ambitions of the EU have failed due to the unanimity requirement in taxation issues. Thus, the EU regulation falls short of being adequate for reaching the long-term emission reduction objectives and energy tax rates (as well as (implicit) carbon tax rates) still differ strongly between Member States. Explicit carbon taxes have so far only been implemented in about one third of the Member States. Given the requirement of unanimity voting any agreement regarding an introduction of EU-wide carbon taxes seems out of reach. Therefore, action to limit greenhouse gas emissions on national level is required, particularly in the sectors not covered by the EU ETS. Fiscal measures such as energy and carbon taxation can contribute towards achieving climate policy targets by pricing the externality.

This is supported by the CATs model simulations for the range of scenarios analysed for Austria. The results for a revenue neutral introduction of carbon taxes generally show a significant effect on emissions (i.e. emission reductions by 3-10% (1.2-3.7 Mt CO_2) compared to the base year), especially in the transport and service sector (with reductions up to 14% (1.5 Mt CO_2) and 20% (0.4 Mt CO_2) respectively). Macroeconomic impacts on GDP are moderately negative without tax recycling (max. -2.2% or -6.9 b €) and can be slightly positive with tax recycling (max. +0.3% or +1.1 b €). It has to be noted, therefore, that the recycling of additional tax revenues is a key aspect in order to mitigate negative impacts on GDP, income distribution (regressivity) and competitiveness.

The need for structural changes in the Austrian tax system has been repeatedly emphasised by international organisations like the OECD. The introduction of a CO_2 tax would permit a shift of the tax burden from e.g. labour to environmental externalities. In addition to reducing greenhouse gas emissions this could also entail positive GDP and employment effects (double dividend). Furthermore, an ambitious climate policy triggers research and innovation and facilitates the structural changes required to achieve a deep decarbonisation. Evidence from other EU Member States that have introduced comprehensive environmental tax reforms including carbon taxes shows that one prerequisite for the implementation is a broad societal and political consensus and the integration of long term climate policy objectives in all areas of policy making.

Research in the CATs project complements the literature by providing (i) a review on economic and legal aspects, (ii) empirical evidence on current energy and carbon policies in the EU (iii) as well as a comprehensive macroeconomic model assessment of CO_2 taxes in Austria.

In future projects, the analysis of the social impacts of environmental fiscal measures could be further enhanced by linking the DYNK[AUT] model with a micro-simulation model. Also, in the CATs project, the impacts of CO_2 taxes on stock efficiencies (through investments in low-carbon technologies) have not been assessed in (enough) detail and it is likely that CO_2 taxes will provide incentives to invest in low-carbon or carbon-neutral technologies in the mid- and long-term. This could be assessed in combination with technical economic bottom-up models in future studies.

3 Motivation and objectives

Motivation

Climate change is one of the big challenges humanity is facing. A transition of the global energy system towards sustainability with dramatically reduced greenhouse gas (GHG) emissions is required in order to limit climate change. Especially after the adoption of the Kyoto Protocol in 1997, climate change policies were increasingly introduced, with the EU taking a leading role. The range of potential instruments for promoting GHG emission reductions includes performance standards, technology standards as well as market-based approaches like energy or emission (carbon) taxes and emissions trading systems. Economic literature generally argues in favour of market-based instruments since they ensure compliance at the least cost to society by offering flexibility in the choice of abatement measures and their timing. Moreover, taxes and auctioned emission permits raise revenues that in turn can be used to subsidise other abatement measures and R&D activities or to mitigate potential negative distributional effects.

For large emitters from industry and energy generation the EU has established the European Emission Trading System (EU ETS) in 2005, which covers about 45% of total GHG emissions in the EU[1]. Since transaction and monitoring costs would be excessive otherwise, the system is applied to large point emitters only. Other emission sources like transport, households and small businesses are, up to now, subject to national energy / carbon taxation which varies substantially between Member States.

Member States have been raising energy taxes prior to the introduction of the EU ETS. These energy taxes have, however, been introduced mainly to raise revenues rather than to pursue environmental targets like reducing GHG emissions or energy use. Even in cases in which an ecological tax reform has been implemented, i.e. a shift of taxes from labour to environment and resource use, the definition of the level of tax rates has been determined by political feasibility and does not consistently reflect the various energy sources' carbon content (e.g. Böhringer and Schwager 2004). Thus, in most cases taxation does not correspond to the theoretical concept of optimal (uniform) energy or carbon taxes.

Under the EU Burden Sharing Agreement for the Kyoto Period, for Austria an emission reduction target of 13% compared to the Kyoto base year 1990 was defined (Council Decision 2002/358/CE). Between 1990 and 2015 emissions in Austria rose, however, by 0.1% (UBA 2017a)[2]; the largest contributor to rising emissions was the transport sector where emissions have grown by more than 20% since 1990. The introduction of a carbon tax should be considered as an option to curb emissions from the non-ETS sectors, and particularly from transport, in Austria.

Objectives of the project

The project CATs focused on carbon taxes as a policy instrument for achieving emission reduction targets particularly in sectors not covered by the EU ETS. A systematic review of carbon taxes in EU Member States was conducted. This review included a quantitative assessment of carbon taxes on the one hand and a qualitative assessment of their implementation, (potential) barriers and legal and political science aspects

[1] The EC had initially been in favour of a carbon tax that could not be adopted due to the resistance of some Member States and the requirement of unanimity in fiscal environmental policies; eventually an ETS was set up, partly due to lobbying activities of the industry (e.g. Skjærseth and Wettestad 2008). Since its start in 2005, many reforms to the design of the EU ETS have been introduced that should help generate a stable and significant price signal for low-carbon investment.

[2] Domestic emission reduction measures were not sufficient for meeting the Kyoto target for the period (2008-2012). Therefore, for compliance allowances from the flexible mechanisms (JI and CDM) were purchased. Taking into account the failed and ultimately not implemented projects, emission reductions purchased under the Austrian JI/CMD program amounted to 71.38 Mt at an average purchase price of € 6.22 per tonne (BMLFUW 2015).

related to carbon taxation on the other hand. Based on this appraisal and the identification of best practice examples a model-based analysis of the economic and emission effects of the introduction of different forms of carbon taxes in Austria was performed.

Carbon taxes are generally defined as 'taxes levied on the carbon content of fuels' (Hoeller and Wallin 1991). Since the economic and legal concepts of 'taxes' can be quite diverse, the broader economic concept of taxation for the economic parts was employed in this project. In those sections where the various legal concepts of taxes, fees, charges etc. could give rise to implementation issues and barriers, a legal approach is used.

In the CATs project, not only consumption taxes were taken into account but also taxes on emission-relevant capital stocks (e.g. cars) since taxes do not merely influence fuel use but do also affect investment decisions. Based on the assessment of carbon taxes in the EU and its Member States as well as on the modelling results, policy recommendations for Austria and for the EU were developed.

The CATs project contributes to the existing literature on carbon taxes in Austria with the following innovative aspects:

- Scenarios for an Austrian carbon tax were developed based on best practice examples derived from the assessment of carbon taxes in EU Member States. This refers to differences in the assumed consumption-based carbon tax rates on the one hand and the design of non-recurrent taxes such as the level and differentiation of registration taxes on the other.
- In addition scenarios were analysed in which tax revenues were recycled via labour cost reductions or lump-sum eco-transfers to households. For the recycling of the CO_2 tax a differentiation between household income quintiles was implemented in order to mitigate the negative effects for lower income quintiles.
- The economic assessment of the role of carbon taxes was complemented by a legal and political economy assessment of the implementation issues and barriers of carbon taxes at Member State and at EU level to attain a better understanding of the political feasibility of implementing carbon taxes.
- Legal and political economy theory are key in devising policy recommendations both for the potential implementation of carbon taxes in Austria and at EU level. Case study country implementation strategies were examined in this project.

4 Content and results

4.1 Content

WP1. Theoretical Background

WP1 provided the theoretical framework for the CATs project and encompassed three tasks:

- a survey of the economic literature on energy and emission taxes;
- an elaboration of the legal aspects of carbon taxation; and
- the development of a set of criteria for the assessment of carbon taxes.

Carbon Taxes in Economic Literature

The theoretical economic literature on energy and emission taxes was reviewed. This review focused on theoretical recommendations regarding the optimal design of carbon taxes, their performance relative to other instruments (in particular emission trading systems) and potential interaction effects. The general effects of carbon taxes on economic growth, employment, distribution and innovation were discussed.

Legal Perspective on Carbon Taxes

A survey of the legal literature was carried out, including a discussion of the various legal definitions and concepts of environmental taxes, fees, charges and levies. It comprised the legislation that provides for a legal justification for levying carbon taxes as well as how to deal with multiple environmental policy instruments and multiple regulation problems. Other issues investigated relate to who should pay the tax (the taxable subject), on what (taxable object), and on the applicability of relevant European law (e.g. state aid rules).

Development of Criteria for the Systematic Assessment of Carbon Taxes in the EU

Criteria for the systematic assessment of carbon taxes were identified. The list of criteria was developed based on the work in the preceding tasks as well as a survey of the relevant literature and was validated in an expert workshop.

WP2. Quantitative Assessment of Carbon Taxes in the EU

To control emissions from private households, transport and other small sources, in contrast to the EU ETS for industry and energy supply, no comprehensive EU policy strategy is in place, despite some harmonisation through the EU's energy taxation directive (Council Directive 2003/96/EC).

Review of Carbon Taxes in EU Member States

In this task a cross-country comparison of energy taxes has been performed. Energy tax rates by fuel and application area were reviewed based on the European Commission's taxation reports. In addition, for the countries that have introduced carbon taxes the carbon component of the taxes was assessed and implicit carbon tax rates were calculated for all Member States for the years 1995 and 2000-2017, provided availability of the data[3].

The development of the taxes was analysed, i.a. in terms of the tax rates applied (and their development over time), and the development of tax revenues[4].

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[3] While data availability is excellent for recent years, for the Eastern Member States that accessed the EU in the 2000s information for the period prior to the accession is highly incomplete.

[4] In addition, potential tax benefits and tax exemptions and the usage of tax revenues in selected front-runner countries have been addressed in WP3.

While the main focus of the CATs project lay on consumption-based carbon taxes, non-recurrent taxes (e.g. vehicle registration taxes) and recurrent taxes on capital stocks (e.g. engine-related insurance taxes) were also discussed.

Impact Analysis of Energy and Carbon Taxes in EU Member States

Moreover, the outcomes of the introduction of the tax were investigated: The development of CO_2 emissions in the transport sector were analysed using data from the Odyssee 2017 database. Moreover, a meta-analysis of studies available for the selected 'front runner' countries was conducted in order to assess the effectiveness of the taxes in more detail, as well as the observed impacts on economic growth and employment, but also the related distributional effects.

WP3. Implementation Issues and Barriers

Complementing the quantitative assessment in WP2, in this work package a qualitative appraisal of carbon taxes at EU level and in selected 'front-runner' countries was performed. The objective of WP3 was to identify barriers and success factors for the implementation of carbon taxes at the different levels of governance from a legal / political science perspective.

Implementation Issues and Barriers at EU level

The legal / political economy barriers to introducing carbon taxes at EU level were assessed in this task. These barriers stem from the uncertainty relating to the voting procedures when proposing an environmental measure. The general background on EU legislative procedures relevant for adopting a carbon tax and subsequently several adoption issues and barriers were addressed. These include the unanimity requirement, national legal frameworks, national interests and institutional memory.

Implementation Issues and Barriers at Member State level

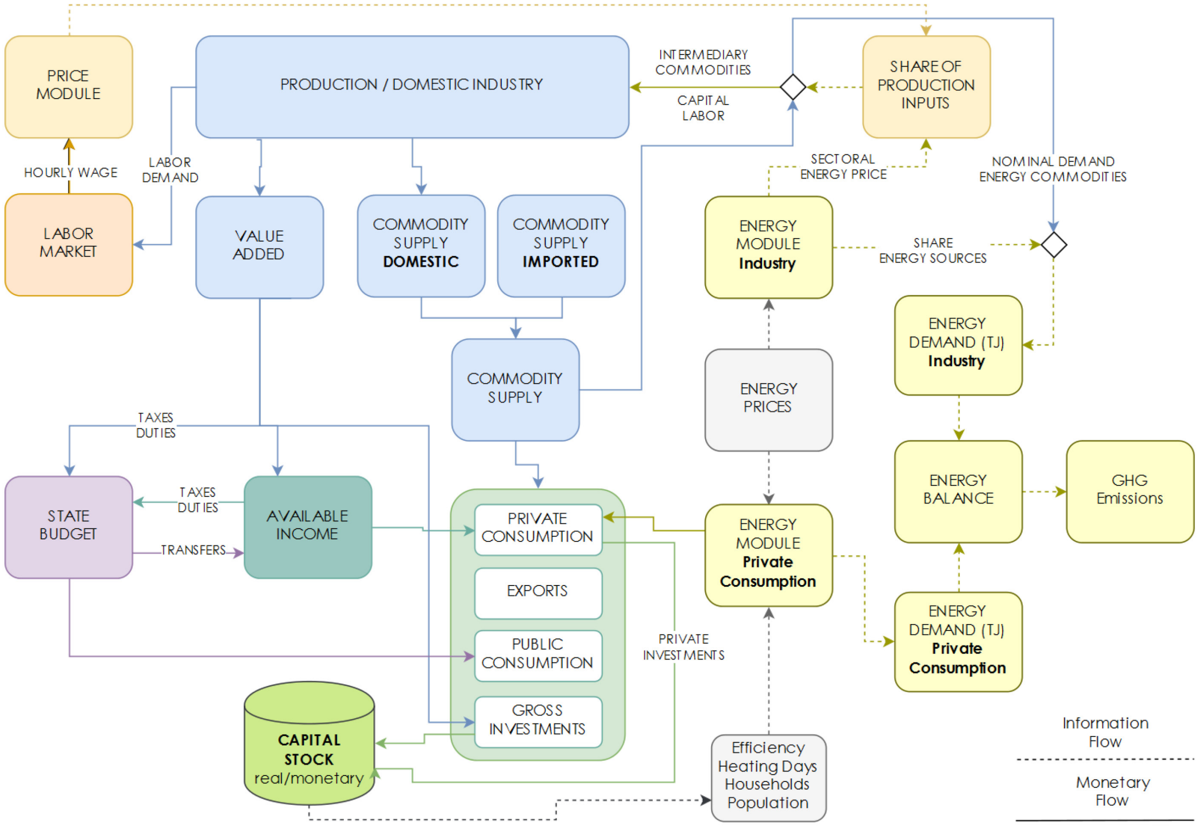
This task examined the implementation issues and barriers for introducing a carbon tax at Member State level. Important success determinants are related to the political economy of introducing taxes (negotiations with stakeholders, concessions, changes in proposed legislation, compromises, revenue raising etc.) which translate inter alia into competitiveness issues, and fairness / equity / distributional issues. The analysis focused on the 'front runner' countries identified in WP2 (Denmark, Sweden, Finland), which have been very successful in terms of the introduction of carbon taxes. The approach was inherently multifaceted taking economic and political aspects into account. It relied on a dual methodological approach employing a literature study with interviews. Interview partners were civil servants in the respective case study countries who had been selected on the basis of their experience.

WP4. Analysis of the Effect of a Carbon Tax in Austria

The WIFO-DYNK[AUT] (WIFO Dynamic New Keynesian Model for Austria) model was used to assess carbon tax scenarios for Austria. The DYNK[AUT] model traces the inter-linkages between 62 industries and final users (e.g. private consumption, gross fixed capital formation, public consumption). It further differentiates between five household income groups and models energy consumption explicitly. Core elements of DYNK[AUT] are described in Sommer and Kratena (2017), and only the most essential characteristics are described here (more details on the integration of household income groups as well as the modelling of energy demand and the implementation of CO_2 taxes can be found in Annex A5).

The model draws on New-Keynesian (i.e. long-run full employment equilibrium and institutional rigidities) as well as neo-classical economic theory (i.e. theory of firm, almost ideal demand system) and can be considered a hybrid form between CGE and static IO models. The DYNK model is an input-output model in the sense that it is demand-driven, as all that is demanded is produced. However, static input-output relationships are extended by the incorporation of econometrically estimated behavioural functions for industry & service sectors, the labour market, and private households.

Figure 1: A schematic overview of DYNK



An overview of the most important interlinkages of the model is provided in Figure 1. The model includes $KLEM^mM^d$ trans-log production functions for each sector to estimate the share of production inputs needed for one unit of sector output (i.e. unit cost). Production inputs are differentiated between capital (K), labour (L), energy commodities (E), imported material commodities (M^m) and domestic material commodities (M^d). An additional nested trans-log production function estimates the shares in energy sources as inputs for energy commodities (the E in $KLEM^mM^d$). Thereby five aggregate energy sources are differentiated: oil, gas, coal, electricity & heating, and renewables. The labour market module determines hourly wages for each sector. The consumption block differentiates the consumption structures of five household income groups, 45 consumption categories (COICOP) and comprises three nests: (i) the level of durables (housing, vehicles, household appliances) and total non-durables, (ii) energy consumption (transport, heating, electricity), (iii) non-energy consumption of eight categories of non-durables. The energy consumption of households in (ii) is linked to the durable stock and the energy efficiency embodied in this stock, which can be influenced by policy instruments. An important feature of the methodological approach used in this project is that the module for income distribution across households and their different consumption structures is fully integrated into the macroeconomic part of the model. Any energy taxation policy instrument and its combination with different compensation schemes not only yields distributional impacts, but also macroeconomic and environmental results. Therefore, in this project the question how far different compensation schemes or characteristics of the tax measure (progressivity) potentially undermine the original environmental target of the instrument can also be answered.

In CATs, the model has been specifically updated with household income data for Austria (EU-SILC, Austrian Consumption Survey), and the module for (private) passenger transport was expanded in order to represent the demand for mobility in physical units. This permits a more detailed representation of the energy price effects on mobility. Furthermore, we also adjusted the model to allow for a more consistent approach of integrating CO_2 price effects in the model. The detailed modelling of energy demand enables the implementation of energy / CO_2 taxation with specific designs that takes into account issues of technology choice as well as of income distribution:

(i) Based on the empirical assessment in WP2, a set of scenarios for the introduction of a CO_2 tax in Austria was developed. One set of scenarios assumed that different CO_2 tax rates were implemented only in non-ETS sectors; another set of scenarios also implemented a floor price for the ETS sectors.

(ii) The effects of the taxes were assessed with and without revenue recycling. The recycling options included lump-sum payments for households and reductions of the employers' social contributions for the service and industry sectors. With respect to households a differentiation between household income quintiles was implemented in order to mitigate the negative effects for lower income quintiles.

(iii) An energy / CO_2 tax was levied at the level of durables, i.e. an increase of the vehicle registration tax (NoVA), so that the energy / carbon efficiency of the vehicle stock could be altered.

WP5. Discussion and Policy Recommendations

Based on the preceding work packages, policy recommendations at EU level and for Austria were developed. At EU level the focus was put on suggestions for the introduction of a European carbon tax or the development of a general legal framework that will facilitate the introduction or advancement of CO_2 taxes at Member State level. For Austria concrete options for implementing a carbon tax were developed focussing on revenue recycling in order to mitigate negative effects on income distribution and competitiveness.

Policy Recommendations at EU level

Building upon the appraisal of implementation issues and barriers for carbon taxation in WP3, policy recommendations at EU level were discussed. It was elaborated if and how a European carbon tax could be achieved. Alternatively, suggestions for the development of a general legal framework that facilitates the introduction or advancement of CO_2 taxes at Member State level were developed. This includes the identification and legal assessment of specific carbon taxes that enjoy broad Member State support and may therefore be more likely to succeed at EU level.

Policy Recommendations for Austria

Given the tax scenarios and related model results, recommendations on how a carbon tax in Austria could be implemented were developed. Special attention was given to distributional issues, i.e. methods to minimise regressive impacts of the carbon tax as well as to design options that support the shift from fossil fuels to employment as input factors. The policy recommendations were discussed at a workshop with relevant stakeholder groups (e.g. chamber of commerce, chamber of labour, ministries, NGOs) ensuring the usability of the project results in policy making.

4.2 Results

WP1. Theoretical Background

The results from WP1 are described in two deliverables. On the one hand the extensive review of economic and legal literature is summarised in two working papers (Kettner and Kletzan-Slamanig, 2018a; Burgers and Weishaar, 2018). On the other hand a list of criteria for an evaluation of taxes was developed which is included in the Annex and can be downloaded from the project webpage (http://cats.wifo.ac.at/).

Economic aspects of the design of a carbon tax

The long lasting discussion of environmental taxation in economic theory is mainly concerned with the internalisation of negative externalities, the main rationale being the adjustment of prices that reduces environmental externalities while still delivering economically efficient and equitable results. Following the work of Pigou (1920) the tax ought to correct the difference between the private and social cost thus resulting in an internalisation of a negative externality and a subsequent reduction in the detrimental activity. However, as the social cost of pollution for instance is difficult to determine other approaches have been developed for setting a tax rate like the standard price approach by Baumol and Oates (1971). Accordingly, the tax rate is set at a level that guarantees that a certain environmental standard is obtained.

Furthermore, economic debate in the last decades centred around the notion of a double dividend (Goulder 1995), i.e. non-negative or positive economic effects in addition to environmental improvements that could be generated by revenue-neutral environmental taxation. Key to the realisation of positive economic effects is the use of tax revenues. Revenue recycling offers the opportunity to lower other distortionary taxes, like payroll taxes, thus altering relative input process and contributing to increased labour demand. Recycling is a key aspect of the concept of ecological tax reforms. It is also of relevance with respect to other points of discussion, i.e. the potential negative effects of environmental taxes on income distribution and international competitiveness. These impacts can be mitigated by targeted approaches to revenue recycling either via lowering labour related taxes or funding environmental investments and R&D.

Legal aspects of the design of a carbon tax

The overview of the legal aspects to the design of a carbon tax shows that many different aspects have to be taken into account in designing a carbon tax, both in respect of legal instruments to be used (tax, levy or fee) and the actual design of the tax.

Taking a legal perspective, it is added to the design issues mapped by the OECD (2011) that:

- multiple pricing, either by multiple instruments or through carbon taxes or other fiscal charges levied by different (tax) administrations (e.g. two countries or two levels of government) should be prevented;
- legal principles – legality, equality, legal certainty, legitimate expectation, fair play, public trust in tax administration, good faith, transparency, proportionality, non-retroactivity and estoppel – and the economically oriented OECD Ottawa Taxation Framework principles – neutrality, efficiency, certainty and simplicity, and effectiveness and fairness – should be taken into account;
- it should be clear who is taxed (the taxable subject also referred to as taxpayer), what is taxed (the tax base), what exemptions are provided (tax incentives) and what the costs to the polluters will be per unit of pollution generated (tax rate);
- the differences in legal implications of referring to the fiscal measure as a tax, a fee or a levy should be considered;
- adding the adjective "environmental" to the name of the tax may have legal implications, as this may imply that revenue is earmarked for environmental purposes;
- in order to achieve the environmental goal it is of utmost relevance that the taxable event is consistent with the tax base;
- in time there should be only predictable changes to the law thus providing legal certainty, legitimate expectation and trust in tax administration;
- European law influences the design of carbon taxes in that the minimum requirements of the Energy Tax Directive and the Excise Directive must be met and the tax should not contain elements that might be prohibited state aid.

List of criteria for the evaluation of energy and carbon taxes

From the comprehensive literature review a list of quantitative and qualitative indicators was derived, that can be used in the evaluation of energy and carbon taxes. This provided the basis for the work in WP2 and WP3.

WP2. Quantitative Assessment of Carbon Taxes in the EU

The results from WP2 are summarised in a Working Paper (Kettner and Kletzan-Slamanig, 2018b) and two book chapters (Kettner and Kletzan-Slamanig, 2017; Kettner and Kletzan-Slamanig, forthcoming). The tables containing the data on energy and implicit carbon tax rates in EU Member States can be downloaded from the project webpage (http://cats.wifo.ac.at/).

The first energy taxes were levied in EU Member States more than a century ago: Denmark was the first Member State to introduce taxes on transport fuels in 1917 followed by Sweden in 1924 (see Speck 2008). Since then, energy taxes have been implemented in all Member States. As of 2016, energy taxes accounted for 4.7% of the total tax revenues of the EU-28 and for 1.88% of GDP respectively. The contributions of energy taxes to total tax revenues vary, however, considerably between Member States ranging from 3.03% in Belgium to 9.85% in Latvia.

In Council Directive 92/82/EEC, the EU established minimum excise duties on mineral oils used as propellants or for heating. The EU framework for energy taxation was then revised and extended in 2003 with Directive 2003/96/EC. This directive provides new minimum tax rates for propellants, heating fuels and electricity.

Table 1 gives an overview of the energy tax rates implemented for the different energy sources and application areas in the 28 EU Member States as of January 2017. It shows that while effective excise duties correspond to the minima in some Member States, in others the tax rates are considerably higher. As also provided for in Directive 2003/96/EC, the highest taxes are levied on fuels used as propellant, i.e. on petrol and diesel, as well as on gas. Minimum tax rates for heating fuels amount to 1-11% of the minimum tax rate for petrol and are highest for gasoil.

Table 1. Energy Tax Rates in EU Member States in €/GJ as of January 2017

	Coal - Heating Business use	Coal - Heating Non-business use	Petrol	Gasoil - Propellant	Gasoil - Heating Business use	Gasoil - Heating Non-business use	Gas - Propellant	Gas - Heating Business use	Gas - Heating Non-business use	Electricity - Business use	Electricity - Non-business use
AT	1.70	1.70	15.20	11.43	3.14	3.14		1.66	1.66	4.17	4.17
BE	0.41	0.41	19.16	14.34	0.50	0.50		0.28	0.00	0.83	0.54
BG	0.31	0.31	11.07	9.19	9.19	9.19	0.43	0.31	0.00	0.28	0.00
CY	0.00	0.31	14.60	12.52	3.47	3.47	2.60	2.60	2.60	1.39	1.39
CZ	0.31	0.31	14.49	11.27	11.27	11.27	0.70	0.31	0.31	0.29	0.29
DE	0.17	0.33	20.19	13.30	1.49	1.92	11.46	8.67	8.76	4.27	5.70
DK	9.62	9.62	20.19	11.67	9.11	9.11	11.55	8.74	8.74	0.15	33.97
EE	0.93	0.93	14.18	12.46	12.46	12.46		0.89	0.89	1.24	1.24
ES	0.15	0.65	13.42	9.21	2.36	2.36	1.15	0.15	0.65	1.42	1.42
FI	7.49	7.49	21.42	14.76	6.36	6.36	5.17	5.17	5.17	1.95	6.26
FR	2.78	2.78	19.84	14.76	3.31	3.31	1.53	1.63	1.63	6.26	6.26
GR	0.30	0.30	21.34	11.40	11.40	11.40	0.00	0.60	0.30	1.39	0.61
HR	0.31	0.31	15.68	14.74	1.57	1.57	0.00	0.15	0.30	0.14	0.27
HU	0.30	0.30	12.12	10.41	10.41	10.41	2.67	0.30	0.30	0.28	0.28
IE	1.89	1.89	17.92	13.32	2.84	2.84	2.60	1.03	1.03	0.14	0.28
IT	0.16	0.32	22.21	17.17	11.22	11.22	0.09	0.34	3.89	2.30	6.31
LT	0.15	0.30	13.24	9.18	0.59	0.59	6.56	0.15	0.30	0.14	0.28
LU	5.00	0.30	14.13	9.36	0.28	0.28	0.00	0.30	1.08	0.14	0.28
LV	0.35	0.35	13.29	9.48	1.09	1.09	2.67	0.46	0.46	0.28	0.28
MT	0.30	0.30	16.75	13.13	6.46	6.46		0.84	0.84	0.42	0.42
NL	0.54	0.54	23.47	13.48	13.48	13.48	4.57	2.55	7.16	11.43	27.99
PL	0.30	0.30	12.40	9.45	6.45	6.45	2.48	0.30	0.30	1.30	1.30
PT	0.59	0.59	18.83	11.18	9.53	9.53	3.13	0.59	0.59	0.28	0.28
RO	0.16	0.32	11.35	9.49	9.49	9.49	2.79	0.18	0.34	0.15	0.30
SE	12.89	12.89	20.57	17.19	8.36	12.02	6.40	5.87	8.89	0.15	8.66
SI	1.86	1.86	16.75	13.10	5.63	5.63	3.45	1.42	1.42	0.85	0.85
SK	0.31	1.00	16.24	10.49	10.49	10.49	2.60	0.37	0.37	0.37	0.00
UK	0.00	0.00	20.23	18.46	3.55	3.55	5.67	0.61	0.61	0.00	0.00
EU MED*	0.15	0.30	10.95	9.18	0.58	0.58	2.60	1.15	0.30	0.14	0.28

* Minimum Excise Duty

Note: Tax rates as displayed in the EU Excise Duty Tables (January 2017); country-specific exemptions not included.

Converting the (minimum) energy tax rates based on the fuels' carbon content into a CO_2 price signal delivers the implicit carbon tax rates levied in the EU Member States as of January 2017 (Table 2). With respect to propellants, implicit carbon minimum tax rates are 128 €/CO_2 for diesel and 140 €/CO_2 for petrol. For coal used as heating fuel, in contrast, minimum tax rates are 1.6 €/CO_2 for business use and 3.2 €/CO_2 for non-business use respectively. Since the CO_2 emission factors of the individual energy sources are assumed to be identical for all Member States (except for electricity), the effective implicit carbon tax rates implemented in the Member States also diverge strongly between application area and energy source. This spread of excise duties is in stark contrast to the economic theory on carbon pricing, postulating uniform taxation of emissions as a prerequisite for efficient regulation.

Table 2. Implicit CO_2 Tax Rates in EU Member States in €/t CO_2 as of January 2017

	Coal - Heating Business use	Coal - Heating Non-business use	Petrol	Gasoil - Propellant	Gasoil - Heating Business use	Gasoil - Heating Non-business use	Gas - Propellant	Gas - Heating Business use	Gas - Heating Non-business use	Electricity - Business use	Electricity - Non-business use
AT	18.09	18.09	194.85	146.56	40.30	40.30		30.74	30.74	99.24	99.24
BE	4.41	4.41	245.61	183.79	6.40	6.40		5.13	0.00	11.69	7.50
BG	3.30	3.30	141.89	117.78	117.78	117.78	7.96	5.74	0.00	2.89	0.00
CY	0.00	3.30	187.23	160.47	44.48	44.48	48.15	48.15	48.15	17.73	17.73
CZ	3.30	3.30	185.74	144.51	144.51	144.51	12.96	5.74	5.74	3.17	3.17
DE	1.81	3.51	258.81	170.47	19.08	24.55	212.22	160.56	162.22	50.36	67.17
DK	102.29	102.29	258.81	149.56	116.80	116.80	213.95	161.83	161.83	2.68	606.14
EE	9.89	9.89	181.75	159.76	159.76	159.76		16.48	16.48		
ES	1.60	6.91	172.10	118.03	30.21	30.21	21.30	2.78	12.04	17.28	17.28
FI	79.68	79.68	274.59	189.25	81.55	81.55	95.74	95.74	95.74	34.85	111.68
FR	29.57	29.57	254.34	189.25	42.40	42.40	28.33	30.19	30.19	93.07	93.07
GR	3.19	3.19	273.61	146.21	146.21	146.21	0.00	11.11	5.56	13.01	5.73
HR	3.26	3.26	201.03	189.00	20.10	20.10	0.00	2.78	5.55	1.81	3.62
HU	3.19	3.19	155.37	133.47	133.47	133.47	49.49	5.62	5.62	3.82	3.82
IE	20.11	20.11	229.72	170.81	36.47	36.47	48.15	19.07	19.07	1.86	3.72
IT	1.70	3.40	284.71	220.17	143.79	143.79	1.67	6.30	71.94	34.54	94.78
LT	1.60	3.19	169.81	117.68	7.54	7.54	121.48	2.78	5.56	4.08	7.93
LU	53.19	3.19	181.10	120.06	3.57	3.57	0.00	5.49	20.00	2.62	5.25
LV	3.72	3.72	170.42	121.60	13.95	13.95	49.44	8.52	8.52	7.44	7.44
MT	3.19	3.19	214.74	168.32	82.76	82.76		15.56	15.56	5.42	5.42
NL	5.74	5.74	300.93	172.76	172.76	172.76	84.63	47.22	132.59	156.43	383.05
PL	3.19	3.19	158.93	121.19	82.73	82.73	45.93	5.56	5.56	13.87	13.87
PT	6.28	6.28	241.37	143.36	122.17	122.17	57.96	10.93	10.93	3.49	3.49
RO	1.70	3.40	145.47	121.63	121.63	121.63	51.67	3.33	6.30	1.94	3.85
SE	137.13	137.13	263.70	220.35	107.15	154.04	118.52	108.70	164.63	4.80	282.00
SI	19.79	19.79	214.69	167.95	72.19	72.19	63.93	26.33	26.33	9.08	9.08
SK	3.30	10.64	208.14	134.51	134.51	134.51	48.15	6.85	6.85	6.20	0.00
UK	0.00	0.00	259.41	236.66	45.50	45.50	105.00	11.37	11.37	0.00	0.00
EU MED*	1.60	3.19	140.32	117.68	7.49	7.49	48.15	21.30	5.56	1.77	3.55

* Minimum Excise Duty

Note: Implicit CO_2 tax rates using UNFCCC emission factors and energy tax rates as displayed in the EU Excise Duty Tables (January 2017); country-specific exemptions not included.

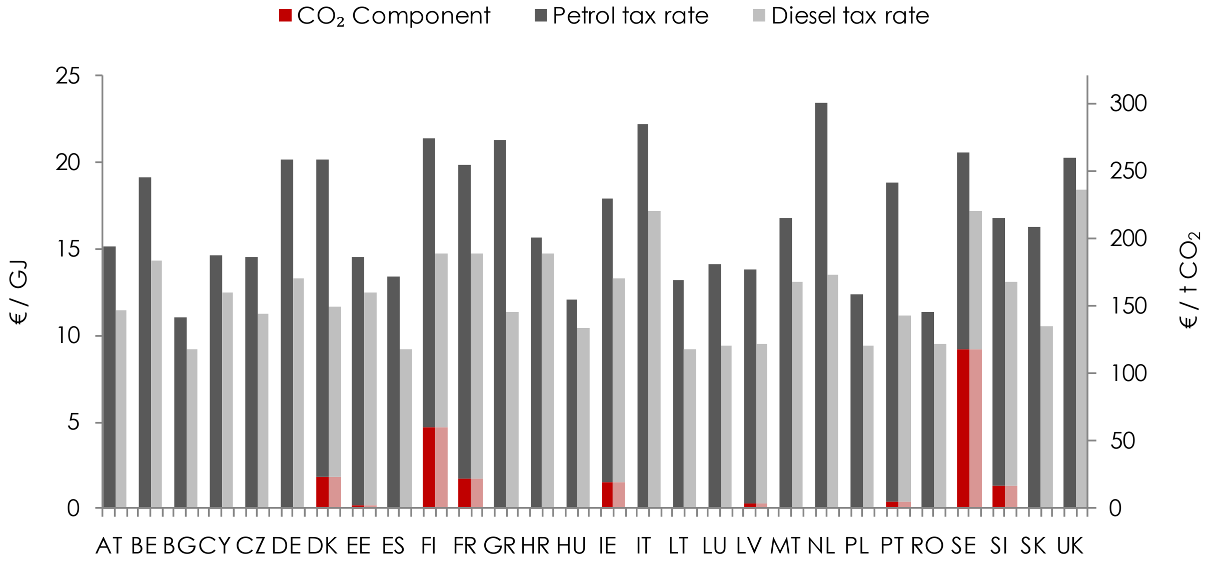
Figure 2 illustrates petrol and diesel tax rates in the EU 28 as of January 2017. Petrol tax rates range between 11.1 €/GJ in Bulgaria and 23.5 €/GJ in the Netherlands; diesel tax rates are in the range of the minimum excise duty of 9.2 €/GJ in Bulgaria, Lithuania and Spain and 18.5 €/GJ in the United Kingdom. Measured in Euro per GJ, petrol tax rates exceed diesel rates in all Member States by up to 87% (Greece). It has to be noted, however, that in the UK the tax rate per litre is identical for petrol and diesel, although this ultimately implies again a higher petrol tax rate per unit of energy due to lower energy content compared to diesel[5]. In the majority of the Member States (i.e. 20 out of 28 countries), excise duties on diesel, however, have risen more strongly than those on petrol over the past 10 years.

In relation to the CO_2 content, energy tax rates translate into an implicit CO_2 tax rate of 142-301 €/t CO_2 for petrol and 118-237 €/t CO_2 for diesel respectively in the EU Member States as of January 2017.

An explicit carbon tax for the transport sector has thus far only been introduced in ten Member States: Denmark, Estonia, Finland, France, Ireland, Latvia, Portugal, Slovenia, Sweden and Poland. In most of these countries the CO_2 tax covers, however, only a small part of the overall tax rate on energy and is well below 10 €/t CO_2. Notable exceptions in this regard are Sweden where the carbon component has increased to 118 €/t CO_2 and Finland with a CO_2 component of 62 €/t CO_2 in 2017.

5 One litre of diesel delivers 19.6 GJ of energy compared to 17.6 GJ for petrol.

Figure 2. Petrol and diesel tax rates in EU Member States as of January 2017



Source: Own calculations based on the EC Excise Duty Tables January 2017.

Upfront taxes such as registration taxes can be a useful complement to fuel based taxes by counterbalancing consumer myopia regarding purchase decisions: Instead of considering the purchase price and the expected usage costs over the whole lifetime of the vehicle, consumers tend to consider only the first years of usage for their decision.

In 2016, 14 EU Member States incorporated the CO_2 emissions of a vehicle for determining registration taxes and recurring ownership taxes. In four of these countries (Cyprus, Estonia, France and Latvia), specific CO_2 emissions are the only criterion for acquisition taxes; in the other countries CO_2 emissions are combined with other factors (such as purchase prices or cylinder capacity). Overall cars' CO_2 intensities tend to be lower in Member States with higher ownership and especially purchase taxes but high vehicle tax levels alone do not guarantee for a shift towards low-emission vehicles (see Kettner and Kletzan-Slamanig, forthcoming).

WP3. Implementation Issues and Barriers

The results from WP3 are summarised in two Working Papers (Weishaar, 2018a; Weishaar, 2018b). A shortened version of the analysis on frontrunner countries is accepted for publication as a book chapter (Weishaar, forthcoming).

Carbon taxes at EU level

The first part of the analysis was concerned with introduction issues and barriers of a CO_2 tax at EU level. The review of the EU legislative procedures indicated that there is legal uncertainty relating to the actual wording and application of the environmental and energy legal basis and if the ordinary legislative procedure employing qualified majority voting could be relied upon. If a CO_2 tax would need to be introduced by means of the special legislative procedure, unanimity voting would be required. In practice there has not been an example where a legislative act was based on the unanimity requirement under Articles 192(2)(a) or 194(3) TFEU. It is submitted that the Commission may refrain from taking legislative action under the unanimity requirement if it is apparent from informal pulsing that there is significant Member State opposition. Additional barriers to introducing a CO_2 tax at EU level stem from national legal systems that influence the transposition of EU rules and co-determine the position of a Member State in the Council. It is of course not only the legal embedding that is important in this respect but also the national interest of a Member State. Even though the Member State government will ultimately have to cast the vote in the Council and represent the ‘national interest’, interests within a country are very diverse and dependent upon a multitude of factors and actors. Legislative processes in the EU prescribe consultations and that relevant national actors such as the national parliaments are duly informed and part of the discourse. It is therefore submitted that the decision making process even under the unanimity requirement is diverse. Stakeholders can seek out different fora at various levels of government to influence the adoption of a CO_2 tax.

Besides the above mentioned barriers to introduce a CO_2 tax at EU level, it is also pointed out that the European Commission has made several unsuccessful attempts to legislate in the area of climate change regulation and may therefore be reluctant to invest time in a course of action that may not be embraced by the Member States. While the above would suggest that the prospects for adopting a CO_2 tax on EU level are at best a scant possibility in practice, EU law does provide for a course of action. In specific circumstances a group of Member States may be allowed to act upon a legislative proposal of the European Union and undertake measures that would otherwise fall within the ambit of the competences of the Union. The so-called ‘enhanced cooperation’ is a procedure where a minimum of nine EU countries are allowed to establish advanced integration or cooperation without the other EU countries being involved. The coalition of the willing Member States benefits from the EU structures. It is regulated by Article 20 TEU and Articles 326 to 334 TFEU. The procedure can help to overcome the dead-lock of proposals which are blocked by an individual country or a small group of countries not wishing to be part of the initiative.

Support for more environmental taxation may also come from an unexpected direction: the Brexit. Britain’s exit leaves a considerable budget gap at Union level. New income bases need to be identified. The Commissioner for the EU Budget recently proposed the introduction of a Plastic tax and a change of the EU ETS. Perhaps a carbon tax could be considered as well.

Carbon taxes in front-runner countries

This paper examines the experience of the front-runner EU countries of the carbon tax (Denmark, Finland and Sweden) and addresses the question which barriers to introducing the CO_2 taxes had to be overcome and how they were surmounted. Additional information is included for Norway and Switzerland.

There have been important barriers and success factors which enabled the introduction of the CO_2 taxes in the case study countries. Similar impediments were at play in all three Member States, relating to recycling, competitiveness and the fostering of support. ‘Issue linking’ to strike a balance between different interests has been of paramount importance in all countries. Recycling money back to industry can improve companies' competitive positions and hence appease them and foster political support or at least lead to less resistance.

The experience of the case study countries shows that the introduction of the CO_2 taxes was possible by employing a consensus approach. In all countries the political resilience of the CO_2 taxes was ensured by frequent adaptations of either the CO_2 tax or its wider framework, the environmental tax reform. The consensus approach underlines the importance of recycling in the policy design and the need to safeguard competitiveness. Both issues are tightly related as they can be used to keep stakeholders happy – though this should not go as far as to significantly reduce the environmental impact of the measure, as was the case in Norway. In the case study countries households received inter alia income tax reductions but were bearing a bigger share of the tax burden while companies were at least in part able to receive tax exemptions or tax refunds. Notably in Denmark cross-subsidisation between households and companies was avoided. This is also a successful approach that has been followed by Switzerland, which recycles CO_2 tax proceeds back to residents via reductions in the health care insurance premium. In the examined countries companies also benefited from energy efficiency schemes that were designed to help them to reduce production costs. Finland is a special case in this regard as for long it did not have such derogations and the Finnish CO_2 tax did also not benefit from flanking support of an environmental tax reform that could offer additional possibilities to support stakeholders. Perhaps this is why the Finnish tax was started relatively low and only increased as provisions favouring industry (e.g. in the energy domain) were extended.

It appears that industry was strongly considered and regarded as an important stakeholder while households were playing a lesser role. Perhaps this can be explained by pointing towards collective action problems that hinder households to undertake action or the acceptance of the environmental goals as a policy justification.

WP4. Analysis of the Effect of a Carbon Tax in Austria

The results from WP4 are summarised in a Working Paper (Kirchner et al., 2018).

WP4 provided a macroeconomic assessment of distributive, macroeconomic, and CO_2 emission impacts of different CO_2 tax scenarios in Austria. The scenarios aimed at covering a reasonable range of tax rate variants and tax recycling schemes (see Table 3 and Table 4). The main focus of the scenarios was on energy-related CO_2 emissions generated in non-ETS sectors, i.e. mostly CO_2 emissions from energy consumption by private households, transport and service sectors.

Table 3: CO_2 tax price scenarios for Austria

Scenario Name	**Explicit CO_2 tax (€/tCO_2)**	**Energy Tax**	**Implicit CO_2 tax rates for fossil fuels (€/tCO_2)**				
			Petrol	**Diesel**	**Oil[1]**	**Gas**	**Coal**
Base	0	Current	195	147	40	31	18
Low	60	Current	255	207	100	91	78
Med	120	Equivalised	315	315	160	178	153
High	315	None	315	315	315	315	315

[1] Refers to heating oil.

Table 4: CO_2 tax recycling/compensation scenarios for Austria

Scenario Name	**Description**
NoRec	No tax recycling
RecH	*All CO_2 tax revenues are recycled via equal per-capita lump sum payments to all households (H)*
RecH[low]	*All CO_2 tax revenues are recycled via equal per-capita lump sum payments to the three lowest households (H) income groups (QNT1 to QNT3)*
RecQ	*All CO_2 tax revenues are recycled via uniformly reduced employers' social contribution for industry & service sectors (Q) affected*
RecQH	*CO_2 tax revenues from households (H) are recycled as in RecH* *CO_2 tax revenues from industry & service sectors (Q) are recycled as in RecQ*
RecQH[low]	*CO_2 tax revenues from households (H) are recycled as in RecH [low]* *CO_2 tax revenues from industry & service sectors (Q) are recycled as in RecQ*

Three additional scenarios were provided: (1) a floor price for ETS sectors; (2) an increase in the vehicle registration tax (NoVA) for vehicle purchase; and (3) policy scenarios until 2030.

The range of short term (i.e. one year) impacts of the simulated CO_2 tax scenarios on energy related CO_2 emissions in non-ETS sectors is illustrated in Figure 3 for the tax recycling scenario *RecQH* that includes lump sum transfers for households and lower labour taxes for industry & service sectors. Total non-ETS emissions decrease by 3% (*Low)* to 10% (*High)*. Impacts are lowest for households due to the very low (short-term) price elasticities estimated for service energy demand and range from -1% to -3%. This indicates that comfortable room temperature as well as mobility (e.g. commuting by private cars) are basic necessities for households, which will not change considerably in the short term even if prices increase strongly. Industry & service sectors react more sensitively with decreases of up to 14% in the transport sector and 20% in the service sector. The impact for overall non-ETS industry & service sector emissions lies between -6% and -17%.

Figure 3: CO_2 emissions impact of the CO_2 tax rates (Tax recycling scenario: RecQH).

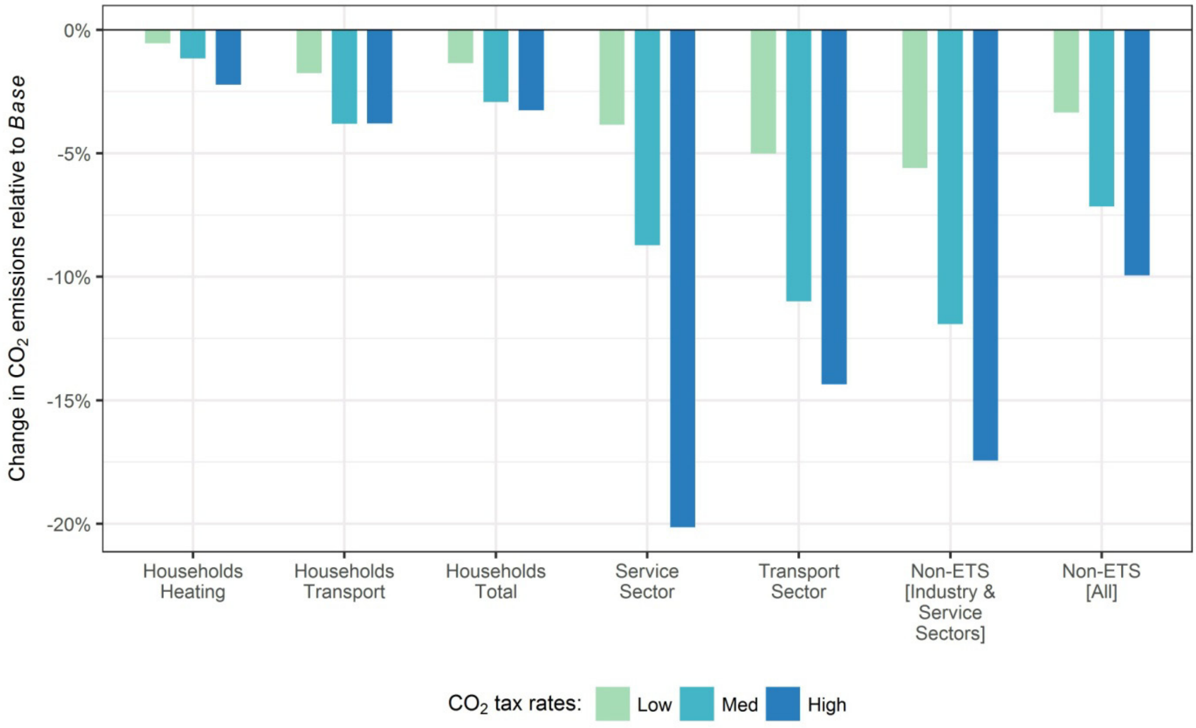
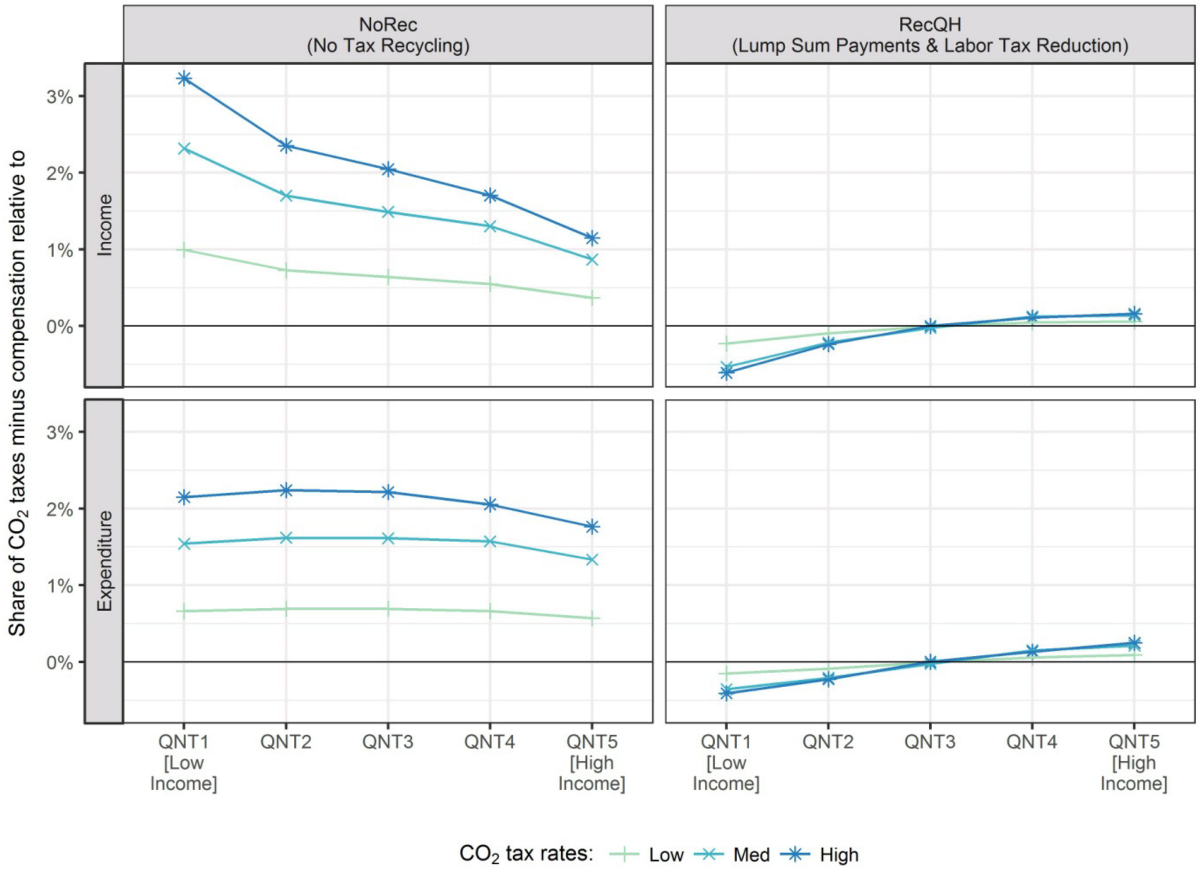


Figure 4 illustrates the "tax burden relative to income" and "tax burden relative to expenditure" for the range of CO_2 tax rates without tax revenue recycling (*NoRec*) and tax compensation for both households and industry & service sectors (*RecQH*). In *NoRec* QNT1 spends between 1.0% (*Low*) to 3.2% (*High*) of their income on CO_2 taxes compared to only 0.4% to 1.1% for QNT5. In absolute terms, annual CO_2 tax payments range from 108 € to 349 € per year and per capita in QNT1 and from 159 € to 489 € per year and per capita in QNT5. The impacts become less regressive (slightly inverted U-shaped) if one looks at CO_2 taxes paid relative to total expenditure. This is because (i) differences in expenditure between the household income groups are smaller than differences in income levels, and (ii) different relative price changes for transport and heating and their respective expenditure shares. As relative price increases in transport fuels are higher in *Low* and *Med* than price increases for heating, the inverted-U-shaped expenditure share of transport fuels across income groups[6] dominates and impacts are almost perfectly proportional (ca. 0.7% in *Low*). If compensation measures in the form of lump sum payments are subtracted from CO_2 taxes paid, the CO_2 tax rate scenarios become progressive both relative to income and expenditure and lead to net increases for QNT1 and QNT2.

6 I.e. middle-income households show a higher expenditure share with respect to transport fuels compared to the lowest as well as highest income group.

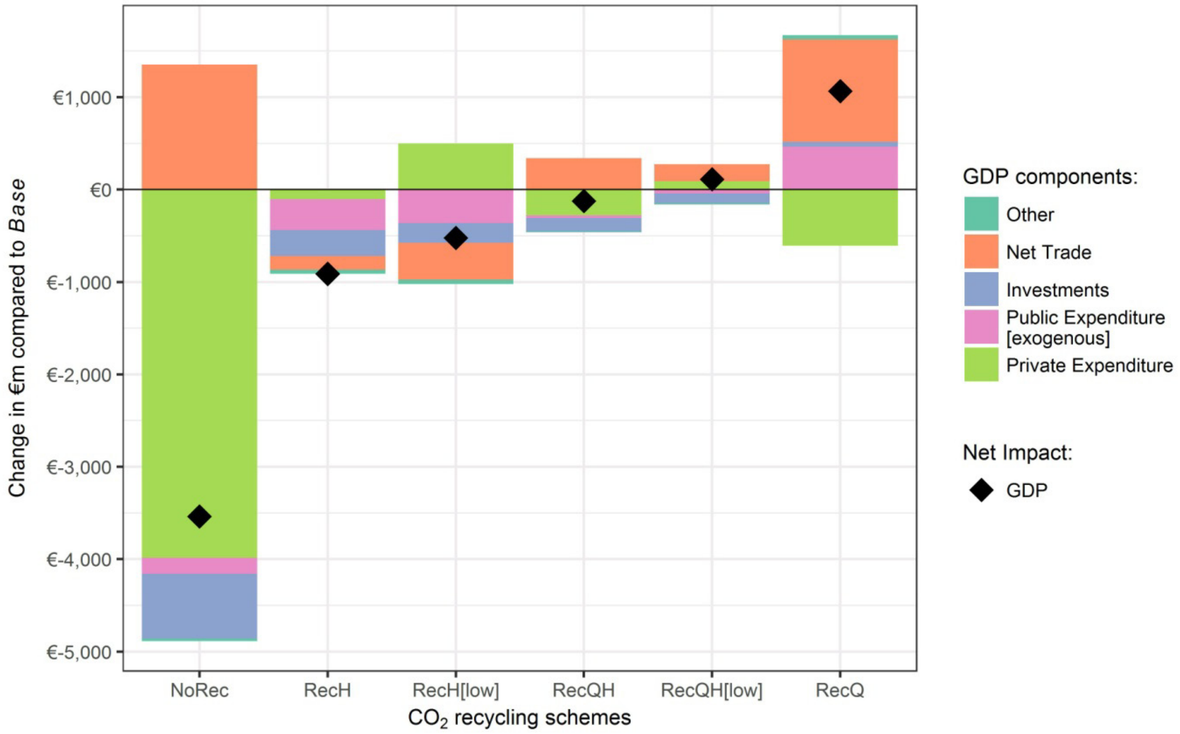
Figure 4: Tax burden impact on households.



The GDP impact of the CO_2 tax rate *Med* and the tax recycling schemes is illustrated in Figure 5. Without compensation (*NoRec*) real GDP is negatively affected (-3.5b € or -1%). This decrease is primarily driven by significant reductions in private expenditure and lower investment (due to lower production output). Public expenditure also decreases, but only in real terms since nominal values are exogenously determined. All revenue-neutral tax recycling schemes considered mitigate the negative impacts on GDP. Notably, recycling via lump sum payments for households only (*RecH*) is less efficient than recycling via lower labour taxes for industry & services sectors only (*RecQ*), with the latter leading to even small positive GDP impacts. Recycling tax revenues to both households and sectors leads to negligible GDP impacts (*RecQH*). Restricting availability of lump sum payments to lower income households (QNT1-QNT3; indicated by *[low]*), increases consumption (and thus GDP) more than uniform lump sum payments for all households. Furthermore reductions in labour taxes boost employment (by ca. 2% in *RecQ & High*).

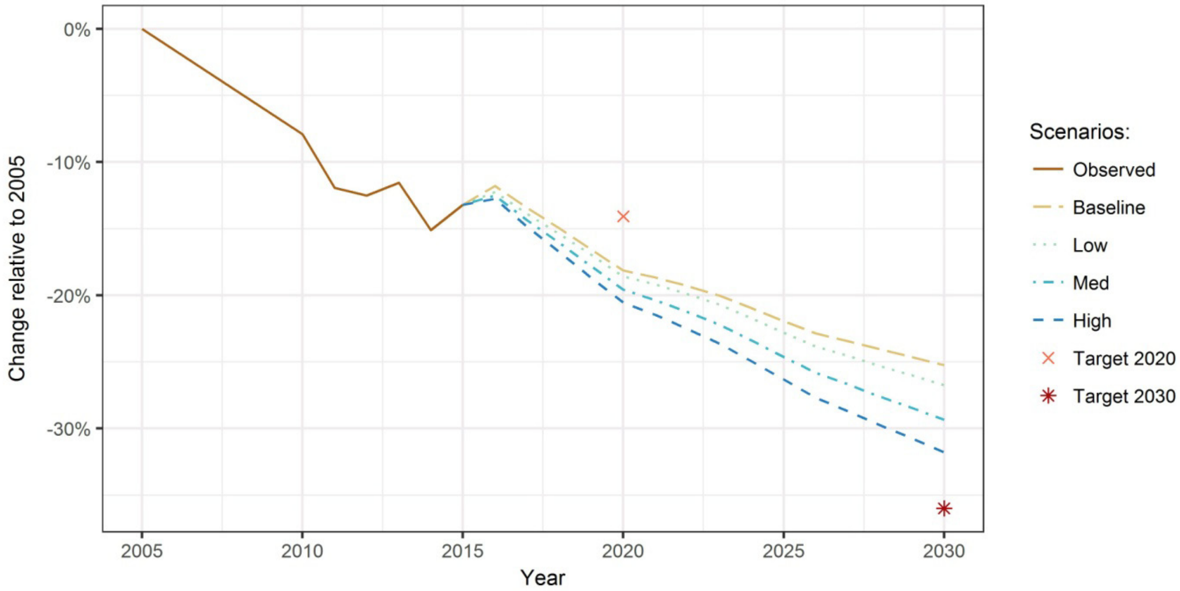
Although one might expect that import shares increase with CO_2 taxes, the impact on net trade is actually positive (i.e. imports decrease stronger than exports). This is because commodities affected by the CO_2 tax, such as petrol and diesel, have a much higher import share than the average commodity. In addition, changes in import shares are generally quite low, as domestic output prices do not change considerably given that energy costs play only a minor role for most sectors. In scenario *High & NoRec* overall import shares (final and intermediate use) increase marginally from 33.2% to 33.5%.

Figure 5: GDP impacts (real values) (CO_2 tax rate: Med).



Possible trajectories of total non-ETS CO_2 emissions until 2030 are shown in Figure 6. It includes the observed trend of non-ETS GHG emissions between 2005 and 2015 as well as the mandatory 2020 target (UBA, 2017b) and the proposed 2030 target (-36%). Relative changes in CO_2 emissions in DYNK[AUT] are used to extrapolate possible trajectories from 2015 to 2030. The *Baseline* scenario CO_2 emissions are considerably driven by economic growth, the forward projection of past energy intensity trends in industry & service sectors, and exogenously assumed trends in household energy efficiencies. Although CO_2 emissions increase between 2014 and 2016 due to very low fossil fuel prices, a declining trend in total non-ETS CO_2 emission in the *Baseline* scenario can be observed already in 2017. This declining trend keeps emissions below the 2020 target, but is not enough to reach the proposed target for 2030 in the model. The CO_2 tax scenarios lead to lower emission trends, but also come short of the 2030 target (*High* leads to a reduction of ca. 32%).

Figure 6: Non-ETS CO_2 emission trends: observed (2005-2015) and modelled (2015-2030).



In addition, the impact of a change in the vehicle registration tax NoVA on vehicle stock efficiency and CO_2 emissions was simulated for the period 2015-2030. Increased revenues from NoVA were assumed to be recycled via equal lump sum payments to all households. Compared to the CO_2 emissions in the CO_2 tax rate scenario *Med* an increase in the NoVA has a more significant impact than the CO_2 tax rate on diesel and petrol. Compared to the *Baseline* emissions in 2030 are only 2% lower in *Med*, but 8% lower with an additional rise in the NoVA. An increase in the NoVA affects the fuel efficiency of diesel and petrol vehicles by augmenting the share of more fuel-efficient vehicles amongst new cars. The share of electric vehicles increases also but only marginally. As shown by Hackbarth and Madlener (2011) other factors than purchase or fuel prices are much more important for the purchase decision of electric cars (e.g. battery recharge time, driving range, and fuel availability).

Overall, the modelling results provide many arguments that carefully designed CO_2 tax policies can play an important part in achieving GHG emission targets for non-ETS sectors in Austria with potentially positive distributive and macroeconomic impacts. The case for CO_2 taxes is further amplified if one would account for the positive benefits and co-benefits of mitigating CO_2 emissions.

WP5. Discussion and Policy Recommendations

The conclusions and recommendations from the CATs project are summarised and published as a Policy Brief (Kettner et al., 2018).

The project analysed the issue of energy and carbon taxation from different points of view, including theoretical (economic and legal) literature, empirical evidence for the EU (quantitative and qualitative) as well as model simulations for a range of taxation scenarios for Austria.

The comparison of theoretical recommendations and actual implementations of energy and carbon taxes reveals various divergences, which exist due to conflicting political objectives (environmental protection, income distribution, competitiveness) and resulting compromises in order to gain acceptance for fiscal measures or environmental tax reforms. It also has to be noted that energy taxes were initially introduced in order to raise revenues. Environmental concerns were included much later on, with a shift to climate change mitigation in the 1990s. Recently, CO_2 emissions are increasingly taken into account in vehicle taxation (registration and ownership taxes). The assessment of energy and vehicle taxation in the EU Member States reveals a broad range of tax rates and a variety of preferential tax treatments. This also translates into different shares of energy tax revenues in total tax revenues.

On EU level, minimum energy tax rates have been defined in Directive 2003/96/EC but attempts to adapt these tax rates to reflect the climate policy ambitions of the EU have failed due to the unanimity requirement in taxation issues. Thus, the EU regulation falls short of being adequate for reaching the long-term emission reduction objectives. Given the requirement of unanimity voting and the existence of diverging national interests of Member States any agreement regarding an introduction of EU-wide carbon taxes seems out of reach. Currently, the EU carries out an evaluation and fitness check of the Energy Tax Directive. It is, however, unclear whether the results of this check will lead to another initiative to adapt minimum energy tax rates to reflect the climate policy ambitions of the EU or how successful such an initiative could be. Support for more environmental taxation may also come from an unexpected direction: the Brexit. Britain's exit leaves a considerable budget gap at Union level. New income bases need to be identified. The Commissioner for the EU Budget recently proposed the introduction of a plastic tax and a change of the EU ETS. The High Level Group on Own Resources also recommended in its final report environmental taxes (including a CO_2 tax) as viable options for generating EU own resources.

Against this background, action to limit greenhouse gas emissions on national level is required, particularly in the sectors not covered by the EU ETS. Fiscal measures such as energy and carbon taxation can contribute towards achieving climate policy targets by pricing the externality.

This is supported by the CATs model simulations for the range of scenarios analysed for Austria. The results for a revenue neutral introduction of carbon taxes generally show a significant effect on emissions, especially in the transport and service sector. In all scenarios including the scenario with a floor price for ETS sectors macroeconomic impacts, in contrast, are moderate. It has to be noted, however, that the recycling of additional tax revenues is a key aspect in order to mitigate negative impacts on GDP, income distribution (regressivity) and competitiveness.

The need for structural changes in the Austrian tax system has been repeatedly emphasised by international organisations (e.g. OECD, 2013; EC 2015). The introduction of a CO_2 tax would permit a shift of the tax burden from e.g. labour to environmental externalities. In addition to reducing greenhouse gas emissions this could also entail positive GDP and employment effects (double dividend). Furthermore, an ambitious climate policy triggers research and innovation and facilitates the structural changes required to achieve a deep decarbonisation.

Evidence from other EU Member States that have introduced comprehensive environmental tax reforms including carbon taxes shows that one prerequisite for the implementation is a broad societal and political consensus and the integration of long term climate policy objectives in all areas of policy making.

5 Conclusions and recommendations

The CATs project provides a comprehensive discussion of carbon taxes from different points of view. These include theoretical foundations (economic and legal), an empirical analysis of energy and carbon taxation in EU Member States, the investigation of legal implementation issues and barriers as well as model simulations of a range of scenarios for Austria.

Theoretical aspects

From an economic perspective, the theoretical focus is on the cost-effective regulation of negative externalities using taxes. Given the actual difficulties of determining the social cost of pollution, i.e. the optimal tax rate, the recommendations of economic literature emphasise other approaches for achieving environmental objectives (e.g. standard price approach) as well as recommendations regarding the optimal design of environmental and especially carbon taxes, their performance relative to other instruments, the concept of a double dividend as well as potential interaction and distribution effects.

The survey of the legal literature concludes that many different aspects have to be taken into account in designing a carbon tax, both with respect to the kind of legal instruments to be used and the actual design of the tax.

This overview of economical and legal considerations may help in creating a sustainable, effective and efficient regulatory system for reducing emissions and gives insights on how to harmonise theoretical recommendations with day to day policy making requirements.

Empirical evidence on energy and carbon taxes in the EU

The minimum tax rates established by the energy taxation directive (Directive 2003/96/EC) are not sufficient in order to establish the price signal required to meet the EU's climate mitigation targets. This has already been noted in the Presidency Conclusions of the European Council of March 2008 with respect to the 2020 targets.

The analysis of energy and carbon taxation in the EU Member States shows that tax rates differ widely between Member States and energy sources. Carbon taxes have so far only been implemented in about one third of Member States. Moreover, effective tax rates do not comply with the requirement of a uniform tax rate for CO_2 that applies to all polluters.

Energy and carbon taxation can, however, make a significant contribution towards achieving emission reductions, particularly in the transport sector where greenhouse gas emissions continue to be on the rise in the EU. Evidence on the economic impacts of energy and carbon taxes furthermore shows that a double divided, i.e. the achievement of a reduction of emissions and positive macro-economic effects, can be achieved. With respect to the distributional impacts of carbon and energy taxes evidence is, however, mixed. While studies generally negate regressive effects of the taxation of propellants, energy and carbon taxes on heating fuels and electricity tend to be found regressive.

Since an EU-wide approach towards energy and carbon taxation seems out of reach Member States should consider carbon taxes at the national level in view of achieving the respective greenhouse gas reduction targets in sectors not covered by the EU ETS.

Legal implementation issues and barriers

The examination of introduction issues and barriers for a CO_2 tax at EU level indicates that there is legal uncertainty relating to the actual wording and application of the environmental and energy legal basis and if the ordinary legislative procedure employing qualified majority voting could be relied upon. If a CO_2 tax would need to be introduced by means of the special legislative procedure, unanimity voting would be required.

Additional barriers to introducing a CO_2 tax at EU level stem from national legal systems that influence the transposition of EU rules and co-determine the position of a Member State in the Council. Legislative processes in the EU prescribe consultations and that relevant national actors such as the national parliaments are duly informed and part of the discourse. It is therefore submitted that the decision making process even under the unanimity requirement is diverse. Stakeholders can seek out different fora at various levels of government to influence the adoption of a CO_2 tax.

The European Commission has made several unsuccessful attempts to legislate in the area of climate change regulation and may therefore be reluctant to invest time in a course of action that may not be embraced by the Member States[7].

In specific circumstances a group of Member States may be allowed to act upon a legislative proposal of the European Union and undertake measures that would otherwise fall within the ambit of the competences of the Union. The so-called 'enhanced cooperation' is a procedure where a minimum of nine EU countries are allowed to establish advanced integration or cooperation without the other EU countries being involved. Support for more environmental taxation may also come from an unexpected direction: the Brexit. Britain's exit leaves a considerable budget gap at Union level. New income bases need to be identified. The Commissioner for the EU Budget recently proposed the introduction of a plastic tax and a change of the EU ETS (Morgan 2018). Perhaps a carbon tax could be considered as well[8].

With respect to Member State level, the analysis of implementation issues and barriers for introducing a carbon tax focussed on "frontrunner" countries Sweden, Denmark and Finland. Important success determinants are related to the political economy of introducing taxes (negotiations with stakeholders, concessions, changes in proposed legislation, compromises etc.) which translate inter alia into competitiveness issues, and fairness / equity / distributional issues. For these the design of the carbon tax exemptions, and safeguards to prevent progressivity and the use of the tax proceeds are important. The examined countries employed different implementation strategies but underscored the importance of successful issue, timing, linking and fostering political support by safeguarding competitiveness and by addressing income distributions.

Model simulations of the introduction of carbon taxes in Austria

A macroeconomic assessment of distributive, macroeconomic, and CO_2 emission impacts of CO_2 taxes in Austria is provided. The simulations indicate significant reductions in CO_2 emissions already in the short-term as well as the mid-term, at least for industry & service sectors. Scenario simulations until 2030 show that mitigation targets in the mid-term future are not met. The distributional impacts depend on the indicator used and the tax recycling mechanisms considered. Without compensation measures regressive impacts are shown for tax burden in relation to income, but rather proportional impacts are found for changes in real income and real expenditure as well as for tax burden in relation to expenditure. Compensation measures in the form of lump sum payments for households and labour tax cuts for industry sectors affected can mitigate potential regressive tax impacts, competitiveness issues for industries, as well as negative macroeconomic

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7 In August 2017, the European Commission has adopted an Evaluation and Fitness Check Roadmap on the evaluation of the Energy Taxation Directive, which ought to be completed in 2018. According to the EC; "the evaluation will focus on identifying the possibilities for simplifying the legislative act, for reducing regulatory burdens and on identifying and calculating regulatory benefits and savings from the enforcement of the Directive" (https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2017-4224148_en).

8 In 2014 the High Level Group on Own Resources was established at EU level with the objective to examine how the revenue side of the EU budget can be made more simple, transparent, fair and democratically accountable. The recommendations of the final report included a CO_2 levy, proceeds from the European emission trade system, an electricity tax, a motor fuel levy (or excise duties on fossil fuels in general), and indirect taxation of imported goods produced in third countries with high emissions as viable candidates for EU own resources (http://ec.europa.eu/budget/mff/hlgor/library/reports-communication/hlgor-report_20170104.pdf).

impacts. Labour tax cuts also boost employment. Recycling CO_2 tax revenues both via reductions in labour costs for businesses and lump sum payments for households could be a reasonable trade-off between economic efficiency and social equity.

The modelling results thus provide many arguments that carefully designed CO_2 tax policies can play an important part in achieving GHG emission targets for non-ETS sectors in Austria with potentially positive distributive and macroeconomic impacts. The case for CO_2 taxes is further amplified if one would account for the positive benefits and co-benefits of mitigating CO_2 emissions.

B) Project details

6 Methods

In WP1, WP3 and WP5 of the CATs project, the methodological approach consisted of a review of the relevant literature on energy and carbon taxes as well as of the relevant legal documents. For the appraisal of factors facilitating or impeding the introduction of carbon taxes (WP3; see Weishaar 2018b), the literature review was complemented by expert interviews. Semi-structured interviews were conducted in the last quarter of 2017 with senior civil servants in the respective case study countries who have been selected on the basis of their experience and their knowledge on the carbon tax introduction. The interviews focused in particular on the political objectives and barriers for implementation of carbon taxes and generally lasted 1.5 to 2 hours.

In WP2 a database on energy and carbon taxation in the EU Member States was set up. Data were collected from different sources and processed, e.g. energy prices and tax rates were corrected for differences in purchasing power in order to allow for international comparisons and deflated in order to enable an assessment of their development over time. In addition, a simple fixed effects model was used in order to obtain an indication of energy price elasticities of car transport in the EU. The quantitative work in WP2 was complemented again by a literature review addressing the environmental, economic and distributional effects of carbon and energy taxation.

In WP4, the WIFO-DYNK[AUT] was used to simulate a broad range of CO_2 tax scenarios for Austria, a core task of the CATs project. In the next sections therefore the scenarios as well as the model are described.

6.1 Scenario development for the model simulations

The CATs scenarios aim at covering a reasonable range of tax rate variants and tax recycling schemes. The main focus of the scenarios is on energy-related CO_2 emissions generated in non-ETS sectors, i.e. mostly CO_2 emissions from energy consumption by private households, transport and service sectors. Three additional scenarios are provided: (1) a floor price for ETS sectors; (2) an increase in the vehicle registration tax (NoVA) for vehicle purchase; and (3) policy scenarios until 2030. These scenarios address further design options for carbon taxes in Austria and give an indication of the effects of the introduction of a carbon tax in the mid-term. Most scenarios are counterfactual comparisons in the short term (i.e. one representative year) comparing scenario results with the model's current base year 2012, labelled Base. For the mid-term scenario the scenario runs are compared to a Baseline simulation until 2030.

The CO_2 tax rate scenarios have two components: (1) an energy tax rate (which is converted into an implicit CO_2 tax rate based on the CO_2 content of the fuels) and (2) an explicit CO_2 tax rate. Current energy tax rates in Austria translate into implicit CO_2 tax rates ranging from 18 €/tCO_2 for coal to 195 €/tCO_2 for petrol in the year 2016[9]. Three tax rate scenarios are considered (see Table 5 for an overview): (1) *Low* – which assumes an explicit 60 €/tCO_2 tax rate on top of current energy tax rates, (2) *Med* – which assumes an explicit 120 €/tCO_2 tax rate on top of energy-equivalised energy tax rates (i.e. the energy tax rate in €/TJ is the same for all fuels), and (3) *High* – which assumes that an explicit and uniform 315 €/tCO_2 tax rate across all fuels replaces current energy tax rates. The explicit CO_2 tax rates in the scenarios *Low* and *Med* are similar to current CO_2 tax levels in Finland and Sweden, respectively. In relative terms the changes in the tax structure would imply price increases of ca. 10% to 21% for petrol, 12% to 33% for diesel, 15% to 43% for oil, 31% to 148% for gas and 82% to 408% for coal. Notably, price increases for gas and coal will be much lar-

[9] Calculations are based on EU Excise Duty Tables and can be downloaded here: http://cats.wifo.ac.at/wp/wp2.htm.

ger as these fuels currently face much lower energy tax rates and thus also much lower implicit CO_2 tax rates than petrol and diesel.

Table 5: CO_2 tax price scenarios for Austria

Scenario Name	Explicit CO_2 tax (€/tCO_2)	Energy Tax	Implicit CO_2 tax rates for fossil fuels (€/tCO_2)				
			Petrol	Diesel	Oil[1]	Gas	Coal
Base	0	Current	195	147	40	31	18
Low	60	Current	255	207	100	91	78
Med	120	Equivalised	315	315	160	178	153
High	315	None	315	315	315	315	315

[1] Refers to heating oil.

The tax recycling scenarios include compensation measures typically applied in the modelling literature, as well as in actual CO_2 tax schemes, such as the one in British Columbia, Canada (Murray and Rivers 2015). This includes, on the one hand, lump sum transfers to households, once with an equal per-capita transfer for all income groups (*RecH*) and once with an equal per-capita payment only for the three lowest income quintiles (*RecH[low]*). On the other hand, we consider a reduction of employers' social contributions for industry & service sectors affected by a CO_2 tax (*RecQ*), effectively lowering the cost of labour for these sectors. In many studies these two compensation schemes have been compared, i.e. recycling all CO_2 tax revenues either through lump sum transfers or through reductions in labour taxes. We focus on a reasonable compromise between these two alternatives, similar to the tax recycling scheme in British Columbia: CO_2 tax revenues from private households are transferred back via lump sum payments to households and CO_2 tax revenues from industry & service sectors are transferred back via uniform reductions of employers' social contributions to the sectors affected (labelled *RecQH* if all household receive lump sum payments and *RecQH[low]* if only the lowest three income groups are eligible for lump sum payments). The tax compensation scenarios are compared to a scenario were tax revenues are not recycled (*NoRec*), which implicitly assumes that the government uses the revenues for the general budget.

Table 6: CO_2 tax recycling/compensation scenarios for Austria

Scenario Name	Description
NoRec	No tax recycling
RecH	*All CO_2 tax revenues are recycled via equal per-capita lump sum payments to all households (H)*
RecH[low]	*All CO_2 tax revenues are recycled via equal per-capita lump sum payments to the three lowest households (H) income groups (QNT1 to QNT3)*
RecQ	*All CO_2 tax revenues are recycled via uniformly reduced employers' social contribution for industry & service sectors (Q) affected*
RecQH	*CO_2 tax revenues from households (H) are recycled as in RecH* *CO_2 tax revenues from industry & service sectors (Q) are recycled as in RecQ*
RecQH[low]	*CO_2 tax revenues from households (H) are recycled as in RecH [low]* *CO_2 tax revenues from industry & service sectors (Q) are recycled as in RecQ*

6.2 The DYNK[AUT] model in a nutshell

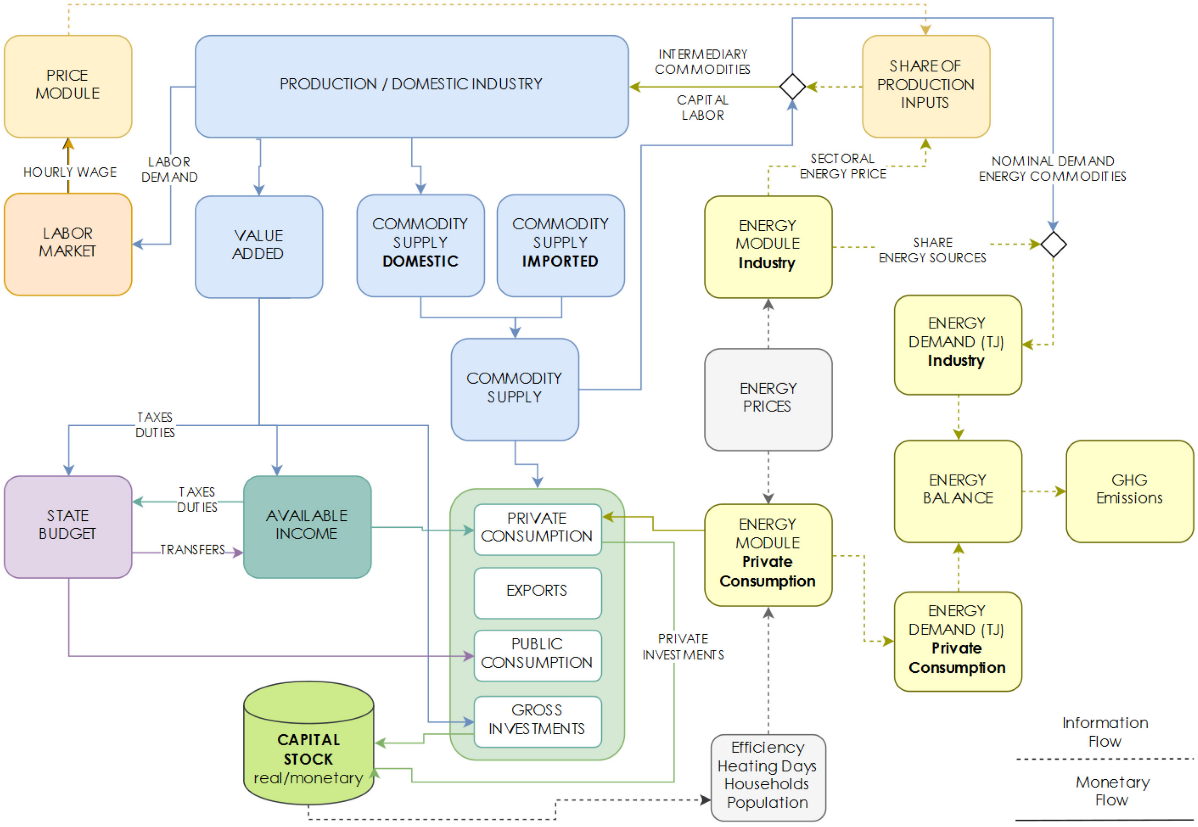
DYNK[AUT] is a macroeconomic Input-Output model with recursive dynamic elements based on an earlier DYNK version for the European Union (Sommer and Kratena 2017). The model draws on New-Keynesian (i.e. long-run full employment equilibrium and institutional rigidities) as well neo-classical economic theory (i.e. theory of firm, almost ideal demand system) and can be considered a hybrid form between CGE and static IO models. Core elements of DYNK[AUT] are already described in Sommer and Kratena (2017); therefore only the most important aspects are reiterated here, such as the integration of household income groups as well as the modelling of energy demand and the implementation of CO_2 taxes (see sections 6.3 and 6.4).

The input-output core of DYNK[AUT] describes the interlinkages between 62 sectors and final users (e.g. private consumption, gross fixed capital formation, public consumption) in Austria. Static input-output relationships are extended by the incorporation of econometrically estimated behavioural functions for industry & service sectors, private households, and the labour market.

The model includes $KLEM^mM^d$ trans-log production functions for each sector to estimate the share of production inputs needed for one unit of sector output (i.e. unit cost). Production inputs are differentiated between capital (K), labour (L), energy commodities (E), imported material commodities (M^m) and domestic material commodities (M^d). If input prices change, so will the shares of production inputs, depending on own-price as well as cross-price elasticities. This ultimately affects the unit cost of the sector output, which itself will have feedback effects on the rest of the economy. In the long-term factor biases will also affect input shares (e.g. trends in capital shares) and total factor productivity (TFP) will affect sectoral growth. An additional nested trans-log production function estimates the shares in energy sources as inputs for energy commodities (the E in $KLEM^mM^d$). Thereby five aggregate energy sources are differentiated: oil, gas, coal, electricity & heating, and renewables. Fuel prices are given exogenously. Commodity consumption of private households is modelled endogenously for 45 consumption categories (COICOP). The model differentiates between (i) investments in durable commodities such as vehicles, housing, and appliances, (ii) non-durable commodities via an almost ideal demand system (AIDS) and (iii) energy service demand (electricity, heating and private mobility). The labour market sub-module determines hourly wages for each sector, which depend on the distance to the natural unemployment rate, the working hours per employee, the previous year's consumer price index, the previous year's sectoral (or overall) labour productivity, and the previous year's hourly wage. DYNK[AUT] also accounts for household income and wealth, changes in gross fixed capital formation (depending on changes in net surpluses for each sector), as well as government expenditure and revenue. Finally, DYNK[AUT] includes two energy modules which capture energy demand by households and industries (see section 6.4). These modules reproduce the energy balances by Statistik Austria and provide energy-related CO_2 emissions for industry sectors and households. CO_2 emissions captured by DYNK represent ca. 72% of all GHG emissions (i.e. 57 vs. 80 Mt CO_2e) and 71% of all non-ETS emissions (i.e. 35 vs. 50 Mt CO_2e) in Austria in 2012.

An overview of these linkages can be seen in Figure 7. DYNK[AUT] has now been coded in GAMS with most econometric estimates conducted in EViews and some data adjustments and graphical output done in the statistic environment software R.

Figure 7: A schematic overview of DYNK[AUT].



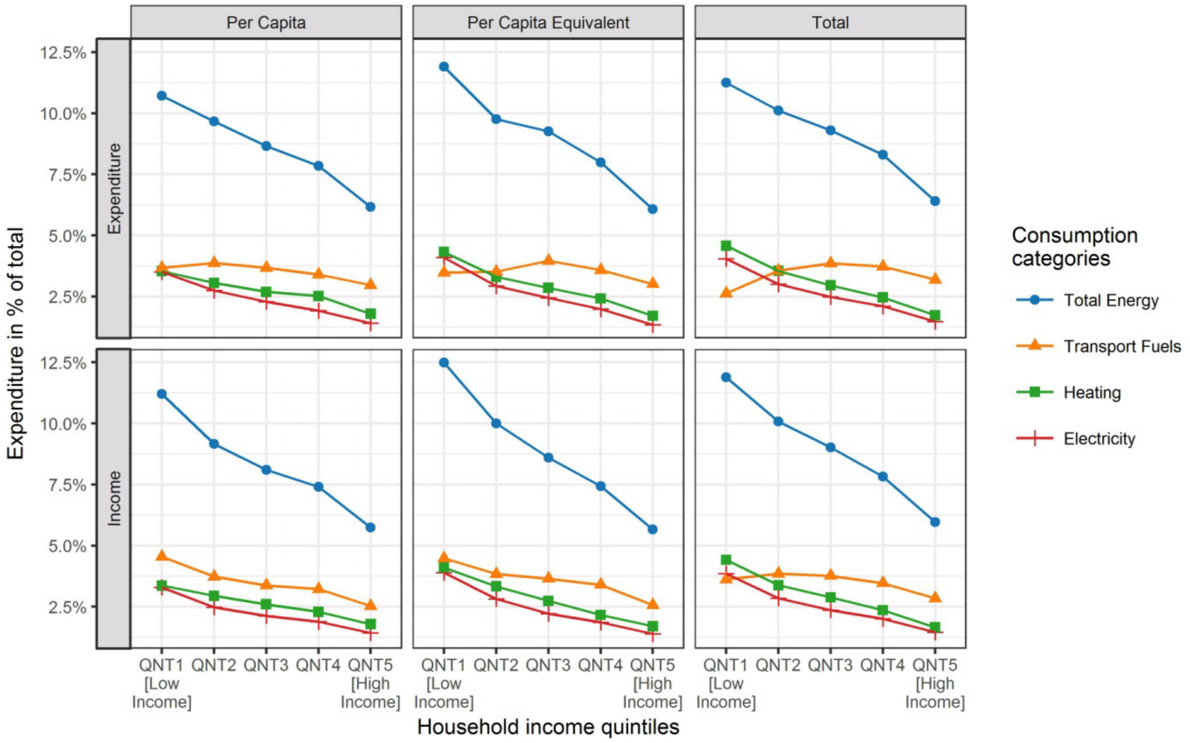
Major data sources for DYNK are Statistik Austria (make and use tables, government expenditure and revenues, employment, energy balances, consumption survey), the World Input-Output Database WIOD (to estimate production functions), EUROSTAT (household income and wealth, government debt, household consumption by quintiles), EU-SILC (household income by quintiles), and the IEA (energy prices).

6.3 Household income groups in DYNK[AUT]

Data on household income groups have been specifically prepared for this analysis and incorporated in DYNK[AUT]. Data from (i) the Austrian consumption survey 2009/2010 (Statistik Austria 2011) and (ii) EU-SILC (Statistics on Income and Living Conditions) 2010 is used to obtain household income quintiles (i.e. five income groups) for the modules on household income, consumption, and final energy demand. The classification of income groups is based on income after taxes and the EU equivalence scale. In the literature on analyzing the distributive impact of energy, environmental, or CO_2 taxes, one finds either net disposable income and / or total expenditure as basis for the classification of household groups. An income classification on expenditure basis was not possible, since the consumption survey had to be merged with EU-SILC, and the latter does not provide data on total expenditure. To ensure consistency with EUROSTAT values for household income a typical RAS procedure is applied to the EU-SILC data (i.e. biproportional scaling, see Miller and Blair 2009). Shares in stocks such as vehicles, housing, and appliances are approximated by the respective shares of investment for the COICOP categories purchase of vehicles (07.1), actual and imputed rents (04.1 and 04.2), and household appliances (05.3). Information on how energy-relevant data is differentiated by quintiles is provided in the next section.

Data from the Austrian consumption survey indicate that low-income households in Austria spend a larger share of their income or expenditure on total energy consumption, independently of the type of classification. This can be used as an initial proxy for the likely CO_2 tax burden. Figure 8 illustrates this for six different classifications, i.e. total, per capita and per capita equivalent values of net income and total expenditure, respectively. Expenditure on total energy, heating, and electricity is considerably regressive in all cases. With income as basis regressive impacts are slightly stronger for each level. Differences between measurement values, however, are often stronger than between income and expenditure. With respect to total energy expenditure per capita equivalent values provide the most regressive picture. Transport fuels show the strongest variations. Here, the tax burden is likely to be almost progressive for total expenditure and considerably regressive for per capita net income.

Figure 8: Household expenditure on energy in Austria 2009/2010 with respect to income or expenditure and three different measurement classifications.



Note: QNT1 is the lowest income quintile and QNT5 the highest. The classification used in the DYNK[AUT] model is income and per capita equivalent. Source: Austrian Consumption Survey 2009/2010.

6.4 Energy demand and CO_2 taxes in DYNK[AUT]

Private households

Data

The Austrian Energy Balances (Statistik Austria 2017a) and the Useful Energy Analysis (Statistik Austria 2017b) are used to derive physical energy demand (in TJ) at aggregate household level by energy use category (appliances, heating, mobility) and energy source (electricity, coal, heating oil, gas, biomass, heat pumps, district heating, wood, diesel and petrol). Data on efficiencies are taken from the ODYSSEE data base[10] (appliances) as well as from previous project cooperations[11] with the Energy Economics Group

[10] http://www.odyssee-mure.eu/project.html (accessed 2017-12-07).

(EEG, TU Vienna; INVERT/EE-Lab for data on heating) and the IVT (TU Graz; NEMO – Network Emission Model for mobility). Data on prices are taken from Statistik Austria (electricity and heating) as well as the fuel price monitor of the former Austrian Ministry of Science, Research and Economy. Data on stocks are, again, based on the ODYSSEE data base, data by the EEG (heating), the IVT (vehicles), and Statistik Austria (total vehicles, population, households)[12]. Data on population and households are provided by Statistik Austria and data on heating degree days are taken from the Austrian Central Institute for Meteorology and Geodynamics (ZAMG).

Energy demand patterns of the five household income groups have been differentiated approximately with data from the Austrian consumption survey (Statistik Austria 2011). Shares in energy demand for appliances are based on consumption shares for the COICOP category housing electricity (04.5.1). For heating they are based on all sub-groups of category 04.5 (Housing – electricity, gas and other fuels), which further includes gas (04.5.2), liquid fuels (04.5.3), solid fuels (04.5.4), further differentiated into wood (04.5.4.1) and coal (04.5.4.2), district heating (04.5.5), and other sources (04.5.6). The share of physical vehicles is derived from data on vehicle ownership from the consumption survey. Although this information does not provide data on propulsion technologies, different shares in diesel and petrol can be approximated based on data on petrol and diesel consumption (07.2.2.1 and 07.2.2.2). Kilometres driven – another important parameter for calculating mobility service energy demand – is differentiated for each quintile according to their share in the COICOP category 07.2.2, i.e. fuels and lubricants for personal transport equipment.

Service energy demand

Private energy consumption is modelled as demand for service energy, i.e. energy flows divided by the efficiency of the energy service provided. By linking the efficiency of the durable stock (vehicles, appliances, housing) to energy demand possible rebound effects due to efficiency improvements can be accounted for (Binswanger 2001; Khazzoom 1980; Sorrell 2009). Service energy demand in DYNK[AUT] is simulated for (i) private mobility (i.e. for vehicles with diesel or petrol propulsion technologies), (ii) appliances (i.e. electricity), and (iii) heating (with an exogenously determined fuel mix). Details on the behavioural equations and econometric estimations are provided in the Appendix of Kirchner et al. (2018).

Service energy demand for diesel or petrol vehicles is affected by changes in the service price (i.e. diesel or petrol prices divided by the efficiency of the diesel or petrol vehicle stock) and changes in the number of vehicles per person. The service price elasticities (γ) are -0.25 for petrol and -0.12 for diesel. The stock elasticities (ξ) are -0.53 for petrol and -0.44 for diesel[13]. Demand for electric vehicles is considered in the model, but currently depends solely on exogenous assumptions. CO_2 taxes will thus affect service energy demand for private mobility directly through changes in fuel prices and indirectly through macroeconomic feedbacks on investments in the vehicle stock. Consumption for public transport is also accounted for in the model, albeit currently only in monetary terms, and depends, inter alia, on a cross-price elasticity for private mobility (i.e. 0.4 taken from Holmgren 2007).

Service energy demand for appliances per household follows a similar pattern as private mobility. Electricity is considered the only energy source used to operate appliances. Changes in service energy demand for appliances depend on changes in the service price for appliances (i.e. the electricity price divided by the efficiency of the appliance stock) and changes in the real stock of appliances. The service price elasticity (γ)

[11] In this model version data sets based on the joint project "Monitoring Mechanism 2017“ are implemented. The project is funded by The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management and operated by the Environment Agency Austria (the project report is forthcoming in 2018).

[12] The nominal stock development is calibrated to correlate with the consumption expenditure of private households. The expenditure data was taken from the Input-Output-Tables on COICOP Consumption (Statistik Austria).

[13] The elasticity for an additional vehicle per capita should be negative, as one may assume that the kilometres driven will decrease for each car.

is -0.25 and the real stock elasticity (ξ) is 0.49. CO_2 taxes will thus affect service energy demand for household appliances only indirectly, i.e. either through changes in the electricity price or through changes in the real stock of appliances.

Household service energy demand for heating depends on an aggregate service price for heating[14] and the number of heating degree days. Households are found to react very inelastically to changes in the service price, i.e. the service price elasticity is -0.07, and more elastic to changes in heating degree days with an elasticity of 0.48. As the aggregate prices are not the same for the household income groups considered (due to respective heating fuel shares), households will react differently since they will face different price changes. CO_2 taxes will affect service energy demand for heating only directly (through the aggregate heating price) and not indirectly. In the current version of DYNK[AUT] heating efficiencies are kept constant and investments in heating technologies are not simulated endogenously.

The available data did not allow for quintile-differentiated estimations regarding elasticities or to extract differences in the efficiency of stocks between income groups (e.g. vehicles, appliances). Wadud et al. (2009), however, show that both elasticities and efficiencies may indeed differ between household income groups. Therefore, some sensitivity analyses for quintile-differentiated elasticities are provided. Differences in efficiencies are not a major concern in the current simulations, as only short-term impacts are considered and the impact of investments on stock efficiency is not modelled.

Integrating service energy demand into the macroeconomic model and CO_2 pricing

Physical energy demand (in TJ) is obtained by dividing service energy by efficiency. With respect to heating exogenously determined fuel shares determine the energy demand for different fuel types. As noted above, energy demand of appliances is restricted to electricity. For private mobility diesel, petrol and (exogenously determined) electricity[15] are differentiated. Given the data on final energy consumption CO_2 emissions can be calculated by applying CO_2 emission factors for each fuel category (UBA 2017b).

In order to integrate data on energy demand into the macroeconomic model, physical fuel demand (in TJ) is multiplied by the respective fuel prices (in €/TJ) to get nominal consumption values in million €. To allow for a consistent integration the COICOP consumption categories operation of personal transport equipment (07.2) and housing – electricity, gas and other fuels (04.5) are further split into an energy part (i.e. the nominal consumption values from the energy module) and a non-energy part (where changes are calculated in the consumption module). By splitting an overestimation of changes in energy fuel prices in these consumption categories is avoided. A CO_2 tax thus directly affects private households by increasing the price for fuels and thus the respective service prices in service energy demand equations. CO_2 tax revenues are calculated in the energy module and are a direct input to the taxes less subsidies variable, which in turn affects government revenues. Because of this consistent integration DYNK[AUT] can account for macroeconomic feedbacks due to changes in private consumption (e.g. sector outputs, factor incomes, government revenues) and how this in turn affects stocks (e.g. vehicles purchased) and thus service energy demand. See Figure 9 for a schematic overview on how energy demand and CO_2 pricing is integrated into the modelling of private consumption in DYNK[AUT].

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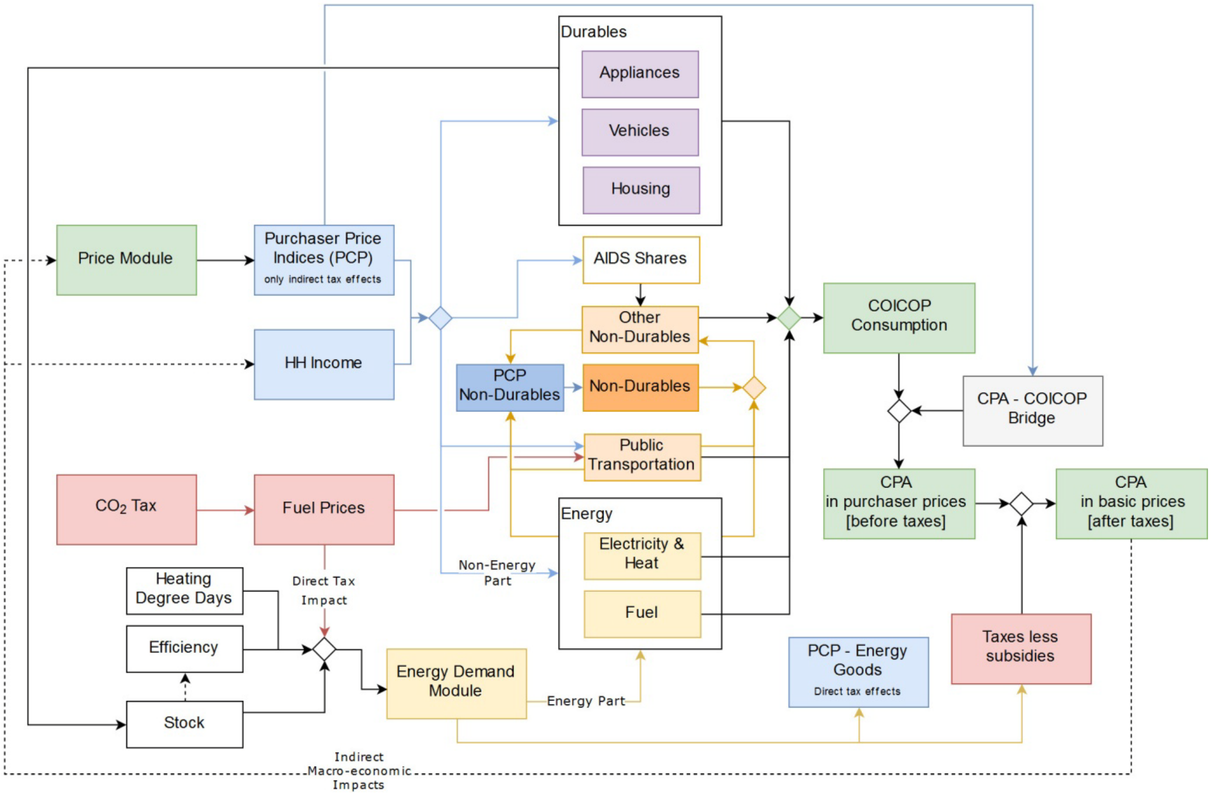
14 The aggregate price for heating is weighted according to the shares of heating fuels and their respective prices for each household income group.

15 Data and trend on electric vehicles is taken from the Monitoring Mechanism project.

Figure 9: Modelling consumption, energy demand and CO_2 taxes for private households in DYNK[AUT].



Industry sectors

The energy demand by industry sectors is based on data on final energy consumption (Statistik Austria 2017a). The 62 NACE sectors are aggregated to the 18 sectors differentiated in the Austrian Energy Balances. From real energy input in basic prices (i.e. the E in $KLEM^mM^d$ in basic prices and divided by its price index; see also section 6.1) and the respective energy intensity (TJ/m€) for each sector aggregate energy demand in TJ is derived. Physical energy demand (in TJ) of the industry sectors differentiated by fuel is obtained by multiplying total energy demand by the (endogenously modelled) real shares of fuel inputs for sector energy input (E), i.e. coal, oil, gas, electricity & heating, and renewables. Based on official CO_2 emission factors (UBA 2017b) fuel energy demand is converted to CO_2 emissions from which CO_2 tax revenues can be calculated (if CO_2 taxes are applied).

In the model the input factor energy (E) is, due to the aggregate level of the supply and use tables, only an approximation of real physical energy input[16]. The price index for E is nonetheless derived from exogenous fuel prices and the respective fuel shares obtained in the model. In order to avoid overestimating the price effect of CO_2 taxes on the aggregate energy input price[17] the impact is modelled as follows: First, fuel prices (in purchaser prices) are adjusted exogenously according to the impact of the CO_2 tax rates on fuel prices. This will affect the fuel shares of the industries. Second, based on the CO_2 emissions derived the CO_2 tax revenue from industries is calculated and transferred to the taxes less subsidies variable. Third, the aggregate energy price (in purchaser prices) is calculated based on changes in the taxes less subsidies rates. This ensures that the price effect accounts for the non-energy commodities that are also part of E. Thus the

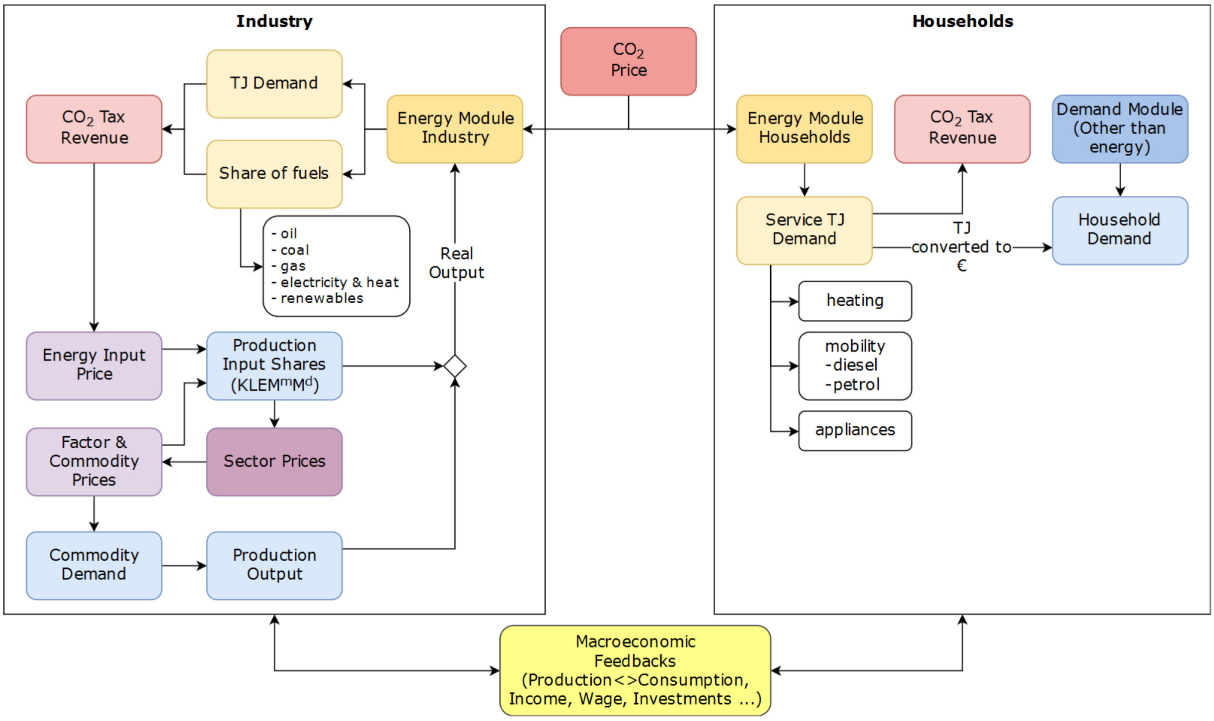
[16] It is the sum of the CPA (Classification of Product by Activity) categories mining and quarrying (05), manufacture of wood (16), manufacture of coke & refined petroleum products (19), and electricity, gas, steam and air conditioning supply (35).

[17] Since E consists of energy and non-energy commodities, a 1:1 transmission of CO_2 prices would lead to higher price effects as (the much smaller) changes in prices for non-energy commodities are not taken into account.

impact that CO_2 prices have on the aggregate energy price and thus on the aggregate energy input (E) of industry sectors can be endogenously accounted for.

Impacts on the competitiveness of domestic industries are captured by (i) the impact on the share of imported material goods (M^m) as an input for sector production and (ii) through the incorporation of Armington elasticities for private consumption. Exports are exogenously given. However, since exports are provided in nominal values, this implicitly assumes a unit elastic demand on real exports (i.e. if domestic prices increase by 1%, real exports will decrease by 1%).

Figure 10: CO_2 price impact chains in DYNK[AUT].



Hence, although energy demand is not modelled first-hand for industry sectors (i.e. only as a derivative of real energy input), the impacts of CO_2 taxes can be simulated endogenously through their impact on taxes less subsidies and thus commodity prices in purchaser prices (and finally the aggregate energy price index). Figure 10 illustrates these CO_2 impact chains (also for private households) and indicates that DYNK[AUT] accounts for all other macroeconomic feedbacks caused by CO_2 taxes (e.g. higher production costs increase sector prices which affect final uses which affect income).

7 Work and time schedule

Table 7. CATs Work and Time Schedule

Work package	Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WP1	**Theoretical background**																					
	Carbon Taxes in Economic Literature						M1.1							D1								
	Legal Perspective on Carbon Taxes						M1.2															
	Criteria for the Systematic Assessment of Carbon Taxes in the EU										D2											
WP2	**Quantitative Assessment of Carbon Taxes in the EU**																					
	Review of Carbon Taxes in EU Member States									M2.1				D3								
	Impact Analysis of Carbon Taxes in EU countries										M2.2			D4								
WP3	**Implementation Issues and Barriers**																					
	Implementation Issues and Barriers at EU level																M3.1	D5				
	Implementation Issues and Barriers at country level																M3.2					
WP4	**Model-based Analysis of Carbon Taxes for Austria**																					
	Input data allocation and preparation																				D6	
	Model development: Expansion of tax relevant elements																		M4.1		D6	
	Scenario implementation, result interpretation and quality management																		M4.2	M4.3	D6	
WP5	**Discussion and Policy Recommendations**																					
	Policy reccommendations at EU level																M5.1					D7
	Policy reccommendations for Austria																	M5.2				D7
WP6	**Project management and dissemination**																					
	Project management and coordination	M6.1																				
	Project website		D8																			
	Expert, stakeholder and dissmenination workshops								M6.2					M6.3							M6.4	
	Reporting												D9									D10

8 Publications and dissemination activities

Publications	
Working papers	
	Kettner C. and D. Kletzan-Slamanig (2018a), Carbon taxes from an economic perspective, WIFO Working Paper No. 554, http://www.wifo.ac.at/wwa/pubid/60971.
	Burgers I. and S.E. Weishaar (2018), Designing Carbon taxes is not an easy task: legal perspectives, WIFO Working Paper No. 559, http://www.wifo.ac.at/wwa/pubid/60978.
	Kettner C. and D. Kletzan-Slamanig (2018b), Energy and Carbon Taxes in the EU: Empirical Evidence with Focus on the Transport Sector, WIFO Working Paper No. 555, http://www.wifo.ac.at/wwa/pubid/60972.
	Kirchner M., M. Sommer, C. Kettner, D. Kletzan-Slamanig, K. Köberl, K. Kratena (2018), CO_2 tax scenarios for Austria – Impacts on household income groups, CO_2 emissions, and the economy, WIFO Working Paper No. 558, http://www.wifo.ac.at/wwa/pubid/60975.
	Weishaar S.E. (2018a), Carbon taxes at EU level – Introduction issues and barriers, WIFO Working Paper No. 556, http://www.wifo.ac.at/wwa/pubid/60973.
	Weishaar S.E. (2018b), Introducing carbon taxes at Member State level – issues and barriers, WIFO Working Paper No. 557, http://www.wifo.ac.at/wwa/pubid/60974.
	Kettner C., M. Kirchner, D. Kletzan-Slamanig, M. Sommer, K. Kratena, S.E. Weishaar and I. Burgers (2018), Options and considerations for a Carbon tax in Austria – Policy Brief.
Book chapters	
	Kettner C. and D. Kletzan-Slamanig (2017), Carbon taxation in EU Member States: evidence from the transport sector, in: Weishaar S.E. et al. (eds.), The Green Market Transition – Carbon Taxes, Energy Subsidies and Smart Instrument Mixes, Critical Issues in Environmental Taxation Vol. 19, Edward Elgar, 17–29.
	Kettner C. and D. Kletzan-Slamanig (forthcoming), Vehicle Taxation in EU Member States, in: Hymel, M. et al. (eds.), Critical Issues in Environmental Taxation Vol. 20, Edward Elgar.
	Weishaar S.E. (forthcoming), Introducing carbon taxes – issues and barriers in: Hymel, M. et al. (eds.), Critical Issues in Environmental Taxation Vol. 20, Edward Elgar.
Conference proceedings	
	Kirchner M., M. Sommer and K. Kratena (2017), Assessing the distributive, economic, and environmental impacts of CO_2 taxes in Austria. In: 18^{th} Global Conference on Environmental Taxation, Sep 27-29, 2017, Tucson, Arizona, USA.
	Kirchner M., M. Sommer and K. Kratena (2017), Distributional impacts of a CO_2 fuel tax on different household income quintiles in Austria. In: 2017 International Energy Workshop, July 12-14, 2017, College Park, Maryland, USA.
	Kirchner M., M. Sommer and K. Kratena (2017), Makroökonomische Simulation von CO_2 Steuern für Österreich, In: 18th Austrian Climate Day, May 22-24, 2017, Wien.
	Sommer, M., Kirchner, M., Kratena, K. (2017), The impacts of a progressive CO_2 tax on socio-economic and environmental indicators in Austria. In: 10. Internationale Energiewirtschaftstagung "Klimaziele 2050: Chance für einen Paradigmenwechsel?", February 15-17, 2017, Vienna, Austria, available at: http://eeg.tuwien.ac.at/eeg.tuwien.ac.at_pages/events/iewt/iewt2017/html//files/fullpapers/113_Sommer_fullpaper_2017-

	02-03_16-04.pdf
Project workshops	
	CATs expert workshop, 1 December 2016, WIFO, Vienna
	CATs stakeholder workshop, 3 April 2017, WIFO, Vienna
	CATs dissemination workshop, 23 October 2017, WIFO, Vienna
Project webpage	
	http://cats.wifo.ac.at/
Dissemination at national and international conferences	
CATs Special Session at the 17th Global Conference on Environmental Taxation (GCET17), Groningen, The Netherlands, 22-23 September 2016	
	Classification of Carbon Taxes from Economic and Legal Perspectives, Presentation by Claudia Kettner, Daniela Kletzan-Slamanig and Stefan E. Weishaar
	Empirical Evidence on Energy and Carbon Taxes in the EU, Presentation by Claudia Kettner and Daniela Kletzan-Slamanig
	The socio-economic and environmental impact of a progressive CO_2 tax, Presentation by Mark Sommer and Kurt Kratena
	Implementation issues and barriers, Presentation by Stefan E. Weishaar
10. Internationale Energiewirtschaftstagung (IEWT2017), Vienna, 15-17 February 2017	
	Umweltsteuern aus ökonomischer und juristischer Perspektive, Presentation by Claudia Kettner, Daniela Kletzan-Slamanig and Stefan E. Weishaar
	Energie und CO_2-Steuern in der EU: Eine empirische Analyse, Presentation by Claudia Kettner and Daniela Kletzan-Slamanig
	The impacts of a progressive CO_2 tax on socio-economic and environmental indicators in Austria, Presentation by Mathias Kirchner, Mark Sommer and Kurt Kratena
18. Österreichischer Klimatag, Vienna, 22-24 May 2017	
	Carbon Taxes in Austria: Implementation Issues and Impacts – Projektüberblick und erste Ergebnisse, Project Presentation
	Makroökonomische Simulation von CO_2-Steuern für Österreich, Poster presentation by Mathias Kirchner, Mark Sommer and Kurt Kratena
12th Conference of the European Society for Ecological Conference, Budapest, 20-23 June 2017	
	Energy and Carbon Taxes: Empirical Evidence from EU Member States, Presentation by Claudia Kettner and Daniela Kletzan-Slamanig
2017 International Energy Workshop, College Park, Maryland, 12-14 July 2017	
	Distributional impacts of a CO_2 fuel tax on different household income quintiles in Austria, Presentation by Mathias Kirchner, Mark Sommer and Kurt Kratena

18th Global Conference on Environmental Taxation, Tucson, 27-29 September 2017	
	Vehicle Taxation in EU Member States, Presentation by Claudia Kettner and Daniela Kletzan-Slamanig
	Assessing the distributive, economic, and environmental impacts of CO_2 taxes in Austria, Presentation by Mathias Kirchner, Mark Sommer and Kurt Kratena
	Implementation issues and barriers, Presentation by Stefan E. Weishaar
41st IAEE International Conference, Groningen, 10-13 June 2018	
	Social, environmental, and macroeconomic impacts of introducing a CO_2 tax for non-ETS sectors in Austria, Presentation by Mathias Kirchner, Mark Sommer and Kurt Kratena (*accepted*)
	Energy and CO_2 Taxation in EU Member States: An Empirical Assessment, Presentation by Claudia Kettner and Daniela Kletzan-Slamanig (*accepted*)

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