ANALYSIS OF THE EFFECTS OF INTRODUCTION OF AN ADDITIONAL CARBON TAX ON THE SLOVENIAN ECONOMY CONSIDERING DIFFERENT FORMS OF RECYCLING[1]

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ABSTRACT: *This paper outlines some of the environmental and economic implications of an additional CO2 tax of EUR 15/tCO2 in Slovenia in the period 2012-2030 in order to determine whether it yield a double dividend. Authors analyze (using E3ME model) different forms of revenue recycling by reducing the social security contributions of either the employers or the employees or by reducing the public deficit, in order to identify the optimal fiscal instrument for improving the environmental and economic welfare (double dividend). In this policy orientated paper authors argue that a reduction of employee social security contributions has more favourable effect than a reduction in employers' social security contributions.*

Keywords: *green tax, environmental tax reform, double dividend, carbon tax, recycling, E3ME model*

JEL Classification: E17, H23, Q50

1. INTRODUCTION – GREEN TAXES AND ENVIRONMENTAL TAX REFORM (ETR)

The idea of a green tax dates back to Arthur C. Pigou (1920); hence, green tax is also referred to as a Pigouvian tax. It is based upon a fundamental principle that the polluters should pay a tax in the amount equal to the damages resulting from their impact on the environment (i.e. negative externalities). The costs are namely not incurred only by the company whose emissions pollute the environment; rather, the costs are sustained by the entire society. It is then the task of the government to impose the green tax to internalize the pollution costs as much as possible. In such case, the polluting industrial activity is reduced to a socially desirable level (Turner, 1994).

Introduction of the green tax represents also an important development in the public finance reform since it involves also a reconsideration of the present tax system, aimed

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predominantly at taxing labour and capital. The environmental tax reform (ETR) argues in favour of green taxes in a revenue-neutral fashion to reduce other distortionary levies. Instead of taxing "good things" like labour, income and capital, the government should start taxing "bad things" like pollution, use of natural resources etc. (Bousqet, 2000; Patuelli et al., 2005). The main goal of an environmental tax reform is therefore an improvement in both environmental (first dividend) and economical aspects (second dividend). Environmental dividend involves reduction in emissions and economic dividend stems from lower costs, improved competitiveness, and higher employment. Therefore, the term "double dividend" is increasingly used to describe the environmental tax reform (Glomm et al., 2008; Ekins, 2009).

Experience from European countries has shown, that effects of a comprehensive ETR have been positive in most cases (Sweden, Denmark, Netherlands, UK, Finland, Norway, Germany). Therefore, the environmental tax reforms (ETR) have become a relevant instrument in the economic policies of the developed world in recent years.

Our primary goal is to determine the effect of an additional carbon tax (EUR 15 per ton of CO2 i.e. EUR 55 per ton of carbon) in the period 2012–2030 on the Slovenian economy, in order to determine whether an additional carbon tax would indeed yield a double dividend. We shall examine the possibilities of different recycling options either through reduction of budget deficit or reduction of employer/employee social security contributions, in the form of different scenarios (using E3ME model) in order to identify the optimal fiscal instrument for improving the environmental (first dividend) and economic welfare (second dividend).

The article is structured as follows. In section two the concept of double dividend is introduced. In section three we present the E3ME model and the impact of green taxes within the model. Results regarding the environmental and economic implications of an environmental tax reform are presented in section four. Finally, the last section deals with the conclusions and policy implications derived from the contents of the paper.

2. A DOUBLE DIVIDEND

The two central dilemmas regarding the green tax have to do with regressiveness and loss of competitiveness. Many authors have argued that incidence of green taxes falls largely on the low-income class (Roed, 2006; West, Williams, 2004; Labandeira, Labeaga, 1999; Tiezzi, 2001; Clinch et al., 2006). Negative effect on cost competitiveness of the economy will be greater when (1) elasticity of demand for a certain good is relatively high; (2) there is strong competition in the industry; (3) a particular sector is highly energy-intensive; (4) ecotax is introduced in a small number of countries; and (5) there is no option to substitute the polluting activity with an environmentally friendlier technology (Kosonen, Nicodème, 2009; Clinch et al., 2006; Patuelli et al., 2005; Baron, 1997; Envoldsen et al., 2009). Thus, if the government introduces ETR without recycling the tax revenue within the system, an economic downturn would likely occur.

Recycling in this case refers to targeted use of green tax revenue, especially for reducing the taxation of labour and social security contributions. Besides a reduction of social security contributions or personal income taxes, other forms of financial recycling are also possible by transfers to households/industries for greater energy efficiency[4] or interventions in corporate income taxes and value added tax. In case of total recycling, the total tax burden remains unchanged (fiscal neutrality) (Speck, Jilkova, 2009; Ludewig et al., 2010; OECD, 2007; Hoerner, Bosquet, 2001; Clinch et al., 2006; Patuelli et al., 2005; Hansen, Holger, 2000).

We expect an environmental tax reform to lead to an improvement from environmental aspects, e.g. owing to lower carbon dioxide emissions, as well as to improve the cost competitiveness of the economy as a result of lower labour costs and higher technological efficiency of businesses. Hence, economic growth and employment will actually increase (Benoit, 2000; Hoerner et al., 2001; Patuelli et al., 2005; Tuladhar, Wilcoxen, 1999). Not surprisingly, the European countries with the highest tax on labour were the first to implement the environmental tax reform and look for double dividend (Finland, Sweden, Denmark, Netherlands, Germany, and Norway).

The first (environmental) dividend of the double dividend hypothesis is widely accepted. Johansson (2000) argues that in Sweden the CO2 emissions were 15% lower than they would have been in the absence of the green taxes. Berkhout and Linderhof (2001) point out that in the Netherlands, the price of electricity and fuel for domestic use rose dramatically as a result of the green tax and ex-post studies show that consumers now use 15% less electricity and 5–10% less fuel. Baron (1997) pointed out that in Denmark recycling of tax revenues through investment in energy efficiency has led to about 4.7% reduction in CO2 emissions. Labandeira et al. (2004) show that in Spain a tax on CO2 emissions has resulted in environmental improvement. Ludewig et al. (2010) demonstrate that use of all motor fuels in Germany was decreasing in the period from 1995 to 2006 by an average rate of 0.3 percent per year. At the same time, use of public transport was rising. Based on an analysis of 139 simulation models, Bosquet (2000) found that a considerable drop in carbon dioxide emissions is among the expected effects of a green tax reform in the short to medium run.

The second (economic) dividend depends mainly on the structure of the economy (e.g. labour market, pre-existing tax structure), time lag and explicit model assumptions. Since the present tax system creates significant disincentives to work and hire, virtually any environmental policy can compound these existing distortions (Carraro et al., 1996; Morgenstern, 1995; Tuladhar, Wilcoxen, 1999; Schöb, 2003). Ludewig et al. (2010) find that 250,000 new jobs were created in Germany in this way. Experience from Denmark (Hansen, Holger, 2000) and Spain (Manresa, Ferran 2005) is similar. However, many authors argue that the "double dividend" theory oversimplifies a number of points and that certain conditions have to be fulfilled for a double dividend.

4 Alternative recycling method are: (1) improvements in the energy efficiency of the building stock, (2) grants for improving energy efficiency in buildings, (3) recycling into local environmental projects to foster community acceptance of ETR, (4) recycling to public transport, (5) subsidising renewable energy and combined heat and power production, (6) subsidising 'cleaner' technology in industry, (7) subsidising R&D (Clinch et al., 2006).

Firstly, ETR is expected to improve the quality of the environment and to reduce the distortions of existing taxes. This view has been questioned in several papers (Goulder, 1995; Benoit, 2000; De Mooij, 1999; Li, Ren, 2012). The basic point is that the double dividend hypothesis ignores the interaction between environmental taxes and pre-existing tax structure. If the initial tax system is suboptimal then ETR can generate a significant double dividend. Similarly Fraser and Waschik (2013) using a CGE model to empirically examine the double dividend hypothesis provide support for the existence of a strong double dividend when revenue is recycled through reductions especially in consumption taxes.

Secondly, the outcome depends very much on labour market conditions in the country (Clinch et al., 2006; Carraro et al., 1996; Schöb, 2003; Koskela and Schob, 1999; Holmlund and Kolm, 2000; Albrecht, 2006; Ciaschini et al., 2012). If there are labour rigidities (as in some countries of Europe), then there will be an employment dividend resulting from the recycled carbon tax revenue. But in the long run, such rigidities become less relevant.

Thirdly, green taxes represent, as a rule, a relatively small share of overall tax revenue of any given country[5]. Hence, a dramatic increase would be required to offset the lower personal income tax revenue. Thus, if green taxes are set high enough to achieve meaningful reductions in emissions, they may cause significant distortions in the tax system. Policy makers will then be forced to trade off cleaner environment against other policy targets (Coxhead, 2000).

Fourthly, Carraro et al (1996) find that the unions' negotiating strength affects the possibility of gains in employment. In the short run the employment may increase due to lower taxes; however, in the long run, net wages completely absorb the tax change, thus bringing employment back to its baseline value. Many authors argue that the effects of a green tax reform are doubtful in the long run.

Nevertheless, while the second dividend may be in doubt, the first dividend remains a powerful argument for the introduction of ETR. Obviously, a strong double dividend occurs under rather "constrained" circumstances. We do not go more into the details since the rise and fall of the double dividend hypothesis and conditions for it has been discussed at length elsewhere (Bovenberg and Goulder 1997; Parry and Oates, 1998; Goulder, 1995; Bosquet, 2000; Fraser and Waschik, 2013). All authors agree that validity of the double-dividend hypothesis cannot be settled as a general matter. In other words, each reform must be evaluated on its own merits by keeping in mind the characteristics of respective countries and the explicit model assumptions.

5 In most EU countries, revenue from green taxes is between 2% and 3% of GDP. There are only four EU countries where such share in lower than 2% (1.9% in Slovakia, 1.9% in Lithuania, 1.6% in Spain, 1.8% in France), and only three countries where this share exceeds 3.5% of GDP (4% in Denmark, 4% in the Netherlands, 3.6% in Slovenia). Green taxes represent the largest share of total tax revenue in Bulgaria (10.7%), the Netherlands (10.3%), and Slovenia (9.6%). The lowest contribution of green taxes to overall tax revenue was observed in France (4.2%), Belgium (4.7%), and Spain (5.2%). Slovenia is considerably above the EU27 average (6.2%) with its 9.6-percent share of green tax revenue in overall tax revenue (European Commission, 2012).

3. THE MODEL

There are two different methodological approaches to modelling the relation between the environment and the rest of the economy. The first approach is based on highly precise modelling of a certain sector; as a rule, however, such models do not yield the best explanations as to the interaction between the sector at hand and the economy as a whole. The other approach is based on structural macroeconomic models. A key advantage of these models, each of them is based on certain underlying assumptions, is that they allow a fairly accurate prediction of macroeconomic results in case of different scenarios. These models provide a better understanding of the economic consequences of environmental measures as they allow studying the economic processes that lead to final results. The downside of these models is that each sector is modelled at the aggregated level[6].

Our analysis is based on the latter approach. We employed the E3ME[7] model, widely used among European researchers in recent years. This is a dynamic simulation econometric model intended for analysis of the effects of E3 policies (economy, energy, environment), especially those pertaining to environmental taxes and regulation. The model allows examining the short-term (annual) and medium-term economic effects, as well as long-term effects of E3 policies for a period of 20 years. Hence, E3ME combines the features of short-term and medium-term sector models estimated using econometric methods with the features of computational general equilibrium models. The E3ME model includes 42 product/industry sectors (OECD classification), with energy sector further disaggregated to include energy-environment interaction and 16 service sectors. It is intended for analysis of macroeconomic effects (with emphasis on environmental components) of environmental economic policies, especially from the aspect of environmental taxation and regulation, for 33 European countries (EU27, Norway, Switzerland, Iceland, Croatia, Turkey, and Macedonia) as a whole. It also allows analysis of environmental effects in each country[8].

The structure of E3ME is based on the System of National Accounts (ESA 95), with additional links to demand for energy and environmental emissions. The model includes a total of 33 sets of econometrically estimated equations which also include components of the GDP (consumption, investment, international trade), prices, demand for energy, and demand for raw materials. Each set of equations is broken down by countries and by sectors. E3ME also allows analyzing the effects of particular scenarios as measured by numerous economic, energy, and environmental indicators. The model is based on the data for the period from 1970 to 2010 and annual projections until the year 2050. The main sources of data include Eurostat, AMECO DC ECFIN database, and IEA; this data set is further complemented by OECD STAN and other databases. Any gaps in the data are estimated using adjusted software algorithms. For a detailed description of the E3ME model, see E3ME Manual (2012).

6 For a detailed description of methodological approaches in modelling the relations between the environment and the economy, see Ščasný et al. (2009).

7 The model was developed and is maintained by the company Cambridge Econometrics.

8 See E3ME Manual (2012) for more detailed description.

3.1. EFFECTS OF ECOLOGICAL TAXATION (GREEN TAX) IN THE E3ME MODEL

One of the purposes of the E3ME model is to provide consistent and coherent analysis of fiscal policy and its relation to greenhouse gas emissions. The E3ME model allows examining how carbon and energy taxes affect the reduction of environmental emissions, as well as how other taxation and economic policies affect reduction of emissions.

The effect of a taxing carbon dioxide emissions (and energy consumption) in the E3ME model on prices and wages is based on two key assumptions. The first assumption is that the effect of tax is transmitted through the price of fuel and any use of subsequent tax revenue to reduce other taxes. Other effects are not modelled. The second assumption is that import of fuels and domestic production are taxed in proportion to the CO2 emission rate and energy value of the fuel, while fuel exports are not taxed. It is assumed that this tax is paid by the fuel producers and importers. This tax is then levied on the final users through higher fuel prices. Another assumption is that the industry will transmit these additional fuel costs on its buyers in the form of higher prices of commodities (goods and services). An increase in the final price is therefore a result of direct and indirect effect of tax on a particular good or service. If tax revenue is used to reduce the rates of taxes levied on the employers, this will result in a decrease of labour costs and, in turn, a drop in production costs. These changes, too, will then be transmitted forward within the E3ME model (E3ME Manual, 2012).

Net effect of tax on prices of products and imports will be transmitted to consumer prices, resulting in a change in the consumption of goods and services. Such change will depend on individual ecotax and the price elasticity of the affected commodities. Higher prices of goods and services will lead to demands for higher wages. Econometric studies have confirmed that in the long run, entire tax is levied on the consumers. This fact is integrated into the E3ME model as a part of its long-term solution.

In the E3ME model, ecotaxes indirectly influence (through direct effect on prices and wages) the macroeconomic parameters such as fuel consumption, production, employment in particular sectors etc.). Namely, a change in the price of fuels resulting from ecotax will, depending on the elasticity of substitution, lead to a change in fuel consumption. Increase of fuel prices due to higher taxes will cause changes in consumer prices, which will be reflected in substitution in consumer expenditure, change of export activity, and change in the relation between domestic production and imports. These changes will in turn affect, via feedback loop, the use of various types of fuel. A reduction in labour costs resulting from "recycling" of tax revenue will initially have a direct positive effect on employment, followed by an indirect effect through relative price competitiveness thereon as more commodities (goods and services) are produced in labour intensive industries.

4. RESULTS OF THE MODEL

Below we present the results of the introduction of the additional carbon tax. We firstly assume that all revenue generated from ecotax is allocated for reduction of the budget deficit or increase of the budget surplus. In subsequent analyses, ecotaxes will be recycled in various ways, e.g. they will be used to reduce the taxes levied on labour costs.

The analysis will be based in section 4.2. on a comparison to a base projection (baseline scenario), and in section 4.3. on a comparison to a budget recycling projection. Results will be presented in the form of a deviation from the base projection and the budget recycling projection. Therefore, we continue by presenting the assumption underlying the base projection, and the way in which this projection was generated.

4.1. DESCRIPTION OF THE BASE PROJECTION (BASELINE SCENARIO) AND UNDERLYING ASSUMPTIONS AND THE ESTIMATION METODOLOGY TOGETHER WITH PARAMETER RESULTS

It is important that the baseline projection (baseline scenario) in the framework of the E3ME model is consistent with the forecasts used in other analyses. The underlying assumption of the baseline projection was that the E3ME projection was consistent with the slightly modified projection of the European commission (modified projection PRIMES BASELINE 2009). PRIMES BASELINE 2009 forecasts are also presented in Table A1 in the Appendix.

Following is a description of the key stages in modelling of the base projection. Inputs for the base projection include historical data (data on economic indicators, energy, and the environment, obtained from different sources (Eurostat, IEA etc.), estimates of parameters for endogenous variables, and fundamental assumptions.

Historical data on economic indicators for Slovenia (employment, output, consumption, exports etc.) is used up to and including 2010. The indicators were calculated from the data published by Eurostat in February 2012. Historical data on energy components (energy consumption by types of fuel etc.) and environmental components is derived from the World Energy Outlook for the period up to 2009.

Endogenous variables are determined using the functions estimated based on historical data. There are around 33 variables for which stochastic functions are estimated. However these variables may well be disaggregated in two dimensions (e.g. there are 19 fuel users and 33 countries) so we will not provide the specification of each variable. Below we first describe the general procedure how these stochastic functions are estimated and then show one example of such function and its parameters for Slovenia.

The functional form of the equations and the parameters are based on the cointegration and error-correction methodology (Engle and Granger, 1987, and Hendry et al., 1984). The process involves two stages. The first-stage is a levels relationship, where an attempt is made to identify the existence of a cointegrating relationship between the chosen variables, selected on the basis of economic theory and a priori reasoning. For example the aggregate energy demand (FRO) is specified as follows:

$$FR0_{i,j,t} = a_{i,j,0} + a_{i,j,1}FRY_{i,j,t} + a_{i,j,2}PREN_{i,j,t} + a_{i,j,3}FRTD_{i,j,t} + a_{i,j,4}ZRDM_{t} + a_{i,j,5ZRDTt\,+} + a_{i,j,6}FRK_{i,j,t\,+}\, u_{i,j,t}$$

where FRY is economic output of energy users i in region j, PREN is average fuel price (across all fuels) deflated by unit cost in region j, FRTD is R&D expenditure by energy user i in region j, ZRDM is EU investment of R&D in machinery, ZRDT is EU investment of R&D in transport, and FRK is investment by energy user i in region j

If a cointegrating relationship exists, then the second stage regression, known as the error-correction representation, is implemented. It involves a dynamic, first-difference, regression of all the variables from the first stage, along with lags of the dependent variable, lagged differences of the exogenous variables, and the error-correction term (the lagged residual from the first stage regression). Due to limitations of data size, however, only one lag of each variable is included in the second-stage. For example in case of aggregate energy demand the error correction equation is specified as:

$$\Delta FR0_{i,j,t} = b_{i,j,0} + b_{i,j,1\Delta}FRY_{i,j,t} + b_{i,j,2\Delta}PREN_{j,t} + b_{i,j,3}DFRTD_{i,j,t} + b_{i,j,4}\Delta ZRDM_{t} + b_{i,j,5}\Delta ZRDT_{t} + b_{i,j,6}\Delta FRK_{i,j,t} + b_{i,j,7}\Delta FR0_{i,j,t-1} + g_{i,j,}ECM_{i,j,t-1}\,,$$

where Δ is difference and ECM is error correction.

Stationarity tests on the residual from the levels equation are performed to check whether a cointegrating set is obtained. Due to the size of the model, the equations are estimated individually rather than through a cointegrating VAR. For both regressions, the estimation technique used is instrumental variables, principally because of the simultaneous nature of many of the relationships (for example wage, employment and price determination).

E3ME's parameter estimate is carried out using a customised set of software routines based in the Ox programming language (Doornik, 2007). The main advantage of using this approach is that parameters for all sectors and countries may be estimated using an automated approach.

The estimation produces a full set of standard econometric diagnostics, including standard errors and tests for endogeneity. However all the estimation procedures and test are carried out by Cambridge Econometrics, the developer of the software[9].

In Table A2 in appendix we provide a summary of the model equations, giving an overview of which variables are used, units of measurement and functional form. A full list of the variables included in E3ME model is available on request. In Appendix 1 we also present in more detail the agregate demand for energy function and the estimated parameters for Slovenia. The other functions and parameters for Slovenia are available upon request.

9 A list of equation results can be made available on request. For each equation, the following information will be given: summary of results, full list of parameter results, full list of standard deviations.

The gaps in any of the E3ME time series was filled by software that was developed by the Cambridge Econometrics. This software uses growth rates and shares between sectors and variables to estimate missing data points, both in cases of interpolation and extrapolation. More precisely, " The most straightforward case is when the growth rates of a variable are known and so the level can be estimated from these growth rates, as long as the initial level is known. Sharing is used when the time-series data of an aggregation of sectors are available but the individual time series is not. In this case, the sectoral time series can be calculated by sharing the total, using either actual or estimated shares. In the case of extrapolation, it is often the case that aggregate data for a number of sectors are available, although the sectoral disaggregation at the E3ME level is not; for example, government expenditure is a good proxy for the total growth in education, health and defence. A special procedure has been put in place to estimate the growth in more disaggregated sectors so that the sum of these matches the known total, while the individual sectoral growth follows the characteristics of each sector. Interpolation is used when no external source is available, to estimate the path interval, at the beginning and end of which data are available". (E3ME, 2014, page 34)

Basic assumptions are derived from various sources. The sources are presented in Table A3 in the Appendix. For Slovenia, the values of these assumptions for the period 2010–2013 are presented in Table A4 in the Appendix. In the same table values of assumptions for particular commodities (e.g. energy prices, fuel prices etc.) are also presented. The baseline scenario is therefore based on all government measures implemented until mid 2010. For example, the CO2 price is determined on the measures introduced by the Slovenian government by mid 2010.

The process of ensuring compliance of the base projection in the E3ME model involves three stages. This is in fact a calibration process. The first stage in reconciling the E3ME projections with the published and slightly modified forecast PRIMES BASELINE 2009 (EU Energy trends to 2030, Baseline scenario 2009, European Commission, 2010). It includes ensuring consistency and transformation of the data into a suitable form. This means that different model dimensions have to be brought into line (geographic coverage, temporal aspect, sector coverage etc.). Transformed data are then saved in a separate file. In the next stage, the model is resolved in such way that model results match the slightly modified PRIMES BASELINE 2009 forecasts saved in a separate file. This is the calibrated forecasting process. In this forecast, the model solves its equations and compares the differences in results with the data saved in the database. Model results are substituted with values from the forecast database. Differences between results and forecasts are saved in a separate database called the "residual" database. In the last stage, the model is solved again using the "residual" database as well. This is the so-called endogenous baseline projection. According the theory, the final result should be the same as in the case of calibrated forecast. In practice, the match is not 100-percent (see, E3ME manual, pages 40–41).

In the E3ME model framework, the calibration process with modified PRIMES BASELINE 2009 forecasts is carried out based on the trends (growth rates) rather than based on levels. This is because historical data in the E3ME model are newer that the data from the modified PRIMES BASELINE 2009. Calibrations for PRIMES BASELINE 2009 forecasts are made for the key economic variables and demand for energy (variables FRO, FRO1, FRO2 ... FRO12) and data on emissions (variables GHG, FCO2 etc.). However, since PRIMES BASELINE 2009 forecasts are based on the year 2010 and they do not include the most recent changes in the economic environment (the economic crisis), short-term calibration for macroeconomic variables is conducted based on AMECO short-term forecasts. Therefore, the baseline scenario is made based on the modified PRIMES BASELINE 2009 forecasts.

The key advantage of the endogenous baseline projection is that it allows us to analyse different scenarios in order to find out how the results change relative to the baseline scenario. There are two baseline endogenous projections: SI endogenous baseline projection and EU endogenous baseline projection. For the SI endogenous baseline projection, calibration is only carried out for Slovenia while other European regions are treated as exogenous. This projection is used in analysis of scenarios that only affect Slovenia (e.g. a change in domestic tax rate). EU endogenous baseline projection involves simultaneously solving the E3ME model for the entire Europe. This projection is used for scenarios that will affect the entire Europe (e.g. a change in oil prices). If this solution is used, results for Slovenia will also include secondary effects from other European regions, brought about through international trade.

Since the introduction of the additional carbon tax in Slovenia is only affecting the Slovenian economy, SI endogenous projection will be used. The remaining part of Europe is treated as exogenous[10].

It is important to stress, that all scenarios that will be presented[11] are based on (1) historical data up to and including the year 2009 (energy and environmental components) or the year 2010 (economic components); (2) on government measures implemented by mid 2010; (3) and on long-term and short-term trends energy and environmental components, that are based on the European Commission projections from 2009 (PRIMES BASELINE 2009). Long-term trends for macroeconomic components are also based on European Commission projections from 2009 (PRIMES BASELINE 2009) while short-term macroeconomic components are based on the AMECO projections. This means that the effects of the economic crisis are only partially included and, as a result, the below results should be used with caution.

4.2. ANALYSIS OF INTRODUCTION OF AN ADDITIONAL CARBON TAX ON THE SLOVENIAN ECONOMY

It is assumed within the E3ME model that payment of carbon tax (tax on carbon dioxide) is levied on the users of fuels based on their emissions; however, only sectors outside ETS are taxed in order to avoid double taxation. The cost, or burden, of the tax is then shifted to the consumers through higher fuel prices.

10 We have also introduced the additional carbon tax in Slovenia by using EU endogenous baseline projection. The results were very similar.

11 Values of particular variables for all scenarios to be used herein are presented in Table A5 in the appendix.

In consequence, this means that we can expect the prices to rise while demand for fuel drops. It is assumed that higher prices will lead to a drop in real income. We can expect household consumption expenditure to decrease, which will in turn decrease demand and cause a drop in gross domestic product. As we assumed this change would not affect the European economy, we expect this will result in a drop of export competitiveness of the Slovenian economy due to higher prices, which will lead to a further decrease in GDP.

According to economic theory, the amount of carbon tax should be equal to the social cost incurred as a result of carbon pollution. Yohe et al. (2007) reviewed the estimates and found that costs estimates are highly unpredictable as they range from USD 1 per ton of carbon (tC) up to USD 1,500 per ton of carbon (tC). Average estimate of social cost of pollution with carbon dioxide for 2005 was USD 43/tC, with a standard deviation of USD 83/tC. The authors found that these costs rise at a rate of 2 to 4 percent per year. Assuming 4-percent annual growth since 2005, carbon pollution cost in 2012 would amount to an average of USD 55/tC or EUR 42/tC (i.e. EUR 11.5/tCO2. We set the amount of extra carbon tax to EUR 15/tCO2 (i.e. EUR 55/tC)[12].

In the article we compare two scenarios: baseline scenario in which no extra carbon tax is introduced and the projection of an introduction of an additional annual carbon tax in the amount of EUR 15 per ton of CO2 (EUR 15 per ton of carbon) for sectors beyond ETS, where all ecotax is recycled into the government budget. Comparison between the two projections is made for some key economic (household consumption expenditure, exports, gross domestic product, total manufacturing output, employment), energy (average fuel prices, demand for energy), and environmental variables (greenhouse emissions) which are presented in detail below.

Average fuel prices including tax (PJRT[13]) change the most in the first year following the introduction of the carbon tax in the amount of EUR 15/tCO2 (EUR 55/tC) (2012) when they rise by 3.67% relative to the baseline scenario in which no extra carbon tax is introduced. After the initial price hike, the price reaches a steady state at a higher figure which is maintained throughout the examined period. The difference in the average fuel price between the baseline scenario and projection that assumes an additional carbon tax of EUR 15/tCO2 (or EUR 55/tC) is approximately 3.5% throughout the period at hand (until 2030).

As expected, the introduction of an extra carbon tax of EUR 15/tCO2 (EUR 55/tC) drives up the average prices of fuel, which in turn causes a decrease in demand for fuels for energy production (FRO[14]). This drop relative to the baseline scenario is relatively the largest in the initial period, after which the decrease in demand for energy is steadied or slowed down. In 2013, for example, demand for energy resulting from the introduction of the carbon tax was projected to be lower by 0.83% compared to the baseline scenario; in 2020 by

12 Determination of the size of the ecotax has been aligned with the Institute of Macroeconomic Analysis and Development (UMAR). We have also used other numbers for ecotax, but we do not report them in the article.

13 PJRT = Average fuel price including tax (in EUR/toe). The model assumes 12 different fuel consumers.

14 FRO = Total demand for energy is in E3ME model measured in thousand tons toe. Model assumes 12 different fuel consumers.

1.64%; and in 2025 by 1.9%. Initial increase in prices and a considerable drop in demand relative to the baseline scenario are followed by a higher and steady level of fuel prices and accordingly lower demand for energy throughout the period of examination.

Household consumption expenditure (RSC[15]) is one of the most important macroeconomic aggregates, since it takes the largest share of GDP structure. Introduction of extra annual carbon tax of EUR 15/tCO2 (EUR 55/tC) would lead to the highest relative drop of household consumption expenditure in 2013 when the decrease amounts to 0.45% relative to the baseline scenario with no introduction of carbon tax. In principle, higher average prices of fuel lead to a decrease in real income which in turn decreases household consumption expenditure. This would result in a drop in aggregate demand and cause a decrease in gross domestic product. After 2013, the difference relative to the baseline scenario gradually decreases and by 2020, for example, consumption is only 0.27% lower compared to the baseline scenario. As expected, the difference between the two scenarios is the largest at the beginning of the period; after 2013, it is gradually decreasing. Moreover, the data shows a relatively low effect of the introduction of the carbon tax on the change in consumption. The reasons can be found in the time lag as the consumers require some time to adjust their behaviour and consumption pattern.

If the extra annual carbon tax in the amount of EUR 15/tCO2 (EUR 55/tC) is introduced, exports (RSX[16]) will decrease relative to the baseline scenario in which no carbon tax is introduced in the short run (until 2017), and increase after 2018. Such development is expected as we assumed the change would not affect the European economy. Higher prices expectedly hinder the export competitiveness of the Slovenian economy; however, the export sector's agility and dynamic character in terms of development of new technological solutions and updates will allow it to neutralize relatively quickly such loss of competitiveness. It should also be noted that changes in exports relative to the baseline scenario are very small (up to a maximum of 0.009%), which points to a relatively low impact of the carbon tax on Slovenian exports.

Introduction of extra annual carbon tax in the amount of EUR 15/tCO2 (EUR 55/tC) would lead to the highest drop of Slovenia's GDP (RGDP[17]) in 2013 when the decrease would amount to 0.3% relative to the baseline scenario with no introduction of carbon tax. This is consistent with our expectations. It has been shown in our previous analysis that higher fuel prices lead to a decrease of real income. As a result, household consumption expenditure will decrease, which will in turn decrease demand and cause a drop in gross domestic product. As we assumed this change would not affect the European economy, higher prices would also result in a drop of export competitiveness of the Slovenian economy, which would lead to a further decrease in GDP. Moreover, the data shows a relatively low effect of the introduction of the said tax on the change in GDP. After 2013, the difference between the two scenarios gradually decreases and by 2020, for example, GDP is only

15 RSC = Household consumption expenditure is in E3ME model measured in EUR million. The model assumes 43 different types of expenditure.

16 RSX = Exports are measured in E3ME model in million euro.

17 RGDP = Gross domestic product is in E3ME model measured by the expenditure method in current market prices in millions of euro.

0.12% lower in case of introduction of the carbon tax compared to the baseline scenario. This conforms to our expectations and the theoretical findings as economic agents require some time to adjust to the new circumstances. Businesses need time to implement technological improvements and updates, and consumers need time to adjust their consumption behaviour and patterns.

We are also interested in the effect of an extra yearly carbon tax of EUR 15/tCO2 (EUR 55/tC) on manufacturing output (QR[18]). The highest drop relative to the baseline scenario would be in 2015. In that year, the difference would amount to 0.32%. Here too, it is evident that introduction of carbon tax in the amount of EUR 15/tCO2 (or EUR 55/tC) has a relatively small effect on production. The difference between the two scenarios is, expectedly, the highest at the start of the period. After 2013, this difference is gradually decreasing so that the deviation from the baseline scenario in 2015 is no more than 0.01%. Technological and organizational updates allowed the enterprises to adapt to the new conditions after a certain period of time. According to the projection, the latter effect prevails in the long run, after 2027.

Employment (YRE[19]) shows a similar dynamics as manufacturing output. Employment is gradually decreasing relative to the baseline scenario. The highest drop in comparison to the baseline scenario can be seen in 2016 when it amounts to 0.36%. There are hardly any differences between the two scenarios at the end of the period. The effect of an additional carbon tax of EUR 15/tCO2 (or EUR 55/tC) on employment appears to be relatively low, similarly to the effect on GDP and manufacturing output.

As expected, the introduction of an extra carbon tax of EUR 15/tCO2 (EUR 55/tC) gradually decreases greenhouse gas emissions (RGHG[20]) in CO2 equivalents. This includes emissions of CO2, CH4, N2O, HFCs, PFCs and SF6. For example, the highest drop in emissions relative to the baseline scenario is seen in 2012 (by 0.6%) and 2013 (by an extra 0.5%) to –1.2%. The decrease in emissions in comparison to the baseline scenario is steadied at approximately 2% after 2020.

4.3. ANALYSIS OF DIFFERENT FORMS OF REVENUE RECYCLING IN CASE OF EXTRA CARBON TAX IN THE SLOVENIAN ECONOMY

Introduction of an extra annual carbon tax of EUR 15/tCO2 (EUR 55/tC) on an annual basis for the period 2012–2030 would result in additional annual tax revenue ranging from a minimum amount of EUR 144.6 million in year 2012 to a maximum amount of EUR 160.1 million in year 2020. The additional tax revenue can be allocated to the economy through different revenue recycling options. We compare the following five revenue recycling options (in each option we have introduced a yearly carbon tax of EUR 15/tCO2 (EUR 55/tC), while other assumptions remain the same as in the baseline scenario):

18 QR = total manufacturing output (EUR million). The model is based on an analysis of 42 different sectors.

19 YRE = Employment (thousands). The model is based on an analysis of 42 different industries.

20 RGHG = Greenhouse gas emissions (in CO2 equivalent thousands of tons)

a) The first scenario analyses the effects of introduction of the extra carbon tax and revenue recycling through a decrease in the budget deficit and tax revenue.
b) In the second scenario, we study the effects of revenue recycling through a decrease in social security contributions for the workers/employees, equivalent to the amount of green tax revenue (fiscal neutrality). Although the yearly decrease of workers' social contributions varies by year, depending on the green tax collected, the average decrease in the period 2012-2030 was 0.6 percentage points i.e. the worker social contributions were on average equal to 18.0% in the observed period (2012-2030).
c) In the third scenario we analyse the effects of revenue recycling through a corresponding decrease in social security contributions payable by the employers subject to the principle of fiscal neutrality. Although the yearly decrease of employers' social contributions varies by year, depending on the green tax collected, the average decrease in the period 2012-2030 was 0.6 percentage points i.e. the employers' social contributions were on average equal to 13.0% in the observed period.
d) In the fourth scenario we allocate the green tax revenue for covering the budget deficit in the period from 2012 to 2016, and for a decrease in workers' social security contributions in 2017 and thereafter. Assuming fiscal neutrality, green tax revenue were first allocated to the budget (period 2012-2016) and for the period 2017-2030 we decreased the workers' social security contributions on average to 18.1%.
e) In the fifth scenario, revenue is recycled through a decrease in budget deficit in the first five years (2012–2016); then, social security contributions payable by the employers are decreased by the relevant amount. Applying the principle of fiscal neutrality, the latter were decreased on average to 13.1% (0.5 percentage points) in the period 2017–2030.

A comparison between different types of recycling will be made especially for some key economic variables (household consumption expenditure, gross domestic product, manufacturing output, employment). Analysis of revenue recycling will be based on a comparison of the second, third, fourth, and fifth scenario, respectively, to the first one. We wish to determine the existence of the double dividend based on a decrease of some social security contributions, improvement in cost competitiveness and the resulting rise in GDP and employment.

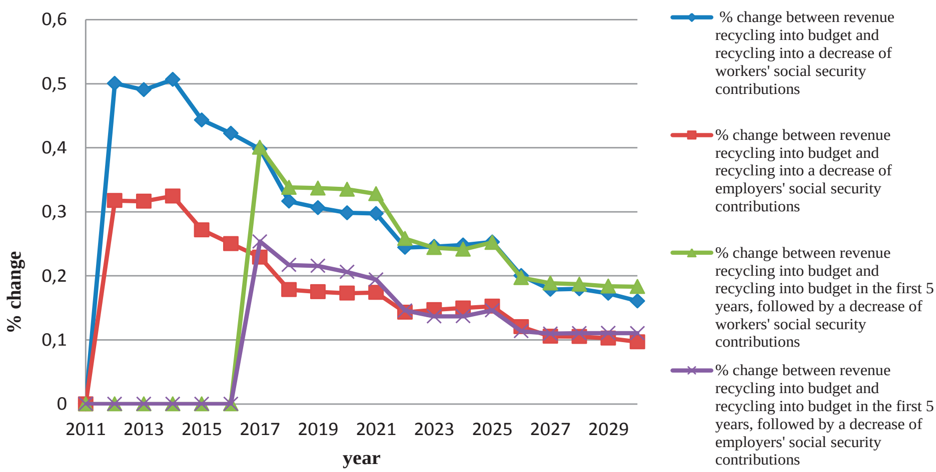
Effect on household consumption expenditure

Figure 1 presents the effect on household consumption expenditure (RSC) in case of different options of recycling of the revenue generated by the extra yearly carbon tax in the amount of EUR 15/tCO2. In our analysis, four scenarios (2nd, 3rd, 4th, and 5th scenario) are compared to the projection in which all carbon tax revenue is allocated exclusively for covering the budget deficit (first scenario). Figure 1 shows that the positive effect on household consumption expenditure in all four scenarios is stronger than in case of the projection in which all generated tax revenue is allocated exclusively for covering the budget deficit (first scenario). This is expected as additional relief through lower social contributions may increase the general population's purchasing power as net wages rise.

Furthermore, it can be observed that revenue recycling through workers' social contributions has a higher effect on household consumption expenditure than recycling through social security contributions payable by the employers in the entire period at hand (both relative to the first scenario). The difference in household consumption expenditure between the two revenue recycling options is decreasing through the years. The reasons can be found in the fact that a decrease in employers' social security contributions would translate to a lower extent into an increase in net wages and the resulting increase in consumption than it would be the case if social security contributions were decreased for the workers.

The result is similar in the case where we allocate the green tax revenue for covering the budget deficit in the period from 2012 to 2016, and for a decrease in workers' social security contributions in 2017 and thereafter. In this case, too, decrease of social security contributions for the workers has a stronger positive effect on household consumption expenditure than a decrease of social security contributions for the employers (both in comparison to the first scenario). Similar as before, the differences between the two scenarios through the years are gradually decreasing. Figure 1 also shows that the best scenarios from the aspect of revenue recycling are the ones that decrease social security contributions for the workers (scenarios 2 and 4). These two scenarios are only different in the first five years; after that, their results tend to match. Similar match can be seen between the two scenarios in which the employer's social security contributions are reduced. It should also be noted that the differences between all scenarios referred to are relatively small.

Figure 1: *Comparison between different forms of carbon tax revenue recycling from the aspect of effect on household consumption expenditure, RSC.*



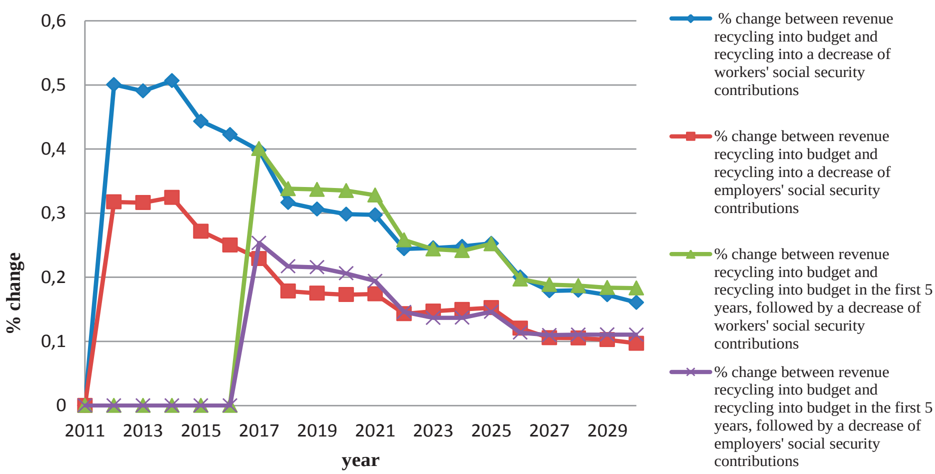
Source: E3ME program and own calculations.

Effect on gross domestic product

Figure 2 shows the effect of introduction of a yearly carbon tax in the amount of EUR 15/ tCO_2 on GDP (RGDP) in different cases of tax revenue recycling. In our analysis, four scenarios (2nd, 3rd, 4th, and 5th scenario) are compared to the first scenario in which all carbon tax revenue is allocated exclusively for covering the budget deficit. It is evident from Figure 2 that the positive effect on GDP in all four scenarios is stronger than in case of the projection in which all generated tax revenue is allocated exclusively for covering the budget deficit. This matches our expectations as additional relief of labour costs through a decrease in social security contributions payable by the employers or the workers translates into an increase in household purchasing power and in turn an increase in GDP. The positive effect is stronger in case of revenue recycling through a decrease in worker's social security contributions in the entire period at hand (both relative to the first scenario). The difference between the two revenue recycling options is decreasing through the examined period. The reasons for this can be found in higher household consumption expenditure (see previous section) which is the largest component of GDP.

The result is similar in the case where green tax revenue is allocated for covering the budget deficit in the period from 2012 to 2016, and for a decrease in social security contributions in 2017 and beyond. Decrease of social security contributions for the workers has a stronger positive effect on household consumption expenditure than a decrease of social security contributions for the employers (both in comparison to the first scenario). In this case, too, the differences between the two scenarios are gradually decreasing through the years. Figure 2 also shows that the best scenarios from the aspect of revenue recycling are the ones that decrease social security contributions for the workers (scenarios 2 and 4). These two scenarios are only different in the first five years; after that, their results tend to match. Similar match can be seen between the two scenarios in which the employer's social security contributions are reduced. It should again be noted that the differences between all scenarios in terms of discrepancy relative to the first scenario are relatively small.

Figure 2: *Comparison between different forms of carbon tax revenue recycling from the aspect of effect on gross domestic product, RGDP.*



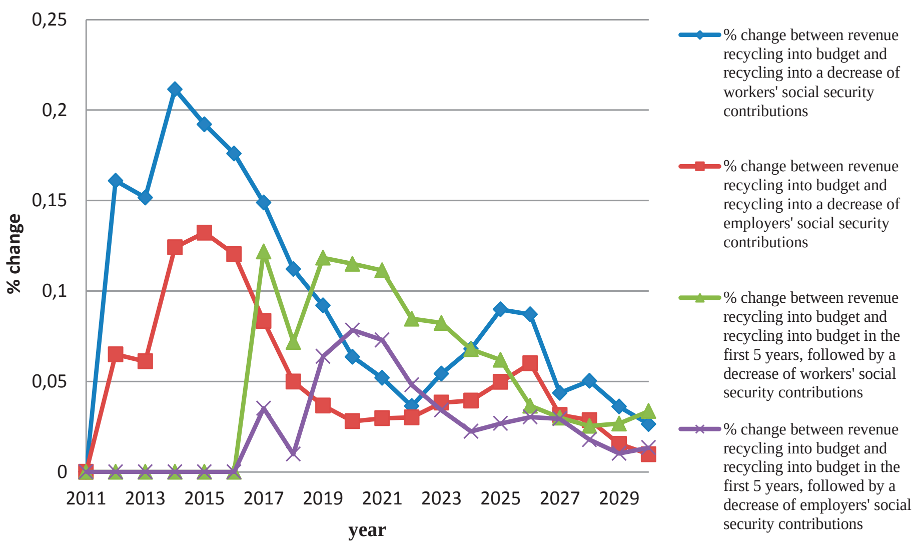
Source: E3ME program and own calculations.

Effect on total manufacturing output

Following is a presentation of the effect of carbon tax introduction on manufacturing output (QR) in case of different forms of recycling. Figure 3 compares four scenarios to the projection in which all carbon tax revenue, is allocated exclusively for covering the budget deficit (first scenario). It is evident from Figure 3 that the positive effect on manufacturing output in all four scenarios (2nd, 3rd, 4th, and 5th) is stronger than in case of the projection in which all generated tax revenue is allocated exclusively for covering the budget deficit. Higher cost relief through a decrease in social security contributions of the employer or the worker and the resulting improvement in cost efficiency appears to motivate total manufacturing output as well.

Recycling through a reduction in social security contributions of the workers has a more positive effect on production than recycling through decrease in social security contributions for the employers in the period 2012–2030 (both relative to the first scenario). The result is similar in the case where we allocate the green tax revenue for covering the budget deficit in the period from 2012 to 2016, and for a decrease in social security contributions in 2017 and thereafter. In both cases, decrease of social security contributions for the workers has a stronger positive effect on manufacturing output than a decrease in the employer's social security contributions. Again, the differences between all scenarios in terms of discrepancy relative to the first scenario are relatively small.

Figure 3: *Comparison between different forms of carbon tax revenue recycling from the aspect of total manufacturing output, QR.*



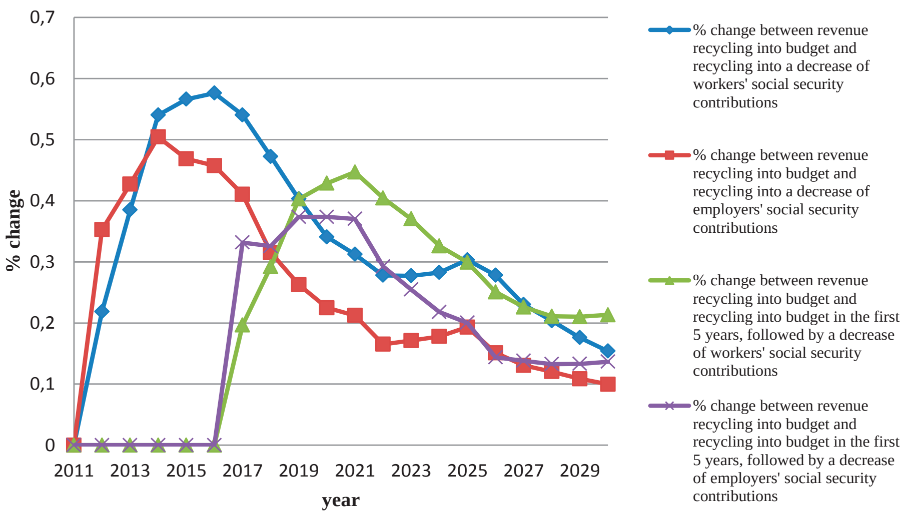
Source: E3ME program and own calculations.

Effect on employment

Following is a presentation of the effect of carbon tax introduction on employment (YRE) in case of different forms of recycling. Four scenarios are compared to the projection in which all carbon tax revenue, is allocated exclusively for covering the budget deficit (first scenario). Figure 4 shows that the positive effect on employment in all four scenarios (2nd, 3rd, 4th, and 5th) is stronger than in case of the projection in which all generated tax revenue is allocated exclusively for covering the budget deficit. Higher cost relief through a decrease in social security contributions (of the employer or the worker) evidently has a positive effect on employment, which is also consistent with the previous two figures.

Revenue recycling through a decrease of the employer's social security contributions has a stronger effect on employment than revenue recycling through worker's social security contributions, but only in the short run until the year 2014. In the long run, the opposite is true; after 2015, the difference between the second and the third scenario is constant. If carbon tax revenue is allocated for covering the budget deficit in the period 2012–2016 and for a decrease in social security contributions in 2017 and beyond, the conclusion is similar. In this case, too, revenue recycling has a stronger effect in the short run (until 2018) if the employer's social security contributions are decreased. Differences between all analyzed scenarios are relatively small in terms of discrepancy relative to the first scenario.

Figure 4: *Comparison between different forms of recycling in case of carbon tax introduction from the aspect of employment, YRE*



Source: E3ME program and own calculations.

5. CONCLUSION

The main goal of the environmental tax reform is economic and environmental improvement. Environmental dividend involves reduction in emissions, while economic dividend has to do with improved cost competitiveness, higher growth, and higher employment. Our primary goal was to determine the effect of an extra carbon tax (EUR 15 per ton of CO2 i.e. EUR 55 per ton of carbon) in the period 2012–2030 on Slovenian economy, in order to determine whether a carbon tax would indeed yield a double dividend.

In the first section, we analysed the effects of the introduction of a yearly carbon tax (EUR 15 per ton of CO2) relative to the baseline projection (in which no tax is introduced) in the period 2012–2030, using the E3ME model. Our analysis has shown that average prices of fuels will increase which will reduce demand for fuels. Higher prices will also lead to lower household consumption expenditure, which would decrease aggregate demand and result in a drop of GDP. GDP would be additionally decreased in the short run by lower export competitiveness of the Slovenian economy, resulting from higher prices, as we assumed that the change in prices would not affect the European economy. In the medium and long run, the effect of carbon tax on the change in GDP, relative to the baseline scenario (i.e. no carbon tax), is always lower. This conforms to our expectations and the theoretical findings as economic agents require some time to adjust to the new circumstances. The E3ME model has shown that Slovenian export sector would look to introduce new technological solutions and updates, thereby neutralizing relatively quickly the negative effects of the introduction of the carbon tax on the competitiveness of the Slovenian economy. Similar dynamics and oscillation as in GDP can be observed in manufacturing output and employment. Greenhouse emissions, too, are reduced in the model, at approximately the same rate.

Economic policy developers in Slovenia, as in many other European countries with implemented environmental tax reform, should be aware that introduction of a carbon tax in Slovenia would have more negative effects in the short run than in the medium and long run. It is therefore of key importance for the success of the green tax reform to introduce the extra carbon tax gradually, transparently, and predictably. This would allow enough time for economic agents to adapt, and for economic policy developers to evaluate the first effects of the green tax reform and to make any adjustments if discrepancies from the planned goals are identified in the course of the reform. This would also prevent recurring discussions as to the urgency of increase of some tax rates and political pressure to decrease such rates as a result of higher prices of oil and petrochemicals in the global market.

In the second section, we used the E3ME model to analyze the effects of different forms of tax revenue recycling, either through a decrease in the budget deficit or through a decrease of social security contributions payable by either the employers or the workers, in case of a yearly carbon tax in the amount of EUR 15 per ton of CO2 in the period 2012–2030. Our analysis has shown that recycling through lowering the social security contributions for workers (2nd and 4th scenario) and employers (3rd and 5th scenario) have a stronger positive effect on household consumption expenditure than the scenario in which all revenue is allocated exclusively for covering the budget deficit (first scenario). Differences between the recycling scenarios are relatively small. Additional relief through a decrease in social security contributions in case of an extra carbon tax would increase the purchasing power of the general population (household consumption expenditure), which would in turn increase the GDP. Higher cost relief through a decrease in social security contributions also has a positive effect on total manufacturing output and employment. We have also shown that recycling through a decrease in social security contributions of workers has a stronger positive economic effect than recycling through a decrease in employers' social security contributions in the entire period at hand. The result is similar in the case where we allocate the green tax revenue for covering the budget deficit in the period from 2012 to 2016, and for a decrease in workers' or employers' social security contributions in 2017 and thereafter.

Policy implications for the Slovenian government are twofold. Firstly, scenarios in which all revenue is allocated exclusively for lowering the social security contributions for workers/employers have a stronger positive economic effect than the scenario in which all revenue is allocated exclusively for covering the budget deficit. Secondly, the optimal fiscal instrument for improving the environmental (first dividend) and economic welfare (second dividend) seems to be recycling through a decrease in social security contributions of workers. The reasons can be found in the fact that a decrease in employers' social security contributions would translate to a lower extent into an increase in net wages and the resulting increase in consumption than it would be the case if social security contributions were decreased for the workers.

However, an environmental tax reform cannot be successful if the political reality in Slovenia is disregarded. As a rule, economists design optimum policy mixes for the attainment of certain goals; however, politics often requires compromises. Experience from other countries has shown that the key to their success was the high rate of consent of all political parties and civil society regarding the urgency of an environmental tax reform. Therefore, the Slovenian government should inform the public about the negative effects of an extra carbon tax. Public support will be higher, if an effective system of measures is put into place to neutralize the harmful effects of the additional carbon tax.

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APPENDIX

Table A1: *PRIMES (Baseline 2009) for Slovenia.*

Slovenia: Baseline 2009										SUMMARY ENERGY BALANCE AND INDICATORS (A)				
ktoe	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
										Annual % Change			
Production	**2902**	**3020**	**3085**	**3492**	**3657**	**4019**	**4221**	**4801**	**4928**	**0.6**	**1.7**	**1.4**	**1.6**
Solids	1432	1216	1062	1184	1252	1505	1573	745	823	-2.9	1.7	2.3	-6.3
Oil	3	2	1	0	0	0	0	0	0	-10.4			
Natural gas	20	16	6	3	4	0	0	0	0	-11.4	-4.9		
Nuclear	1192	1245	1226	1518	1557	1557	1557	2904	2904	0.3	2.4	0.0	6.4
Renewable energy sources	254	542	788	787	845	957	1091	1152	1201	12.0	0.7	2.6	1.0
Hydro	254	279	330	298	338	353	365	366	368	2.7	0.2	0.8	0.1
Biomass & Waste	0	263	458	489	502	568	653	690	715		0.9	2.7	0.9
Wind	0	0	0	0	0	6	14	20	24				5.2
Solar and others	0	0	0	0	6	31	57	74	92			26.2	4.9
Geothermal	0	0	0	0	0	1	1	1	1			28.1	4.1
Net Imports	**2572**	**3063**	**3381**	**3825**	**4276**	**4824**	**5248**	**4846**	**4586**	**2.8**	**2.4**	**2.1**	**-1.3**
Solids	130	186	245	323	269	293	373	233	216	6.5	0.9	3.3	-5.3
Oil	1804	2239	2430	2604	3075	3546	3735	3645	3474	3.0	2.4	2.0	-0.7
- Crude oil and Feedstocks	598	589	151	0	1	1	1	1	1	-12.8	-38.2	1.9	-0.4
- Oil products	1206	1650	2278	2604	3074	3544	3734	3644	3473	6.6	3.0	2.0	-0.7
Natural gas	723	750	820	925	980	1073	1239	1153	1098	1.3	1.8	2.4	-1.2
Electricity	-85	-142	-114	-28	-58	-115	-135	-246	-270				
Gross Inland Consumption	**5523**	**6111**	**6427**	**7299**	**7904**	**8808**	**9431**	**9607**	**9473**	**1.5**	**2.1**	**1.8**	**0.0**
Solids	1645	1402	1306	1539	1521	1798	1946	978	1039	-2.3	1.5	2.5	-6.1
Oil	1754	2290	2393	2554	3046	3511	3696	3606	3434	3.2	2.4	2.0	-0.7
Natural gas	763	746	826	929	984	1073	1239	1153	1098	0.8	1.8	2.3	-1.2
Nuclear	1192	1245	1226	1518	1557	1557	1557	2904	2904	0.3	2.4	0.0	6.4
Electricity	-85	-142	-114	-28	-58	-115	-135	-246	-270				
Renewable energy forms	254	571	788	787	855	983	1127	1213	1269	12.0	0.8	2.8	1.2
as % in Gross Inland Consumption													
Solids	29.8	22.9	20.3	21.1	19.2	20.4	20.6	10.2	11.0				
Oil	31.8	37.5	37.2	35.0	38.5	39.9	39.2	37.5	36.2				
Natural gas	13.8	12.2	12.8	12.7	12.5	12.2	13.1	12.0	11.6				
Nuclear	21.6	20.4	19.1	20.8	19.7	17.7	16.5	30.2	30.7				
Renewable energy forms	4.6	9.3	12.3	10.8	10.8	11.2	11.9	12.6	13.4				
Gross Electricity Generation in GWh_e	**12440**	**12652**	**13622**	**15114**	**16193**	**18404**	**20168**	**22179**	**22930**	**0.9**	**1.7**	**2.2**	**1.3**
Self consumption and grid losses	1584	1497	1662	1943	1965	2244	2385	2400	2804	0.5	1.7	2.0	1.6
Fuel Inputs for Thermal Power Generation	**1543**	**1523**	**1342**	**1507**	**1622**	**1987**	**2246**	**1272**	**1349**	**-1.4**	**1.9**	**3.3**	**-5.0**
Solids	1296	1315	1253	1411	1431	1702	1849	886	959	-0.3	1.3	2.6	-6.4
Oil (including refinery gas)	155	119	12	9	2	7	2	6	5	-22.5	-15.5	-0.9	10.6
Gas	92	90	62	58	147	165	274	232	235	-3.8	9.0	6.4	-1.6
Biomass & Waste	0	0	15	30	42	114	120	148	151		10.5	11.1	2.3
Geothermal heat	0	0	0	0	0	0	0	0	0				
Hydrogen - Methanol	0	0	0	0	0	0	0	0	0				
Fuel Input in other transformation proc.	**596**	**582**	**253**	**90**	**93**	**175**	**225**	**315**	**343**	**-8.2**	**-9.5**	**9.2**	**4.3**
Refineries	542	505	170	1	1	1	1	1	1	-11.0	-38.9	1.9	-0.4
Biofuels and hydrogen production	0	0	0	0	39	106	173	212	238			16.0	3.3
District heating	53	76	83	89	53	68	50	102	103	4.7	-4.5	-0.5	7.4
Others	1	1	0	0	0	0	0	0	0				
Energy Branch Consumption	**122**	**121**	**112**	**104**	**112**	**131**	**137**	**134**	**166**	**-0.9**	**0.0**	**2.1**	**1.9**
Non-Energy Uses	**6**	**122**	**238**	**310**	**351**	**406**	**446**	**465**	**468**	**43.8**	**4.0**	**2.4**	**0.5**
Final Energy Demand	**3373**	**3948**	**4440**	**4892**	**5448**	**6167**	**6597**	**6576**	**6393**	**2.8**	**2.1**	**1.9**	**-0.3**
by sector													
Industry	1469	1180	1424	1657	1693	1835	1977	1908	1837	-0.3	1.7	1.6	-0.7
- energy intensive industries	729	587	840	1038	1046	1149	1248	1201	1152	1.4	2.2	1.8	-0.8
- other industrial sectors	740	593	585	619	647	686	730	707	685	-2.3	1.0	1.2	-0.6
Residential	853	1180	1124	1186	1205	1305	1355	1371	1365	2.8	0.7	1.2	0.1
Tertiary	122	259	580	575	569	604	610	609	593	16.9	-0.2	0.7	-0.3
Transport	930	1329	1312	1475	1981	2423	2655	2688	2598	3.5	4.2	3.0	-0.2
by fuel													
Solids	243	115	97	80	60	63	63	60	52	-8.8	-4.7	0.5	-1.9
Oil	1513	2106	2239	2404	2857	3283	3450	3334	3153	4.0	2.5	1.9	-0.9
Gas	603	468	569	665	655	695	753	679	630	-0.6	1.4	1.4	-1.8
Electricity	837	807	905	1096	1153	1263	1382	1441	1447	0.8	2.5	1.8	0.5
Heat (from CHP and District Heating) [A]	177	192	195	196	257	363	336	422	434	1.0	2.8	2.7	2.6
Renewable energy forms	0	260	435	452	466	500	612	640	675		0.7	2.8	1.0
Other	0	0	0	0	0	0	1	1	1			11.9	0.8
RES in Gross Final Energy Consumption [B]			**768**	**810**	**832**	**911**	**1093**	**1177**	**1230**		**0.8**	**2.8**	**1.2**
TOTAL GHGs Emissions (Mt of CO_2 eq.)	**18.1**		**18.6**	**20.1**	**21.3**	**24.1**	**25.6**	**20.8**	**18.9**	**0.3**	**1.4**	**1.8**	**-3.0**
of which ETS sectors GHGs emissions				9.0	8.8	10.2	11.2	7.1	5.7			2.5	-6.5
CO_2 Emissions (energy related)	**13.2**	**14.1**	**14.0**	**15.3**	**16.7**	**19.3**	**20.8**	**16.3**	**14.4**	**0.6**	**1.8**	**2.2**	**-3.6**
Power generation/District heating	6.2	6.2	5.5	6.2	6.4	7.6	8.4	4.4	3.2	-1.1	1.4	2.8	-9.1
Energy Branch	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.9			
Industry	2.5	1.8	2.3	2.3	2.2	2.3	2.5	2.0	1.8	-0.7	-0.8	1.3	-3.1
Residential	1.7	2.1	1.3	1.4	1.5	1.6	1.6	1.6	1.5	-2.5	1.3	0.8	-0.7
Tertiary	0.0	0.0	1.0	1.0	0.9	1.0	0.9	0.9	0.9	47.0	-0.1	-0.1	-1.0
Transport	2.7	3.9	3.8	4.3	5.8	6.9	7.4	7.4	7.0	3.5	4.3	2.5	-0.5
CO_2 Emissions (non energy related)	**1.1**	**0.9**	**0.9**	**1.1**	**1.1**	**1.2**	**1.4**	**1.4**	**1.4**	**-1.9**	**1.8**	**2.1**	**0.2**
Non-CO_2 GHGs Emissions	**3.8**		**3.7**	**3.7**	**3.5**	**3.5**	**3.4**	**3.2**	**3.1**	**-0.4**	**-0.6**	**-0.1**	**-1.0**
TOTAL GHGs Emissions Index (1990=100)	**100.0**		**102.8**	**110.8**	**117.6**	**133.1**	**141.2**	**115.1**	**104.4**				

SUMMARY ENERGY BALANCE AND INDICATORS (B)										Slovenia: Baseline 2009			
	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
										Annual % Change			
Main Energy System Indicators													
Population (Million)	1.996	1.989	1.988	1.996	2.034	2.053	2.058	2.047	2.023	0.0	0.2	0.1	-0.2
GDP (in 000 MEuro'05)	20.0	19.4	24.0	28.7	32.7	38.4	44.0	48.2	50.7	1.9	3.1	3.0	1.4
Gross Inl. Cons./GDP (toe/MEuro'05)	276.7	315.3	267.9	254.2	241.6	229.5	214.3	199.5	186.8	-0.3	-1.0	-1.2	-1.4
Carbon intensity (t of CO_2/toe of GIC)	2.39	2.30	2.18	2.09	2.12	2.20	2.20	1.69	1.52	-0.9	-0.3	0.4	-3.6
Import Dependency %	46.6	50.1	52.6	52.3	53.9	54.5	55.4	50.2	48.2				
Total Energy-related Costs [(1)] (in 000 M€05)			3.6	3.9	4.8	6.2	7.9	8.9	9.2		3.0	5.0	1.6
as % of GDP			15.0	13.6	14.8	16.2	17.9	18.4	18.1				
Energy intensity indicators													
Industry (Energy on Value added)	109.1	109.6	100.0	92.4	82.7	76.8	73.2	67.1	63.9	-0.9	-1.9	-1.2	-1.4
Residential (Energy on Private Income)	99.0	123.5	100.0	92.2	85.2	79.3	71.5	65.3	60.7	0.1	-1.6	-1.7	-1.6
Tertiary (Energy on Value added)	27.6	54.1	100.0	82.4	72.6	65.0	57.1	51.6	47.0	13.7	-3.2	-2.4	-1.9
Passenger transport (toe/Mpkm)	33.4	45.5	38.5	32.6	32.1	31.2	30.3	27.5	24.6	1.4	-1.8	-0.6	-2.1
Freight transport (toe/Mtkm)	22.8	56.0	42.7	41.9	46.1	47.0	45.2	43.2	40.6	6.5	0.8	-0.2	-1.1
Carbon Intensity indicators													
Electricity and Steam production (t of CO_2/MWh)	0.42	0.41	0.34	0.34	0.32	0.32	0.34	0.16	0.11	-2.0	-0.7	0.5	-10.5
Final energy demand (t of CO_2/toe)	2.05	1.99	1.89	1.86	1.90	1.91	1.88	1.81	1.75	-0.8	0.0	-0.1	-0.7
Industry	1.72	1.55	1.65	1.39	1.28	1.23	1.25	1.06	0.96	-0.4	-2.5	-0.3	-2.4
Residential	1.98	1.81	1.17	1.21	1.24	1.23	1.19	1.14	1.11	-5.2	0.6	-0.4	-0.7
Tertiary	0.17	0.13	1.65	1.76	1.66	1.64	1.54	1.49	1.44	25.7	0.0	-0.8	-0.7
Transport	2.88	2.91	2.89	2.94	2.91	2.85	2.78	2.74	2.70	0.0	0.1	-0.4	-0.3
Indicators for renewables (excluding industrial waste) (%) [(2)]													
RES in gross final energy demand (%)			16.7	15.9	14.7	14.2	15.9	17.2	18.4				
RES in transport (%)			0.5	0.3	2.3	4.7	6.8	8.3	9.6				
Gross Electricity generation by fuel type (in GWh)			**13622**	**15114**	**16193**	**18404**	**20168**	**22179**	**22930**		1.7	2.2	1.3
Nuclear energy			4760	5883	6035	6035	6035	12480	12480		2.4	0.0	7.5
Coal and lignite			4630	5314	5179	6738	7501	3182	3777		1.1	3.8	-6.6
Petroleum products			40	34	9	19	8	14	13		-14.0	-0.8	4.6
Gas (including derived gases)			313	324	869	897	1604	1281	1306		10.8	6.3	-2.0
Biomass & waste			45	100	171	529	555	645	659		14.3	12.5	1.7
Hydro			3833	3460	3927	4100	4249	4256	4283		0.2	0.8	0.1
Wind			0	0	0	66	167	234	278				5.2
Solar, tidal etc.			0	0	3	20	48	86	135			32.5	10.9
Geothermal and other renewables			0	0	0	0	0	0	0				
Net Generation Capacity in MW_e			**2748**	**3084**	**3293**	**4039**	**3971**	**4548**	**4846**		1.8	1.9	2.0
Nuclear energy			696	696	706	706	706	1515	1515		0.1	0.0	7.9
Renewable energy			846	963	1041	1175	1388	1506	1623		2.1	2.9	1.6
Hydro (pumping excluded)			846	963	1038	1079	1147	1149	1166		2.1	1.0	0.2
Wind			0	0	0	75	191	267	317				5.2
Solar			0	0	3	21	50	90	140			32.5	10.9
Other renewables (tidal etc.)			0	0	0	0	0	0	0				
Thermal power			1206	1424	1547	2158	1877	1527	1707		2.5	2.0	-0.9
of which cogeneration units			453	389	448	614	589	649	644		-0.1	2.8	0.9
of which CCS units			0	0	0	0	0	0	185				
Solids fired			948	947	894	1495	1244	870	1039		-0.6	3.4	-1.8
Gas fired			223	446	624	626	552	573	585		10.8	-1.2	0.6
Oil fired			17	10	10	10	2	1	1		-5.2	-13.6	-12.0
Biomass-waste fired			17	21	19	27	79	83	83		1.4	15.2	0.5
Fuel Cells			0	0	0	0	0	0	0				
Geothermal heat			0	0	0	0	0	0	0				
Load factor for net electric capacities (%)			53.1	52.3	52.8	48.7	54.5	52.7	50.3				
Efficiency for thermal electricity production (%)			32.2	32.9	33.0	35.4	37.0	34.6	36.7				
CHP indicator (% of electricity from CHP)			7.2	8.2	12.5	18.7	19.0	16.9	16.4				
CCS indicator (% of electricity from CCS)			0.0	0.0	0.0	0.0	0.0	0.0	8.3				
Non fossil fuels in electricity generation (%)			63.4	62.5	62.6	58.4	54.8	79.8	77.8				
- nuclear			34.9	38.9	37.3	32.8	29.9	56.3	54.4				
- renewable energy forms and industrial waste			28.5	23.6	25.3	25.6	24.9	23.5	23.3				
Transport sector													
Passenger transport activity (Gpkm)	**21.6**	**21.4**	**25.0**	**26.9**	**29.5**	**32.8**	**35.6**	**37.1**	**38.0**	**1.5**	**1.7**	**1.9**	**0.7**
Public road transport	6.5	4.1	3.5	3.1	3.3	3.5	3.7	3.8	3.8	-6.0	-0.6	1.1	0.4
Private cars and motorcycles	13.5	16.5	20.5	22.7	24.9	27.8	30.1	31.4	32.1	4.3	2.0	1.9	0.6
Rail	1.4	0.6	0.7	0.8	0.8	0.9	1.0	1.1	1.1	-6.8	1.7	1.9	1.1
Aviation	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.0	3.7	4.9	4.7	3.3
Inland navigation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Freight transport activity (Gtkm)	**9.1**	**6.4**	**8.2**	**14.3**	**22.4**	**29.8**	**34.8**	**38.6**	**40.9**	**-1.1**	**10.6**	**4.5**	**1.6**
Trucks	4.9	3.3	5.3	11.0	18.4	25.2	29.3	32.5	34.6	0.8	13.3	4.7	1.7
Rail	4.2	3.1	2.9	3.2	4.0	4.6	5.5	6.0	6.3	-3.8	3.4	3.3	1.3
Inland navigation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Energy demand in transport (ktoe)	**930**	**1329**	**1312**	**1475**	**1981**	**2423**	**2655**	**2688**	**2598**	**3.5**	**4.2**	**3.0**	**-0.2**
Public road transport	51	33	27	23	25	26	26	26	25	-6.2	-0.9	0.3	-0.2
Private cars and motorcycles	642	918	909	829	892	961	1012	951	859	3.5	-0.2	1.3	-1.6
Trucks	181	329	316	570	1000	1362	1535	1625	1635	5.8	12.2	4.4	0.6
Rail	29	29	34	29	35	40	43	42	31	1.4	0.3	2.1	-3.2
Aviation	27	20	25	23	29	35	40	44	48	-0.8	1.6	3.3	1.9
Inland navigation	0	0	0	0	0	0	0	0	0				

Source: EU energy trends to 2030 – update 2009 (2010), pp. 114-115.

Table A2: *Equation summary.*

Equ'n set	Endog var	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	Units	NVAR 2
1	FR0	FRY	PREN	FRTD	ZRDM	ZRDT	FRK	RDEU				th.toe	9
2-5	FRF	FR0	PFRF	FRTD	ZRDM	ZRDT	FRK	RDEU				th.toe	9
6	RSCP	PRPDP	RRLR	CDEP	ODEP	RVD	RDEU	RUNR	RPSC			m euro 2000 prices	10
7	CR/RMAC	PRPDP	PRCR	RRLR	PRSC	CDEP	ODEP	RDEU				consumption ratio	9
10	KR	YR	PKR/PYR	YRWC	PQRM(3)	RDEU	RRLR	YYN				m euro 2000 prices	9
11	QEX	QWXI	PQEX	PQRW	YRKC	YRKN	SVIM	RDEU				m euro 2000 prices	9
12	QIX	QZXI	PQRX	PQRZ	YRKC	YRKN	SVIM	RDEU				m euro 2000 prices	9
13	QEM	QRDI	PQRM	PYH	EX	YRKC	YRKN	SVIM	RDEU	YYN		m euro 2000 prices	11
14	QIM	QRDI	PQRM	PYH	EX	YRKC	YRKN	SVIM	RDEU	YYN		m euro 2000 prices	11
15	YRH	YNH	YRKC	YRKN	RDEU	YYN						hours per week	7
16	YRE	YR	LYLC	YRH	PQRM(3)	YRKC	YRKN	RDEU				thousd	9
17	PYH	YRUC	PQRM	YRKC	YRKN	PQRM(3)	REDU	YYN				index 2000=1	9
18	PQRX	PQRY	PQRE	PQWE	EX	YRULT	YRKC	YRKN	RDEU			index 2000=1	10
19	PQRM	PQRF	PQRE	PQWE	EX	YRUL	YRKC	YRKN	RDEU			index 2000=1	10
20	YRW	LYWE	LYRXE	LYRP	RUNR	RBNR	LAPSC	ARET	RDEU	DLAPSC	YYN	th. Euro per person-year	12
21	LRP	RSQ	RWSR	RUNR	RBNR	RSER	RDEU					rate [0,1]	8
22	RRI	RWS	RPSC	VRYM	RLR	RDEU						m euro	7
23	RDW	RRPD	RRLR	CDEP	ODEP	RDEU	RUNR	RPSC				m euro 2000 prices	9
24	YRN	YRY	YRX	RDEU								m euro 2000 prices	5
31	MU	QR	PMAT	YRD	KR	MUM	RDEU					th. tonnes	

Source: E3ME Manual (2012).

Table A3: *Baseline assumptions, complete with sources.*

	DATA SOURCES
World assumptions	
1. Commodity prices	
- food	CE own assumptions
- beverages	CE own assumptions
- agricultural raw materials	CE own assumptions
- metals	CE own assumptions
- energy	IEA, PRIMES
- oil	IEA, PRIMES
- global inflation	CE own assumptions
Region specific assumptions	
1. Exchange rates	DG ECFIN AMECO database over historical, fixed afterwards

- euro exchange rates (WREX)	
- purchasing power standard (WRPX)	
2. Interest rates	DG ECFIN AMECO database over historical, fixed afterwards
- short-term rate (WRSR)	
- long-term rate (WRLR)	
3. Macro variables	Not use for E3ME regions (endogenous) forecasts calibrated to PRIMES 2009 projection Historical data stored in databank from Eurostat Other Regions (CE own assumptions + results from E3MG modelling)
- GDP (WGDP)	
- GDP deflator (WHUC)	
4. Government consumption (WRSG, GW01, GW02,GW03)	Eurostat, Cambridge Econometrics
- defence	- fixed after last year of historical data
- education	- fixed after last year of historical data
- health	- fixed after last year of historical data
5. Fiscal policy	DG ECFIN AMECO database, DG TAX AND CUSTOMS "Taxes in Europe" database over historical period, fixed afterwards
- taxes on goods and services (WITR)	
- standard rate on VAT (WSVT)	
- taxes on income and capital gains (WDTR)	
- taxes on international trade (WTTR)	
- subsidies and other transfers to households (WBNR)	
- social security taxes paid by employees (WSSR)	
- social security taxes paid by employers (WERS)	
6. Population (WRPO, PAR1…. PAR6)	Eurostat population projections
- total population	
- male/female split	
- children/working-age/ old-age pensioner split	

7. Labor force (LRP1, LRP2)	Not use for E3ME regions (endogenous) Historical data stored in databank from Eurostat LFS
- male/female participation rates	

Source: E3ME program.

Table A4: *Baseline assumptions for Slovenia and the world in the E3ME model.*

SLOVENIA

Code	Description	unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
WREX01	Exhange rate	local currency per euro	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
WRPX01	Exhange rate: PPP (not used)	local currency per euro	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386
WRSR01	Interest rate: short run (not used)	percent	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
WRLR01	Interest rate: long run	percent	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038
WGDP01_MA06	GDP (not used for E3ME regions)	year on year growth	1.379	1.937	2.451	3.248	3.248	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541
WHUC01_MA12	inflation (not used for E3ME regions)	annual rate	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
WRSG01_MA02	Government spending	year on year growth	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029
GW01_DEFENCE	Government spending: Defence	share of total government spending	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
GW02_EDUCATION	Government spending: Education	share of total government spending	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245
GW03_HEALTH	Government spending: Health	share of total government spending	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297
WITR01_TAX_G&S	Tax: Indirect	1+share of household spending	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184
WSVT01_TAX_VAT	Tax: VAT	Rate	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
WDTR01_TAX_INC	Tax: Direct	Rate (wages)	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174
WTTR01_TAX_TRADE	Tax: Import tariffs (not used)	Rate	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002
WBNR01_SUBS&TRANS	Benefit Payment	share of wage	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366
WSSR01_SS_TOTAL	Soc. sec employees' contibution	rate	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186
WERS01_SS_ERS	Soc. sec employers' contibution	rate	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136
WRPO_POP_TOTAL	Population	year on year growth	0.276	0.237	0.209	0.198	0.168	0.14	0.116	0.087	0.056	0.03	-0.008	-0.035	-0.07	-0.104	-0.138	-0.161	-0.185	-0.208	-0.225	-0.245	-0.264
PAR1_M_CHILD	Population: male 0-15	share of total population	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.069	0.068	0.067	0.067	0.066	0.065	0.064	0.063
PAR2_F_CHILD	Population: female 0-15	share of total population	0.066	0.066	0.067	0.067	0.067	0.068	0.068	0.068	0.068	0.069	0.069	0.068	0.068	0.067	0.067	0.066	0.065	0.064	0.063	0.063	0.062
PAR3_M_WORK_AGE	Population: male 16-64	share of total population	0.357	0.357	0.356	0.354	0.352	0.35	0.347	0.345	0.342	0.339	0.336	0.333	0.331	0.329	0.327	0.325	0.324	0.322	0.32	0.319	0.317
PAR4_F_WORK_AGE	Population: female 16-64	share of total population	0.339	0.339	0.338	0.336	0.334	0.332	0.329	0.327	0.324	0.321	0.319	0.317	0.314	0.313	0.311	0.31	0.308	0.307	0.305	0.304	0.303
PAR5_M_OLD	Population: male 65+	share of total population	0.066	0.066	0.067	0.069	0.071	0.074	0.076	0.079	0.082	0.085	0.088	0.091	0.094	0.097	0.099	0.102	0.104	0.107	0.109	0.112	0.114
PAR6_F_OLD	Population: female 65+	share of total population	0.102	0.102	0.102	0.104	0.105	0.107	0.109	0.111	0.113	0.116	0.118	0.12	0.123	0.125	0.127	0.13	0.132	0.134	0.137	0.139	0.141
LRP1_M_PARTN_RATE	Participation rate: male (not used)	percent of male working population	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761
LRP2_F_PARTN_RATE	Participation rate: female (not used)	percent of female working poulation	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675

WORLD

Code	Description	unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
PFMG(01)	Commodity Price: Food	year on year growth	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
PFMG(02)	Commodity Price: Beverages	year on year growth	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
PFMG(03)	Commodity Price: Agriculture Raw Material	year on year growth	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
PFMG(04)	Commodity Price: Metals & Minerals	year on year growth	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
PFMG(05)	Commodity Price: Energy	year on year growth	6.031	6.929	6.929	6.929	6.929	6.929	5.861	5.861	5.861	5.861	5.861	4.566	4.566	4.566	4.566	4.566	4.566	4.566	4.566	4.02	4.02
PFMG(06)	Commodity Price: Brent oil	year on year growth	20.586	2.27	2.27	2.27	2.27	2.27	6.367	6.367	6.367	6.367	6.367	5.126	5.126	5.126	5.126	5.126	5.126	5.126	5.126	4.814	4.814
PFMG(07)	Agregate Global Inflation	year on year growth	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Source: E3ME program.

Table A5: *Values of economic, environmental, and energy variables in different scenarios for the period 2011-2030.*

SCENARIO	RECYCLING / YEAR	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Green revenues from a cabon tax																					
baseline scenario	/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	all	0	144.639	147.335	150.279	153.514	154.514	155.882	157.703	159.536	160.94	159.514	158.126	157.011	156.118	155.148	153.213	151.235	149.65	148.493	147.099
Gross domestic product in million of euro (RGDP)																					
baseline scenario	/	28749.77	29436.21	30415.7	31443.8	32502.98	33411.88	34355.28	35349.36	36385.24	37449.73	38176.75	38926.43	39697.25	40507.05	41345.79	41865.08	42408.16	42959.87	43502.27	44051.21
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	28749.77	29415.28	30322.49	31386.87	32439.38	33356.36	34305.07	35300.83	36336.85	37402.58	38133.77	38889.22	39663.53	40473.73	41309.04	41825.57	42374.68	42926.33	43462.15	44009.93
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	28749.77	29478.9	30380.23	31450.78	32501.63	33419.58	34367.1	35350.45	36384.39	37445.14	38171.98	38916.1	39691.16	40504.11	41344.97	41858.34	42407.76	42959.18	43488.57	44029.78
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contibutions	28749.77	29446.68	30353.49	31427.92	32481	33394.67	34337.66	35326.3	36362.72	37426.74	38155.76	38906.42	39681.3	40491.9	41329.51	41846.16	42394.95	42944.81	43476.59	44021.18
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	28749.77	29415.28	30322.49	31386.87	32439.38	33356.36	34360.18	35339.48	36378.32	37451.36	38185.97	38932.13	39706.17	40515.79	41349.45	41852.42	42399.23	42950.67	43487.95	44039.86
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contibutions	28749.77	29415.28	30322.49	31386.87	32439.38	33356.36	34328.9	35318.64	36363.46	37433.86	38163.37	38911.42	39684.97	40495.51	41331.45	41843.31	42391.35	42941.27	43476.87	44026.62
Household consumption expenidtores in million of euro (RSC)																					
baseline scenario	/	16705.19	16945.31	17470.62	18004.52	18550.77	19074.5	19612.02	20159.48	20729.08	21316.29	21789.22	22266.06	22770.05	23289.98	23818.74	24183.24	24543.27	24956.55	25382.57	25810
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	16705.19	16891.03	17392.22	17931.52	18477.28	19004.83	19545.53	20096.52	20667.77	21256.98	21732.45	22210.29	22713.19	23230.92	23758.01	24122.45	24495.48	24913.65	25332.61	25754.82
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	16705.19	16975.57	17477.51	18022.34	18559.2	19085.13	19623.32	20160.12	20731.11	21320.4	21797.08	22264.55	22769.02	23288.56	23818.11	24170.78	24539.25	24958.42	25376.35	25796.2
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contibutions	16705.19	16944.68	17447.24	17989.73	18527.51	19052.41	19590.35	20132.39	20703.96	21293.73	21770.3	22242.09	22746.6	23265.72	23794.24	24151.53	24521.36	24939.85	25358.64	25779.81
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	16705.19	16891.03	17392.22	17931.52	18477.28	19004.83	19623.81	20164.48	20737.44	21328.23	21803.74	22267.61	22768.59	23287	23817.9	24169.99	24541.67	24960.25	25379.2	25801.98
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contibutions	16705.19	16891.03	17392.22	17931.52	18477.28	19004.83	19595.12	20140.13	20712.34	21300.78	21774.67	22242.68	22744.26	23262.72	23792.73	24149.85	24522.38	24941.19	25360.65	25783.29
Export in million of euro (RSX)																					
baseline scenario	/	16705.19	16945.31	17470.62	18004.52	18550.77	19074.5	19612.02	20159.48	20729.08	21316.29	21789.22	22266.06	22770.05	23289.98	23818.74	24183.24	24543.27	24956.55	25382.57	25810
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	16705.19	16891.03	17392.22	17931.52	18477.28	19004.83	19545.53	20096.52	20667.77	21256.98	21732.45	22210.29	22713.19	23230.92	23758.01	24122.45	24495.48	24913.65	25332.61	25754.82
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	16705.19	16975.57	17477.51	18022.34	18559.2	19085.13	19623.32	20160.12	20731.11	21320.4	21797.08	22264.55	22769.02	23288.56	23818.11	24170.78	24539.25	24958.42	25376.35	25796.2
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contibutions	16705.19	16944.68	17447.24	17989.73	18527.51	19052.41	19590.35	20132.39	20703.96	21293.73	21770.3	22242.09	22746.6	23265.72	23794.24	24151.53	24521.36	24939.85	25358.64	25779.81
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	16705.19	16891.03	17392.22	17931.52	18477.28	19004.83	19623.81	20164.48	20737.44	21328.23	21803.74	22267.61	22768.59	23287	23817.9	24169.99	24541.67	24960.25	25379.2	25801.98
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contibutions	16705.19	16891.03	17392.22	17931.52	18477.28	19004.83	19595.12	20140.13	20712.34	21300.78	21774.67	22242.68	22744.26	23262.72	23792.73	24149.85	24522.38	24941.19	25360.65	25783.29
Total manufacturing output in million EUR (QR)																					
baseline scenario	/	21531.41	22199.45	22996.59	23848.7	24729.97	25510.09	26305	27079.24	27880.9	28705.55	29188.84	29579.96	30044.5	30518	31034.2	31365.94	31634.17	31984.08	32300.69	32646.13
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	21531.41	22214.99	22980.56	23826.07	24692.9	25477.39	26276.24	27057.75	27861.56	28683.53	29166.47	29562.1	30035.12	30511.67	31026.06	31348.3	31652.37	32012.02	32319.98	32665.44
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	21531.41	22229.12	22990.89	23850.03	24719.05	25502.39	26295.74	27072.12	27872.67	28688.84	29167.51	29558.76	30035.01	30513.88	31034.17	31358.98	31651.61	32016	32318.01	32659.15
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contibutions	21531.41	22211.22	22976.19	23839.81	24714.27	25495.9	26284.69	27062.03	27864.91	28685.59	29167.42	29564.31	30038.1	30513.06	31029.63	31359.26	31654.73	32013.31	32315.45	32658.35
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	21531.41	22214.99	22980.56	23826.07	24692.9	25477.39	26288.89	27055.07	27870.52	28696.19	29179.96	29571.86	30047.22	30522.01	31034.96	31350.33	31652.39	32008.75	32315.32	32662.03
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contibutions	21531.41	22214.99	22980.56	23826.07	24692.9	25477.39	26266.32	27043.07	27865.38	28694.51	29175	29566.49	30037.94	30513.28	31029.36	31355.16	31657.81	32011.4	32315.07	32660.95
Emplyment in thousands (YRE)																					
baseline scenario	/	936.692	950.426	955.094	955.764	958.411	952.612	946.927	938.577	932.254	925.688	920.588	913.883	909.383	905.041	901.945	894.97	887.232	880.346	873.976	869.069
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	936.692	950.497	953.889	953.042	955.141	949.1	943.516	935.464	929.486	923.195	918.308	911.838	907.599	903.398	900.288	893.212	886.057	879.566	873.35	868.53
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	936.692	952.573	957.562	958.191	960.549	954.568	948.615	939.884	933.233	926.34	921.176	914.372	910.114	905.951	903.019	895.697	888.096	881.357	874.887	869.867
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contibutions	936.692	953.847	957.965	957.848	959.617	953.441	947.391	938.413	931.928	925.27	920.258	913.345	909.153	905.006	902.028	894.562	887.215	880.625	874.298	869.396
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	936.692	950.497	953.889	953.042	955.141	949.1	945.369	938.196	933.23	927.152	922.413	915.526	910.96	906.343	902.984	895.451	888.059	881.422	875.185	870.382
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contibutions	936.692	950.497	953.889	953.042	955.141	949.1	946.645	938.51	932.958	926.643	921.709	914.505	909.912	905.366	902.092	894.496	887.281	880.734	874.513	869.717
Greenhouse gas emissions in CO2 equivalent thousands of tons of carbon																					
baseline scenario	/	5588.252	5737.804	5874.773	5998.528	6122.417	6186.53	6258.1	6330.867	6398.466	6463.33	6332.618	6210.716	6091.337	5971.548	5854.552	5768.035	5689.808	5612.959	5535.926	5457.153
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	5588.252	5699.225	5801.967	5910.516	6027.753	6082.999	6146.05	6218.732	6292.517	6359.086	6221.624	6089.353	5966.265	5851.007	5738.6	5651.438	5565.019	5486.641	5416.851	5343.681
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	5588.252	5699.981	5805.95	5914.157	6031.337	6086.616	6150.177	6222.895	6296.066	6362.511	6224.386	6091.057	5966.674	5851.668	5740.395	5654.128	5568.177	5487.795	5416.669	5343.986
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contibutions	5588.252	5703.375	5806.024	5908.469	6024.208	6085.302	6154.044	6224.437	6292.099	6356.679	6222.169	6092.201	5968.397	5851.377	5738.25	5651.396	5567.058	5489.025	5417.842	5343.073
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	5588.252	5699.225	5801.967	5910.516	6027.753	6082.999	6146.645	6223.044	6296.215	6362.05	6224.478	6092.933	5969.082	5853.194	5740.442	5653.166	5566.013	5487.111	5417.339	5344.526
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contibutions	5588.252	5699.225	5801.967	5910.516	6027.753	6082.999	6150.509	6222.179	6289.215	6355.302	6224.07	6095.759	5969.932	5849.961	5736.272	5651.136	5567.327	5489.403	5417.561	5342.396
Total demand for energy in thousand toe (FRO)																					
baseline scenario	/	6528.858	6735.286	6929.519	7113.159	7305.409	7421.845	7549.201	7677.035	7798.161	7916.722	7704.82	7521.981	7359.104	7208.643	7072.313	7047.299	7031.582	7019.494	7007.009	6991.417
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	6528.858	6679.237	6836.475	7007.4	7193.944	7299.16	7414.321	7541.112	7670.133	7791.199	7571.272	7375.161	7207.594	7063.331	6933.324	6906.806	6879.445	6864.735	6861.451	6852.784
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	6528.858	6680.491	6841.556	7011.197	7197.421	7303.375	7420.242	7547.516	7675.336	7795.493	7574.27	7376.883	7208.198	7064.885	6936.641	6911.035	6884.056	6866.505	6861.389	6853.399
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contibutions	6528.858	6685.019	6841.814	7004.185	7188.617	7301.797	7425.046	7549.017	7669.717	7787.832	7571.796	7378.862	7210.618	7064.275	6933.412	6907.077	6882.391	6868.113	6862.943	6852.137
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	6528.858	6679.237	6836.475	7007.4	7193.944	7299.16	7415.302	7546.529	7674.064	7794.156	7574.749	7380.27	7211.954	7066.593	6935.68	6908.626	6880.418	6865.489	6862.725	6854.685
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contibutions	6528.858	6679.237	6836.475	7007.4	7193.944	7299.16	7420.551	7545.693	7665.209	7785.534	7574.371	7383.883	7212.714	7061.986	6930.139	6906.192	6882.481	6868.658	6862.821	6851.513
Average fuel (energy) price including taxes in EURO/toe (PJRT)																					
baseline scenario	/	3144.918	3140.383	3144.66	3156.688	3174.105	3182.884	3195.34	3212.91	3235.262	3260.783	3303.043	3347.844	3396.56	3449.189	3506.829	3552.643	3598.905	3642.847	3684.911	3730.16
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	3144.918	3255.683	3262.142	3270.724	3287.534	3298.071	3312.47	3330.179	3351.101	3375.623	3418.701	3464.836	3514.412	3566.701	3623.994	3670.967	3719.383	3764.525	3807.132	3853.669
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	3144.918	3255.151	3261.36	3271.114	3288.359	3298.943	3312.897	3330.404	3351.084	3375.115	3417.795	3463.749	3513.401	3565.553	3622.774	3669.708	3718.03	3763.33	3805.992	3852.584
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contibutions	3144.918	3254.813	3261.43	3271.553	3288.754	3298.492	3311.932	3329.914	3351.437	3375.757	3418.011	3463.634	3513.341	3565.882	3623.334	3670.273	3718.387	3763.46	3806.219	3853.038
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	3144.918	3255.683	3262.142	3270.724	3287.534	3298.071	3312.327	3329.656	3351.871	3376.649	3419.513	3465.23	3514.767	3566.705	3623.515	3670.092	3718.494	3763.498	3806.108	3852.698
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contibutions	3144.918	3255.683	3262.142	3270.724	3287.534	3298.071	3311.844	3329.706	3352.208	3376.789	3418.878	3464.365	3514.366	3567.033	3624.048	3670.382	3718.387	3763.411	3806.358	3853.222

Source: E3ME program and own calculations.

Appendix 1: *Aggregate demand for energy and its parameters for Slovenia.*

In Table A6 we show the specification of aggregated demand for energy that is used in the E3ME model. The equation is based on the work of Barker, Ekins and Johnston (1995), Hunt and Manning (1989) and Bentzen and Engsted (1993).

»The aggregate energy equation considers the total fuel used (summation of 12 fuel types) in thousand tonnes of oil equivalent (th.toe) by 19 fuel users. The demand for energy by a fuel user is dependent on the ‚activity' for the fuel user. This is chosen as gross economic output for most sectors, but household fuel demand is a function of total consumers‘ expenditure. A restriction is imposed such that as activity increases then demand for energy use will not decline (all other factors being equal).

The average price ratio captures the effect of prices relative to the fuel used, and is deflated by unit costs. The equations have been tested so that relative price increases cause demand to fall but relative price decreases have no effect. Such asymmetrical price effects in aggregate energy demand equations have been the subject of other research (Gately, 1993; Walker and Wirl, 1993; Grubb, 1995). The idea is that because energy is used via capital stock with a long lifetime, and since technical change is progressive and is not generally reversed, when energy prices rise and energy savings are introduced, then when energy prices fall again, these savings are not reversed i.e. energy demand responds to rises in real prices, but not falls. The effect changes the properties of the model in a non-linear fashion: if in the base run real energy prices fall over the projection period, then increases in energy taxes will have no effect until they start to increase real prices (one year to the next, not compared to the base).

The long-run price elasticity for road fuel is imposed at -0.7 for all regions, also Slovenia, following the research on long-run demand (Franzen and Sterner, 1995) and (Johansson and Schipper, 1997).

The measures of research and development expenditure and investment capture the effect of new ways of decreasing energy demand (energy saving technical progress) and the elimination of inefficient technologies, such as energy saving techniques replacing the old inefficient use of energy. Research and development expenditure in industries 16-18 (machinery) and 19 (motor vehicles) for the EU as a whole take into account spillover effects from international companies.« (E3ME Manual, 2012, page 49-50).

Tabel A6: *Specification of agregate demand for energy.*

Co-integrating dynamic equation:

DLN(FR0(.))		[total fuel used by fuel users]
=	BFR0(,.1)	[constant]
+	BFR0(.,2) * DLN(FRY(.))	[activity measure]
+	BFR0(.,3) * DLN(PREN(.))	[average price ratio]
+	BFR0(.,4) * DLN(FRTD(.))	[R&D by fuel user]
+	BFR0(.,5) * DLN(ZRDM)	[EU R&D in machinery]
+	BFR0(.,6) * DLN(ZRDT)	[EU R&D in transport]
+	BFR0(.,7) * DLN(FRK(.))	[investment by fuel user]
+	BFR0(.,8) * DRDEU	[German unification]
+	BFR0(.,9) * D09R	[2009 recession dummy]
+	BFR0(.,10) * DLN(FR0(-1))	[lagged changes in fuel use]

Co-integrating long-term equation:

DLN(FR0(.))		[total fuel used by fuel users]
=	BFR0(.,11) * ECM(-1)	[lagged error correction]
+	BFR0(,.12)	[constant]
+	BFR0(,.13) * LN(FRY(.))	[activity measure]
+	BFR0(.,14) * LN(PREN(.))	[average price ratio]
+	BFR0(.,15) * LN(FRTD(.))	[R&D by fuel user]
+	BFR0(.,16) * LN(ZRDM)	[EU R&D in machinery]
+	BFR0(.,17) * LN(ZRDT)	[EU R&D in transport]
+	BFR0(.,18) * LN(FRK(.))	[investment by fuel user]
+	BFR0(.,19) * RDEU	[German unification]
+	BFR0(.,20) * D09R	[2009 recession dummy]
+	ECM	[error]

Identity:

PREN	=	PFR0(.)/PRYM	[average price ratio]

Restrictions:

BFR0(.,3 .,4 .,5 .,6 .,7 .,14 .,15.,16 .,17 .,18) <=0	['right sign']
BFR0(.,2), BFR0(.,13) >=0	[modeling energy demand/activity ratio]
0>BRF0(.,11)>-1	['right sign']

Definitions:

BFR0	is a matrix of parameters
FR0	is a matrix of total fuel used by 22 fuel users for 33 regions, th toe.
PREN	is a matrix of average price used deflated by unit cost for 33 regions, euro/toe
FRY	is a matrix of activity for 22 fuel users and 33 regions, m euro at 2005 prices
FRTD	is R&D in machinery by the EU, m euro at 2005 prices
ZRDM	is R&D in transport by the EU, m euro at 2005 prices
ZRDT	is a matrix of investment by 22 fuel users for 33 regions, m euro at 2005 prices
FRK	is a matrix of prices of value added at market prices for each region (2005 = 1.0, local price)
PRYM	is a matrix of average prices in euro/tonne of all fuels used by each fuel user
PFR0	is a matrix of average prices in euro/tonne of all fuels used by each fuel user
RDEU	is a dummy matrix for German unification (=0 for other countries)
D09R	is a dummy matrix for 2009 recession (=0 until 2008, =1 from 2009 onward)
(.)	indicates that a matrix is defined across sectors
LN	indicates natural logarithm
DLN	indicates change in natural logarithm
ECM	[error]

Source: E3ME Manual (2012).

In Table A7 we show the values of estimated paramaters of agregated demand for energy for Slovenia.

Tabel A7: *Values of parameters of agregated demand for energy function for Slovenia.*

	COEFFICIENTS																			
FUEL USERS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Power own use & trans.	0.055	0	-0.328	0	-0.456	0	-0.473	0	0	-0.2	-0.95	7.964	0.247	-0.177	0	-0.088	-0.058	-0.027	0	0
2 O.energy own use & tra	-0.064	0	0	-0.031	0	-0.64	0	0	0	-0.2	-0.2	5.337	0.232	-0.331	-0.086	-0.019	-0.056	-0.044	0	0
3 Iron & steel	0.02	0	0	0	0	-1	0	0	0	0.6	-0.95	9.106	0.117	-0.263	-0.091	-0.249	-0.037	-0.013	0	0
4 Non-ferrous metals	0.005	0	-0.85	0	0	0	-0.169	0	0	0.095	-0.216	7.931	0.297	-0.311	-0.015	0	-0.184	-0.208	0	0
5 Chemicals	0.008	1.2	-1.3	0	0	0	0	0	0	0.093	-0.417	7.69	0.432	-0.253	-0.135	-0.073	-0.308	-0.011	0	0
6 Non-metallics nes	0.138	0.06	-0.273	-0.032	0	0	-0.021	0	0	0.01	-0.799	6.685	0.292	-0.279	-0.05	-0.027	-0.132	0	0	0
7 Ore-extra.(non-energy)	0.153	0	-1.3	0	0	0	0	0	0	-0.2	-0.2	9.544	0.751	-0.331	0	-0.166	-0.653	-0.026	0	0
8 Food, drink & tob.	-0.008	1.2	-1.3	0	0	0	0	0	0	-0.2	-0.936	4.555	0.609	-0.221	-0.003	-0.14	-0.061	-0.251	0	0
9 Tex., cloth. & footw.	-0.078	1.2	-0.504	-0.295	-1	0	-0.111	0	0	-0.2	-0.2	7.24	0.546	-0.269	-0.015	-0.049	-0.44	-0.08	0	0
10 Paper & pulp	0.049	0	-1.024	0	0	-1	-0.06	0	0	0.159	-0.2	4.684	0.635	-0.387	-0.005	-0.029	-0.106	-0.091	0	0
11 Engineering etc	0.065	0	-0.871	0	-1	0	-0.27	0	0	0.134	-0.2	6.39	0.406	-0.214	-0.005	-0.162	-0.155	-0.04	0	0
12 Other industry	0.076	0	0	0	0	0	-1.56	0	0	0.228	-0.95	12.476	0.709	-0.492	-0.02	-0.512	-0.278	-0.358	0	0
13 Rail transport	-0.042	0.844	-0.344	0	0	0	-0.024	0	0	-0.2	-0.723	5.764	0.19	-0.212	0	-0.136	-0.043	-0.016	0	0
14 Road transport	-0.107	0	-0.095	0	0	0	0	0	0	0.454	-0.574	6.184	0.602	-0.7	0	0	-0.021	-0.008	0	0
15 Air transport	0.035	0	0	0	0	0	-0.013	0	0	0.249	-0.2	5.399	0.457	-0.403	0	-0.174	0	-0.065	0	0
16 Other transp. serv.	0	0	0	0	0	0	0	0	0	0	0	0	0.146	-0.359	0	-0.08	-0.38	-0.327	0	0
17 Households	-0.004	0	0	0	0	0	0	0	0	-0.2	-0.2	3.875	0.718	-0.217	0	-0.026	-0.072	-0.258	0	0
18 Other final use	0.362	0	-0.91	-0.228	0	0	-3	0	0	0.6	-0.95	5.73	0.666	-0.248	-0.049	-0.085	-0.038	-0.361	0	0
19 Non-energy use	0.124	0	-0.681	0	-1	0	0	0	0	-0.2	-0.2	7.721	0	-0.221	0	-0.003	-0.133	0	0	0

Source: E3ME model.

The price elasticities of energy demand for fuel users are for example shown in column 3 and 14. Column 3 shows price elasticites of demand based on co-integrating dynamic equation, while column 14 shows long term elasticites of demand based on co-integrating long-term equation.. For example, 1% increase of average price ratio (variable PREN) causes decrease in quantity demanded for energy in road transportation for 0.7%.