# ***Short-run impact of the implementation of EU Climate and Energy Package for Poland***

Jan HAGEMEJER#, Zbigniew ŻÓŁKIEWSKI*


## ABSTRACT

The aim of the study is to analyse the short run impact of the EU Climate and Energy Package on the Polish economy. We focus on the short-run reaction of the economy to the shock, before the persistent structural change takes place, thereby allowing for short-term policy conclusions. The results show a relatively mild response of the economy to a seemingly significant shock in the costs of production. There is a considerable negative effect on private consumption. While the reaction of the economy depends on the flexibility of the labour market and the response of the investment demand, we observe that while budget-neutral transfers to the households dampen the private consumption response, lowering of labour costs boosts economic activity, leading to some degree of the so-called "double dividend".


JEL: C68, Q48, Q54

Keywords: computable general equilibrium, environmental policy, climate change

#National Bank of Poland, Economic Institute and the University of Warsaw, Faculty of Economic Science, corresponding author, jan.hagemejer@nbp.pl

*National Bank of Poland, Economic Institute

The views expressed in this paper are those of the authors and not of the National Bank of Poland.

# 1 Introduction

The EU climate and energy package (CEP) is a complex set a of policy measures undertaken by EU countries to contribute to global efforts aimed at preventing further deterioration of climate, manifesting itself by global warming. Reduction of the emissions of greenhouse gases, was chosen as operational goal of CEP consistent with global agreements of Kyoto and Durban, to stop global warming. CEP includes wide variety of measures and policies, working both through market mechanism (notably Emissions Trading System (EU ETS)) and also providing set of regulatory measures (eg., establishing targets of the renewable energy sources in total energy consumption or the share of biofuels in the total fuel consumption in transport). Currently binding targets[1] cover 2020 horizon, according to the "20-20-20" following general objectives:

- A reduction in EU greenhouse gas emissions of at least 20% below 1990 levels'
- Achieving 20% of EU energy consumption from renewable resources
- A 20% reduction in primary energy use to be achieved by improving energy efficiency.

These should be clearly recognized as initial phase of the implementation of the EU climate policy, given complexity of the problem and apparent long-run horizon of economic processes under consideration. Accordingly, further climate policy targets and specific measures beyond 2020 were put forward by European Commission[2] as 'Roadmap 2050' and are currently intensely debated among EU countries. Simultaneously, Europeans leaders have been active in the on-going political process

[1] See European Commission web page: http://ec.europa.eu/clima/policies/package/index_en.htm where all the documentation of EU activities on climate may be found.

[2] European Commission (2011).

for reaching a new global agreement[3] to follow on the Kyoto Protocol's and '…to demonstrate international leadership on climate issues' (European Commission,2007, p. 2). Reaching new legally binding framework for more ambitious climate action at global scale, including large non-European developed countries and also developing world seems to be crucial for the success of the climate policy.

With its focus on complex, long-term outcomes, analyses of expected costs and benefits of climate policies are usually analysed over the horizon of decades rather than years[4]. This is a natural time-span for completion of necessary changes in production and consumption pattern, change in consumer behaviour, formation of social preferences towards pro-ecological attitudes etc. However, short-run implication of the implementation of EU Climate and Energy Package and its transitional dynamics may be also interesting area of analysis, with potentially important policy implications. There are several reasons for that. First, there is evident asymmetry in time distribution of costs and benefits of climate policy: costs concentrate at initial phases of the process while most of the benefits materialise in the long-term[5] (eg. see Barker (2008)). Therefore, benefits of climate policies are mostly highlighted in the studies focused on 'end-of-the-horizon' point in time while short-run analyses illustrate and quantify efforts that are necessary to improve climate. Second, implementation of the EU Climate and Energy Package has its timetable with 'milestones' when certain new measures or mechanisms are set in motion what may trigger a sizeable shock to the economy. Absorption of this shock in the short-run may be relevant from economic policy perspective before medium and long-run effects materialise. In case of EU CEP, such an important milestone will be January 1, 2013, when the third phase of the implementation of Emissions Trading

[3] The highlight of this process over the last months was Durban climate conference (November/December 2011), http://ec.europa.eu/clima/policies/international/negotiations/durban/index_en.htm

[4] Eg., European Commission (2008), Capros *et al.* (2008), Zagame *et al.* (2009), and review papers of Dannenberg *et al.* (2007) and Tol (2010).

[5] As European Commission stated: 'The climate and renewable energy targets are ambitious in nature and will require a significant initial economic investment, even if the overall long term benefits are positive and important for the sustainable development of the EU economy' (European Commission (2008)).

System takes place and most of the allocation of emission permits will be subject to auctioning instead of free distribution. Third, some important transitional processes may concentrate in specific intervals of time, posing some threat to macroeconomic stability. For instance, this may be the case with large investment programs that, if concentrated in time, may hit the supply side constraints of real economy (construction) and banking (eg., financing large investments for nuclear power plants).

In the opinion of the authors, Poland is an example of the case of the country for which one may expect non-negligible short-run effects of the implementation of EU CEP, especially from January 1, 2013, when the IIIrd phase of Emissions Trading System is to be launched. The aim of this paper is to quantify and analyse short run (for years 2013 – 2014) impact of implementation of EU ECP on the Polish economy. The main analytical tool has been a computable general equilibrium (CGE) model, being used in the National Bank of Poland for various analyses (see: Gradzewicz *et al.*, 2006)), that was adapted for the purpose of climate policy problems[6]. Our paper is organized as follows. Section 2 provides the literature review on the expected impact of CEP on the Polish economy. In section 3 we describe data and model used for the simulations. Section 4 provides the description of simulation scenarios and an analysis of the simulation results is the subject of section 5. Finally, section 6 concludes.

## 2 Literature review

Given the focus of the paper, the literature review will cover works on short-run economic impact of climate policies and on the effects of EU Climate and Energy Package on the Poland's economy. As said above, most of the literature on economics of climate change deals with long-term socio-economic and environmental impact of climate policy. Some explicit recognition of the theoretically anticipated short term effects of climate policies may be found in Pissarides (2008). When analysing theoretically the short term effects of the introduction of carbon tax, the author

[6] This paper draws substantially on the study NBP (2012).

emphasizes two assumptions, critical for the macroeconomic adjustment immediately after the tax measures have been applied: limited factor substitution and sticky wages. Accordingly, after the production cost (and then price) of electricity increases as the result of carbon tax, this shock passes through to other industries and causes price increases in the rest of economy, with some rather slight reduction of the demand for electricity (as it is assumed to be inelastic). Given sticky wages, downward adjustment of output will result in the cuts in employment. Increase of the price of energy for final users will, given again limited possibilities to substitute away from energy in the short run, cause drop in overall real consumption. Overall, short run impact of carbon taxation for aggregate output may be rather limited but unevenly distributed throughout industries, with the energy-intensive sectors affected utmost. As the authors of NBP (2012) emphasize, the extent of the output reallocation will depend on the price elasticities of demand for particular products and on the cross elasticities. In case of Poland where comparative advantage lies to a large extent in high emission industries , cost shock induced by the implementation of the IIIrd phase of EU ETS may exert negative impact on competitiveness and eventually result in the fall in aggregate exports. At the same time, if carbon leakage effects had materialized and Poland lost market shares in manufacturing and electricity generation[7], imports of high emission products might increase. Eventually, current account my deteriorate but on the other hand, capital account may improve as additional foreign capital inflows to finance energy-related investments, although with some delay. Authors of NBP (2012) also presume that in case of Poland this energy cost shock may lead eventually not only to changes in relative prices but also may result in temporary increase in the aggregate price level[8]. This effect may be strengthened through the inflation expectations channel as it has

[7] In the view of Spencer *et al.* (2011), this type of effects in case of Poland may be expected to be mitigated.

[8] In case of Poland, the energy price shock resulting from the implementation of EU CEP may be quite strong. For instance, according to the official government forecasts (see: Ministry of Economy (2009)), over the horizon 2010 – 2015 the price of energy for the households is expected to rise by about 21%, and for enterprises – by more than 16 per cent. According to the estimates presented in NBP (2012), inflation in 2013 alone may accelerate by 0.3 – 1.5 percentage points (with respect to BaU scenario) mostly as the result of the rising energy prices (actual scale dependent, among others, on the price of emission allowances)

been proved (see: Łyziak (2009a) for Poland, with the reference to some European countries) that inflation perception and then inflation expectations[9] are driven by prices of frequently bought goods and services. Another short run effect of EU ETS is additional revenues of general government as emissions permits have been auctioned. Then, the way these revenues are spent by the government, may have significant impact on the overall effect of implementation of carbon tax or obligatory purchase of emission permits by firms, partly in the short run. In the literature, several options of recycling the revenues from carbon tax (or sale of emission permits) are analysed and simulated. The range of possibilities involves here the 'passive' option of using these additional revenues for reducing the debt level, and the 'active' options of transfers to households, or reducing some distortionary taxes (eg., tax wedge on wages to reduce labour cost), or partly reducing tax wedge and partly subsidising private environmentally oriented R&D (see: Zagame *et al*. (2009), ILO (2009), Morley and Abdullah (2010), Schöb (2003)). The literature on policy options with respect to the use of environmental tax proceeds seem to prove that some 'active' spending of these additional revenues may generate positive impact on various important macro-economic variables[10] (eg. employment, consumption, GDP), thus alleviating negative in the short term impact of higher taxation on economic activity. For instance, according to Zagame *et al*. (2009) the most favourite effect on GDP and employment may be achieved if government, when introducing environmental tax, simultaneously reduces some burden on labour cost and recycles part of the proceeds from the new tax into environmentally related R&D. While some of these effects may materialise rather in the medium-to-long run (especially R&D investment), there are some other policy options, analysed in Zagame *et al*. (2009), that may alleviate the burden of the new tax in the short run, like social transfers financed by environmental tax, that will positively affect household consumption. While some grain of salt should be advised while planning benefits of double

[9] It is important to bear in mind that consumer inflation expectations are mostly backward-looking in Poland (see Łyziak (2009b))

[10] This combined effect of imposing carbon tax: improvement of environment condition and positive (at least less negative) impact on macro variables is called in the literature *double dividend* effect (eg., ILO (2009)).

dividend effect[11], smart recycling of the environmental tax proceeds, especially involving reduction of other distortionary taxes (eg., tax wedge on wages), seems to be one of the valid options to alleviate negative shock to economy, resulting from the introduction of carbon tax.

As for the impact of the Climate and Energy Package on Poland, the literature to-date focuses on its the long-run implications (mostly, till 2020 or 2030) as for other countries. There is only scanty evidence on short-run impact or transition path to long run goals. According to the official European Commission estimates (EC, 2008), overall impact of the implementation of Climate and Energy Package for Poland, as measured by the GDP level loss at terminal 2020 with respect to the baseline, will be 1.5 – 1.6% (depending on whether emission permits are auctioned or distributed freely) *versus* 0.35 – 0.54% of GDP for EU-27. Some other analyses of the effects of EU climate policy provide similar results, at least as long as order of magnitude is concerned (eg., 0.65% of GDP for EU-27 and 0.96% for Poland, Zagame *et al*. (2009); 0.55% of GDP for EU-27 and 1.4% for Poland in World Bank (2011), upon ROCA model), while other review studies demonstrate significant diversification of estimates obtained by the various authors (Tol (2010)). The magnitude of cost (in terms of the foregone GDP) of transformation to low-carbon economic model in Europe till 2020 as was presented by the European Commission is considered as rather moderate by some authors (eg. Zagame *et al.* (2009)). There are, however, also opinions that distortions within the EU package lead to a much higher cost than necessary to meet the EU climate targets (Bohringer *et al*. (2009)). Nevertheless, these results show that Poland and most countries in the region are expected to bear much higher cost of implementation[12] of the CEP package *vis-à-vi*s European average.

[11] As authors of ILO (2009) emphasise, drawing upon some multi-country studies, '…the overall impact on employment is country-specific – positive for some countries and slightly negative for others' (p. 41).

[12] The reasons for this unfavourable position of Poland (and most regional peers) are first of all: relatively large and extraordinarily dependent on coal the power sector, low efficiency of energy generation, to large extent obsolete energy infrastructure, inefficient use of energy in transport, housing and communal services etc (NBP (2012), World Bank (2011)).

All the publications quoted above provide the estimates of the aggregate impact of EU Climate and Energy Package on European economies, including Poland, over the entire horizon till 2020 (mean deviation from the baseline or point estimates for 2020). The only study on Poland where transition to the final target is analysed in the shorter periods of time is Bukowski and Kowal (2010), being important contribution to World Bank (2011) report. Bukowski and Kowal (2010) paper covers 2010 – 2030 time horizon and the intermediate results are reported for 5 year periods, ie. for 2015, 2020 ,2025 and 2030. As for the aggregate impact of the climate package on GDP for 2020, Bukowski and Kowal (2010) estimate the GDP loss at 1.8% – 3.1% (depending on the closure of the model) against the BaU (business-as-usual) scenario, ie. achieving EU CEP targets will be more costly for the Polish economy than estimated by the European Commission. Analysis of the transition path to the transformation process provides some interesting observations. First, there is strong asymmetry in the balance of cost and benefits over time, ie. costs are accumulated in the earlier phases of implementation of the package while benefits materialize later on. In all four simulation variants, GDP deteriorates against the baseline till over 2010 – 2015, then this tendency still strengthens until 2020, and only from 2020 on GDP path converges back to the BaU line. Second, these simulations very clearly show how important are particular policy measures, accompanying implementation of Climate and Energy Package. The authors focus on fiscal policy and assuming Ricardian equivalence, close the model with either raising taxes (PIT or VAT) or reducing expenditures (social transfers or public consumption) to bridge the gap, caused by the additional cost of the implementation of the climate package for the public finance. According to this study, expenditure cutting policies noticeably dominate those oriented at raising taxes, and the most visible differences can be observed for the fiscal measures related to labour. For instance, if PIT tax is raised to finance additional environment-related expenditures then GDP falls below the baseline by 2.2% in 2015, further deteriorates to 2.4% loss of GDP by 2020 and only in the next years recovers to arrive at 0.6% below baseline GDP in the terminal 2030 year. But as for the employment, increasing PIT rate and therefore raising overall taxation of labour exerts strongly negative impact on employment level that falls short vis-à-vis baseline by 6.8% in 2030. If government instead of raising PIT decides to cut social transfers, negative shock to GDP is much smaller than before (1.5% and 1.8% below the baseline, in 2015 and 2020 respectively) and by the end of the simulation horizon (2030), GDP is even above the baseline by 0.2%. The mechanism at work in this case is adjustment of households that react to reduced social transfers by giving up leisure and intensify their efforts to find the job. Eventually, in this scenario employment after initial drop (by 0.7% in 2015) recovers relatively fast and is already in 2020 above the baseline (by 3.2%) and exceeds BaU level by 3.3% in 2030.

The results discussed above provide rationale for analysing not only long-run costs and benefits of implementation of Climate and Energy Package but also short-run impact and transitional processes. And this is at this area that our paper contributes to rather scanty literature on short-run impact of EU climate policy.

# 3 The model[13]

In order to evaluate the effects of the EU Climate Action, we use a Computable General Equilibrium model. The model used here was developed through a joint project of several institutions: the World Bank, the National Bank of Poland, the Ministry of Finance and the Ministry of Economic Affairs and Labour. The detailed documentation of the model is provided by Gradzewicz *et al*. (2006). Given the space constraints we do not replicate this documentation here, but we present in detail the most relevant features of the model.

In order to assure compatibility with national accounts, the economic institutions that are present in the model are households, enterprises, the government and banks (financial sector behavior is not explicitly modeled) and the rest of the world. Below we present a short description of the production and demand structure of the model.

All the model equations used for actual computations are written down as percentage deviations of economic variables from the benchmark equilibrium. Levels of variables enter the equations as constants that are revised in each simulation

[13] This section is adapted from Hagemejer *et al.* (2011)

iteration. The notation uses upper-case letters to denote variables in levels and lower-case letters do denote percentage changes.

Supply of goods is driven by an assumption of imperfect substitutes in production, governed by a constant elasticity of transformation function between the domestically delivered and exported products. Agents in the economy are assumed to take the exogenous world prices as given. The supply is (in percentage deviation form[14]):

$$x_{mw} = \sum_{o} \lambda_{wo}^{m} p_{om} + z_m$$

where $x_{mw}$ is the percentage output of good $m$ to destination $w$ (domestic or any export destination o), $\lambda_{wo}^{m}$ are the own and cross price elasticities of supply good $m$ in all destinations, $p_{om}$ are the prices of good $m$ in each of the destinations and $z_m$ is the percentage change of total output of good $m$.

The production technology is a multi-nested concept with a CES aggregates of value added (three types of labour and capital) and intermediate goods[15]. Firms minimize costs (expenditure on inputs) given the factor prices and the level of supply. The demand for factors of production can be expressed, in percentage form as:

$$v_{mn} = \sum_{l} \lambda_{ml}^{n} q_l^m + z_m - a_m,$$

where $v_{mn}$ is the demand for factor $n$ in production of good $m$, $\lambda_{ml}^{n}$ are the own and cross elasticities of factor demand and $a_m$ is the rate of technical progress in the production of good $m$. In the above equation, $q_l^m$ is the price that the firm has to pay for a unit of each factor of production $l$, including all taxes and social contributions. In the case of labour, we will refer to this as “cost of labour”.

Firms operate under zero profit conditions, therefore all the expenditures on employment of factors of production equal to the overall revenue across markets.

---

[14] Derivation of the demand for factors and supply to markets together with the technique of linearization is described in detail in the model documentation.

[15] This sort of treatment is now standard in general equilibrium literature.

Firms behave in a similar fashion to banks – they save a constant rate of the inflows of funds they receive from other institutions and transfer out the remaining portion of income.

Intermediate goods can be either domestically produced or imported. Both intermediate and final demand is driven by the Armington (1969) assumption, stating that goods domestically produced are imperfect substitutes to those imported (CES Armington aggregate). Similarly, imported goods are imperfect substitutes depending on the country of origin. The import demand for good *m* from destination *j* is therefore (in percentage deviation form) equal to:

$$m_{wj} = \sum_{o} \varepsilon_{wo}^{j} q_{oj} + td_j,$$

where $\varepsilon_{wo}^{j}$ are the so called Armington (own and cross) elasticities of demand, $q_{oj}$ is the price of the imported good from country *o* in the domestic currency net of all taxes and tariffs and $td_j$ is (percentage change) of total demand for good *j* encompassing all demand sources by agents in the economy.

The non-standard features of the model include non-homothetic utility function of households generating demand with non-unitary income elasticities, allowing varying shares of expenditures of normal vs. inferior goods. Each household *h* derives its income from renting its endowments of factors of production to the firm (in absolute terms):

$$YT_h = \sum_{f} W_{hf} S_{hf} + \sum_{i} PTR_{ih,}$$

where $YT_h$ is the taxable income, $W_{hf}$ and $S_{hf}$ are the (after-tax and social contribution) take-home wages (as opposed to the "cost of labour" variable) and supply levels of each factor *f*, and $PTR_{ih}$ are the transfers received from all other institutions *i*. The disposable income $YD_h$ is obtained by applying the income tax rate $IT_h$ and deducting all the outgoing transfers to other institutions. Households are assumed to save $TS_h$ at fixed percentage of the disposable income.

Households derive utility from consumption of physical goods and leisure and therefore labour supply is endogenous and conditional both on household income from various sources and relative prices of factors of production and physical goods and services. The budget constraint of the household has to therefore include the value of leisure, and the total amount that is spent on consumption is therefore:

$$EY_h = YD_h + \sum_{hp} Q_{hp} D_{hp} - TS_h,$$

where $Q_{hp}$ and the $D_{hp}$ are the price and demand for leisure type *p*. The household labour supply ($S_{hp}$) is the labour endowment $L_{hp}$ minus the demand for leisure $D_{hp}$ and the number of unemployed $LU_{hp}$:

$$S_{hp} = L_{hp} - (D_{hp} + LU_{hp})$$

The demand functions of the model can be derived from a general non-homothetic utility function (eg. Linear Expenditure System) given the budget constraint. In percentage change form, this specification boils down to the following simple specification of the demand for consumption or leisure is expressed as:

$$d_{hn} = \sum_{l} \varepsilon_{nl}^{h} q_{hl} + \gamma_{hn} e y_h,$$

where $d_{hn}$ is the percentage deviation of $D_{hn}$, the demand for commodity $l$ of the and $q_{hl}$ is the price of this commodity. $\varepsilon$ and $\gamma$ are the price and income elasticities of demand respectively. The general form of preferences allows the use of non-unitary income elasticity of demand. Note that the price for leisure in absolute terms is equal to $Q_{hp} = (1 - \mathrm{SUBST_{hp}}) W_{hp}$ due to subsidy to leisure $SUBST_{hp}$. The leisure subsidy is to be understood as the part of the social transfers (as opposed to those covered by the PTR variable) that is supposed to affect the opportunity cost of time.

Another feature of the model that is worth elaborating on is the behavior of the government that can be summarized by the formation of the budget that encompasses:

- Tax revenues net of subsidies on the production of goods (exogeneous tax/subsidy rates diversified by goods)
- Import tariffs net of export subsidies (exogeneous tax/subsidy rates diversified by good/destination)
- Taxes on the factor supply net of subsidies to leisure consumption (different tax/subsidy rate for each factor type/household)
- Income taxes from all the other institutions (different rates for each household/institution)
- The value of government consumption measured at the aggregate price index
- Government transfers to/from other institution.

In the standard closure the government consumption is exogeneously determined in real terms, while transfers are exogeneously determined in monetary terms. All the tax revenues and expenditures on subsidies are determined endogenously at fixed rates given the activity and income levels. This includes the expenditures on leisure subsidies and unemployment benefits that are conditional on the activity rates on the household and the demand for labour.

The equilibrium is defined as a set of prices/factor wages and quantities such that:

- Firms minimize expenditure given technology, factor prices and tax/subsidy rates and choose optimal bundle of inputs (demand for inputs is determined)
- Firms maximize revenue across markets (home/foreign) and choose optimal supply levels (supply to markets is determined)
- Firms operate at zero profits (goods prices are pinned to production costs)
- Consumers maximize utility given preferences, goods and factor prices and tax/subsidy rates, transfers and exogenous savings rates (demand for goods/services and supply of labour is determined)
- Product markets clear, ie. supply equals demand across uses (private/public consumption, investment, exports and domestic intermediate use) - prices of goods assure market clearing

- Factor markets clear, ie. supply of labour is equal demand of labour and the demand for capital is equal to the stock of capital (wages assure labour market clearing, the rental rate of capital assure capital market clearing).
- Government determines its savings given the (exogeneous) public consumption, tax/subsidy rates, (endogeneous) goods prices, quantities and incomes.
- The foreign savings are determined as a difference between total imports and total exports and (exogeneous) net transfers.
- The total value of investment is equal to the total savings in the economy. Investment demand is determined given goods prices.

The database used together with the model is a social accounting matrix based on National Accounts together with the input and output table. The latest National Accounts data available at the time of the database preparation was that from 2007. We use the latest available input-output table for 2005 provided by the Central Statistical Office.

The dataset is supplemented with data coming from auxiliary sources. The labour market data comes from the Labour Force Survey that allows us to disaggregate the labour supply into three categories of labour (low, medium and high skilled based on the level of education). The Household Budget Survey provides the disaggregated data on the household level (incomes, consumption spending etc.) based on which 10 aggregate household accounts are created (employed, self-employed, farmer, pensioner and other each in poor vs. non-poor category). The consumption data is matched to sectoral data through a concordance table. The detailed sectoral VAT revenues data together with disagregated international trade data in the NACE classification comes from the Ministry of Finance. The National Accounts data is augmented with the tax revenue data obtained from the Ministry of Finance and the Household Budget Surveys in order to compute the income tax rates for every household. While the model itself does not take into account progression (ie. households moving between tax thresholds), the initial tax rates are different based on the tax revenues from each of the households and they can be shocked accordingly to take into account changes in the effective tax rates.

The resulting database is balanced using a iterative Friedlander procedure resulting in a social accounting matrix that satisfies the double accounting principle, ie. each institutions income receipts are equal to the sum of its expenditures and similarly the value of produced goods plus imports is equal to the value of domestically consumed goods plus exports.

# 4 The simulation scenarios

In the short run, the need to purchase tradeable emission permits in the form of EUA – European Emission Allowance, will push the firms' costs of production upward. The size of this cost increase will depend on size of the required EUA purchase (starting from 2013 the percentage share of free permits will decrease over time) and the price of EUA.

The future EUA price levels are subject to a great deal of uncertainty, as currently most of the $CO_2$ permits are provided to firms costlessly. Therefore, the market for emission permits is characterized by relatively small turnover and transactions are not taking place continuously. Therefore, the simulation scenarios assume a range of different prices. These are based on historical prices in the period of 26.02.2008 r. – 06.12.2011 r., and include the minimum, maximum and average historical price together with an emergency scenario where the price of EUA is higher than the maximum historical price plus 3 standard deviations. The average EUA price is chosen as the central scenario. The price scenarios are presented in Table 1.

**Table 1 Range of EUA prices considered**

| Description | Price |
|---|---|
| Minimum price | 8 EUR |
| Average price | 14 EUR |
| Maximum price | 29 EUR |
| Maximum price + 3 standard deviations. | 40 EUR |

Source: own calculations based on historical prices in the period of 26.02.2008 r. – 06.12.2011 r.

For each of the assumed prices of $CO_2$ emission permits, the shock to costs of firms is calculated using the extrapolated sectoral production volumes and values for 2013 and 2014. Using fixed emission per unit of output coefficient based on data from 2008, these projected production provides a projection of sectoral emission. This is confronted with a reduced emission limit and provides an estimated number of extra permits that need to be purchased at the sectoral level. The assumed EUA prices in each scenario together with the PLN/EUR conversion rate at 4.5 provide an estimate of the extra cost that needs to be covered, which, given the future revenues of the sector, provides a production tax equivalent of similar burden.

Some simplifying assumptions are made:

- The non-ETS sectors are treated in the same way as ETS sectors (due to lack of precise information on how the reduction in non-ETS sectors will be implemented)
- We do not take into account the exclusion of sectors exposed to carbon-leakage from ETS due to the fact that we observe sectors at too general (two digit) level of aggregation

Moreover, we assume that households and entreprises have a completely price-inelastic demand for elasticity and that additional imports of energy are not possible in the short-run. Taking the above assumptions into consideration, we may treat the obtained results of the reaction in the real economy to the shocks imposed by the EU Climate Action as overly pessimistic (they are overestimated).

We also need to choose an appropriate model closure for our simulations. The standard choice for the labour market regime is the:

1. Keynesian closure (KE) – fixed wages (unemployment possible)
2. Classical closure (CL) – flexible wages (full employment)

In the basic closure, the investment level is determined by the level of total savings in the economy. Taking account the short-run horizon of the simulations, we choose the Keynesian closure as more appropriate. Scenarios KE8, KE14, KE29 and KE40 correspond to Keynesian regime under different prices of EUA permits. T

Our simulations are also run under alternative closures:

1. Keynesian-savings (KS) – Since in the benchmark closure, holding other things equal, an increase in the government surplus generates a positive investment shock in the economy, we might underestimate the negative impact of the cost shock on the activity level. To eliminate the investment response, we allow the household savings rate to adjust. Fixed wages.
2. Keynesian-transfer (KT) – we allow the government to implement a social transfer to the households that is financed with the extra net revenues from pollution permits, in order to dampen the detrimental effect of climate change policy on the private consumption. Fixed wages.
3. Keynesian-double-dividend (KD) – we allow for a reduction in distortionary taxes on labour financed by the extra revenues from pollution permits under the assumption of budgetary neutrality. Fixed wages.
4. Classical-double-dividend (CD) – same as above under flexible wages.

The KD and CD closures allow for replacement of distortions caused by the taxation on input use with other sources of revenues, in this case – taxation levied on emission intensive products. Since the main objective of pollution permits is internalizing the marginal cost of abatement, these taxes are not distortionary as they are meant to restore optimal relative price structure. On the other hand, as a result of tax replacement, distortions in the relative price of capital and labour are reduced and a so-called *double-dividend* is obtained: emission is reduced and additionally distortions are lower.

# 5 Simulation results

## *5.1 Basic scenarios*

The extra cost of pollution permits treated as an extra tax on output causes a shock to the energy prices and also a direct shock to producer prices of other emitting sectors which leads to a unambiguous reduction in economic activity. In the central scenario (KE14), where a ton of $CO_2$ emission is priced a 14EUR, the GDP falls by slightly over 0.1% relative to the business-as-usual scenario (BaU) in 2013. If the EUA prices reach the emergency level of 40 EUR per ton, the negative impact on GDP is -0.3% relative to the BaU scenario. An increase of the emission price by 10EUR per ton is expected to cause a fall in GDP relative to BaU by 0.087pp.

The reduction in economic activity and the bump in the relative consumer prices cause a drop in private consumption by 0.4% in the central scenario and in the extreme case may reach 1.1% relative to BaU. The increase in the costs of production causes exports to fall by 0.1%. Imports fall as well, not only because of the reduction in the demand for intermediates, but due to income effects of the increase in the prices of energy that constitutes a considerable share of the disposable income of households.

**Table 2 GDP and other macro variables**

| | 2013 | | | | 2014 | | | |
|---|---|---|---|---|---|---|---|---|
| **Variable** | **KE8** | **KE14 central** | **KE29** | **KE40** | **KE8** | **KE14 central** | **KE29** | **KE40** |
| GDP | -0.1 | -0.1 | -0.3 | -0.3 | -0.1 | -0.1 | -0.3 | -0.4 |
| Private consumption | -0.2 | -0.4 | -0.8 | -1.1 | -0.3 | -0.5 | -1.0 | -1.3 |
| Investment | 0.1 | 0.2 | 0.4 | 0.6 | 0.0 | 0.1 | 0.1 | 0.2 |
| Exports | -0.1 | -0.1 | -0.2 | -0.3 | -0.0 | -0.0 | -0.1 | -0.1 |
| Imports | -0.1 | -0.2 | -0.5 | -0.7 | -0.2 | -0.4 | -0.7 | -1.0 |
| Overall consumption | -0.2 | -0.3 | -0.6 | -0.9 | -0.2 | -0.4 | -0.7 | -1.0 |
| Domestic demand | -0.1 | -0.2 | -0.4 | -0.5 | -0.2 | -0.3 | -0.6 | -0.8 |
| Bgt Deficit (%GDP) | -0.1 | -0.1 | -0.3 | -0.4 | -0.1 | -0.1 | -0.3 | -0.4 |

Source: own calculations based on the model simulations. Changes in percentage points relative to the BaU scenario.

According to the simulation results, the extra revenues from sales of the EUA permits contribute to the drop of the budget deficit by 0.1-0.4 pp. (0.1pp. in the central scenario). It is worth mentioning, that due to the reduction in economic activity the tax base is considerably reduced and therefore the drop in the budget deficit is lower by half than the initial increase in the EUA sales revenues (eg. there is a considerable reduction in the personal and corporate income taxes). The increase in the economy-wide savings drives the increase in overall investment by 0.2%. While we might expect the investment to go up while firms adjust to the new regulatory environment and increase energy efficiency and at the same time reduce emissions per unit of output, the extra investment that shows up is a pure effect of extra savings in the economy, and therefore it is not the exact estimate of emission-reduction-related investment, which, according to expert opinions, is expected to be considerably higher. If the new investments is financed by the government (as the ETS directive suggests), the budget deficit change should be reduced correspondingly.

Most of the impact of the regulatory shock introduced by the EU climate change is taking place in 2013. The projected growth of energy production is relatively slow over 2013 and 2014 and the one-off reduction of freely available pollution permits in 2013 causes most of the observed changes. The extra drop in economic activity in 2013 is less than 0.1% and the cumulated impact of the increase of the EUA price by 10EUR in 2013 and 2014 is equal to 0.11pp. of GDP.

**Table 3 Sectoral changes**

| Sector | Variable | KE8 | KE14 central | KE29 | KE40 |
|---|---|---|---|---|---|
| Mining | Exports | -0.3 | -0.6 | -1.2 | -1.6 |
| | Imports | -0.5 | -0.9 | -1.9 | -2.6 |
| | Producer prices | 0.1 | 0.1 | 0.2 | 0.3 |
| | Output | -0.3 | -0.5 | -1.0 | -1.3 |
| | Value added | -0.3 | -0.5 | -0.9 | -1.3 |
| | Employment | -0.3 | -0.6 | -1.1 | -1.6 |
| Construction | Exports | 0.0 | 0.1 | 0.1 | 0.2 |
| | Imports | 0.0 | 0.0 | -0.1 | -0.1 |
| | Producer prices | 0.0 | 0.0 | 0.0 | 0.0 |
| | Output | 0.0 | 0.0 | 0.0 | 0.1 |
| | Value added | 0.0 | 0.0 | 0.0 | 0.1 |
| | Employment | -0.1 | -0.1 | -0.3 | -0.4 |
| Manufacturing | Exports | -0.3 | -0.6 | -1.2 | -1.6 |
| | Imports | 0.0 | 0.0 | 0.0 | 0.0 |
| | Producer prices | 0.2 | 0.4 | 0.7 | 1.0 |
| | Output | -0.2 | -0.4 | -0.9 | -1.2 |
| | Value added | -0.3 | -0.5 | -1.0 | -1.4 |
| | Employment | -0.3 | -0.6 | -1.2 | -1.6 |
| Market services | Exports | 0.3 | 0.4 | 0.9 | 1.3 |
| | Imports | -0.3 | -0.5 | -1.0 | -1.3 |
| | Producer prices | -0.1 | -0.2 | -0.4 | -0.5 |
| | Output | 0.0 | 0.0 | 0.1 | 0.1 |
| | Value added | 0.0 | 0.0 | 0.1 | 0.1 |
| | Employment | -0.1 | -0.1 | -0.3 | -0.4 |
| Overall | Exports | -0.1 | -0.1 | -0.2 | -0.3 |
| | Imports | -0.1 | -0.2 | -0.5 | -0.7 |
| | Producer prices | 0.1 | 0.1 | 0.3 | 0.4 |
| | Output | -0.1 | -0.1 | -0.3 | -0.4 |
| | Value added | -0.1 | -0.1 | -0.2 | -0.3 |
| | Employment | -0.2 | -0.3 | -0.5 | -0.8 |

Source: own calculations based on the model simulations. Changes in percentage points relative to the BaU scenario.

The sectors that are the most exposed to the shock are those who either use energy intensively or are a source of $CO_2$ emissions on their own. To overall drop in production in the central scenario amounts to roughly 0.1% and can reach 0.4% in the highest emission permit price scenario. The central scenario predicts a corresponding drop of employment by 0.3 and a fall in exports by 0.1 and imports 0.2. Most of the impact is concentrated in manufacturing where producer prices go up by 0.4%, production falls by 0.4% and exports fall by 0.6 with unchanged imports. The changes in manufacturing result from a change in relative prices that hampers the short run competitive position of Poland.

The fall in manufacturing output leads to a drop in demand for fuels that results in a fall of production in the mining sector by 0.5% and a drop in the imports of fuels by 0.9%. Employment in the mining sector falls by 0.6%.

Introduction of environmental policy does not affect the service sector to a large extent. However, due to low domestic demand, price of this category fall. Construction output does not change as the fall in consumption demand is offset by a boost in investment demand.

In the short run, tightening of EU environmental policy leads to a lower level of economic activity, and the change in relative prices leads at the same time to a reduction of output in the high emission industries relative to those that have much lower emission intensity, such as services.

**Table 4 Changes in the situation of households**

| Household group | Variable | KE8 | KE14 central | KE29 | KE40 |
|---|---|---|---|---|---|
| Poor | Disposable income | -0.1 | -0.2 | -0.4 | -0.6 |
| | Consumption | -0.2 | -0.3 | -0.6 | -0.8 |
| | Consumption price index | 0.1 | 0.1 | 0.2 | 0.2 |
| Non-poor | Disposable income | -0.2 | -0.4 | -0.9 | -1.2 |
| | Consumption | -0.2 | -0.4 | -0.8 | -1.1 |
| | Consumption price index | 0.0 | 0.0 | 0.0 | 0.0 |
| All | Disposable income | -0.2 | -0.4 | -0.8 | -1.2 |
| | Consumption | -0.2 | -0.4 | -0.8 | -1.1 |
| | Consumption price index | 0.0 | 0.0 | 0.0 | 0.0 |

Source: own calculations based on the model simulations. Changes in percentage points relative to the BaU scenario.

The shock in the production sectors have a significant impact on the situation of households. Due to the fall in employment, the disposable income of households falls by 0.4%. Poor households, where the share of labour income is lower than average, the fall in the disposable income is milder (0.2%) than in the non-poor households (0.4%). The fall in the private consumption in those household is lower (0.3% vs 0.4% in non-poor households). However, since poor households spend a relatively larger share of their disposable income on energy than the non-poor households, their consumption price index goes up relative to the average.

**Table 5 Labour market situation**

| Variable | KE8 | KE14 central | KE29 | KE40 |
|---|---|---|---|---|
| Wages | 0.0 | 0.0 | 0.0 | 0.0 |
| Change in unemployment rate (pp.) | 0.4 | 0.7 | 1.5 | 2.0 |
| Activity rate | 0.3 | 0.6 | 1.1 | 1.6 |
| Demand for leisure | -0.2 | -0.3 | -0.6 | -0.8 |

Source: own calculations based on the model simulations. Changes in percentage points relative to the BaU scenario.

Due to gross wage rigidity, the fall in labour demand translate into an increase in unemployment. This is greatly amplified by the fall in disposable income, which drives the activity rate upwards. The central scenario predicts an increase of unemployment by 0.7pp. relative to the BaU scenario.

**Table 6 Employment, wages and activity rate**

| Variable | Skill level | KE8 | KE14 central | KE29 | KE40 |
|---|---|---|---|---|---|
| Employment | High | -0.1 | -0.2 | -0.5 | -0.7 |
| | Medium | -0.1 | -0.3 | -0.5 | -0.7 |
| | Low | -0.2 | -0.4 | -0.8 | -1.1 |
| Wage | High | 0.0 | 0.0 | 0.0 | 0.0 |
| | Medium | 0.0 | 0.0 | 0.0 | 0.0 |
| | Low | 0.0 | 0.0 | 0.0 | 0.0 |
| Activity | High | 0.3 | 0.56 | 1.2 | 1.6 |
| | Medium | 0.3 | 0.48 | 1.0 | 1.4 |
| | Low | 0.8 | 1.34 | 2.8 | 3.8 |

Source: own calculations based on the model simulations. Changes in percentage points relative to the BaU scenario.

The changes in labour demand are mostly driven by the drop in activity in manufacturing and mining. This leads to a relatively highest decrease in employment of low-skill labour (by 0.4% in the central scenario). In this group the activity rate experiences also the highest increase, which suggests that households that supply the low-skilled labour are to a larger extent affected by rising unemployment.

## 5.2 Flexible wages, investment, social support and double dividend

Table 7 shows the results of supplementary simulations. The only difference between the scenario CL14 under classical closure is the wage flexibility. Under flexible wage regime, the drop in labour demand drives the wages down by 0.4%, result in in higher employment. While under classical closure the effect on GDP is negligible, the fall in private consumption is still the same as in the central (Keynesian) scenario, therefore the change in relative prices still has important implication for distribution of welfare.

Scenario KS14 is based on rigid wages and short-term rigidity of investment. In response to the change in disposable income, households smooth consumption by reducing their savings rates so that the overall savings in the economy remain unchanged (Ricardian equivalence). While the overall effect the policy change of GDP is equivalent to that of the central scenario (-0.1%), the fall in the private consumption is now less pronounced (0.3%).

The KT14 scenario assumes that the extra savings of the government are transferred to the households in order to compensate for the loss of purchasing power due to the environmental policy change. The transfer is revenue-neutral, so that the budget deficit is unchanged with respect to the BaU scenario. With falling disposable incomes of the households, investment in the economy falls and therefore despite the mild effect on consumption (0.2%), overall GDP falls in line with the central scenario.

The lump-sum social transfer does affect the degree to which the prices in the economy are distorted by pre-existing taxes. Scenarios KD14 (Keynesian) and CD14 (classical), allow for the policy aimed at obtaining the so-called *double dividend*; the extra revenues generated from the sales of the $CO_2$ emission permits are used, under budgetary neutrality, to lower the tax levied on labour use. We assume that the burden of the tax reduction will benefit employers and employees to the same extent. Due to the reduction, net wages increase by 0.5%. In the KD14 scenario with fixed wages, the reduction in the total cost of labour leads to a much lower drop in employment relative to the central scenario (employment falls by 0.1%). With flexible wages, the boost in activity due to reducing labour tax burden drives the GDP up by 0.1% relative to the BaU scenario. It is also worth noting, that in the classical scenario, where the split in extra surplus generated from the cut in taxes is automatically determined by demand and supply, the total after tax cost of labour falls by 0.8% which is much larger than the increase in net wage (0.2%), which can explain such a large boost in production activity.

**Table 7 Major indicators – supplementary scenarios**

| Variable | KE 14 central | CL14 | KS14 | KT14 | KD14 | CD14 |
|---|---|---|---|---|---|---|
| GDP | -0.1 | -0.0 | -0.1 | -0.1 | -0.1 | 0.1 |
| Private consumption | -0.4 | -0.4 | -0.3 | -0.2 | -0.1 | 0.0 |
| Investment | 0.2 | 0.4 | 0.0 | -0.4 | -0.3 | -0.1 |
| Exports | -0.1 | 0.1 | -0.1 | -0.1 | -0.1 | 0.2 |
| Imports | -0.2 | -0.1 | -0.3 | -0.3 | -0.2 | 0.0 |
| Domestic demand | -0.2 | -0.1 | -0.2 | -0.2 | -0.2 | 0.0 |
| Bgt deficit (%GDP) | -0.1 | -0.2 | -0.1 | 0.0 | 0.0 | 0.0 |
| Output | -0.1 | -0.0 | -0.2 | -0.2 | -0.1 | 0.0 |
| Disposable income | -0.4 | -0.4 | -0.4 | -0.2 | -0.1 | 0.0 |
| Employment | -0.2 | -0.1 | -0.3 | -0.3 | -0.1 | 0.2 |
| Unemployment | 0.7 | 0.0 | 0.6 | 0.5 | 0.6 | 0.0 |
| Wage | 0.0 | -0.4 | 0.0 | 0.0 | 0.5 | 0.2 |

Source: own calculations based on the model simulations. Changes in percentage points relative to the BaU scenario.

# 6 Conclusions

Our simulations show that the overall effect of the shift into the new stage of the EU environmental policy starting in 2013 is rather mild. This conclusion is conditional on the low expected price of the $CO_2$ emission permits. The reason behind such a moderate reaction of the economy is the overall low industry emission in the analyzed years relative to the limit set by the EU environmental policy, that is both due to earlier reduction of emissions through technology upgrading but probably more importantly due to the slowdown of the Polish and other European economies in the recent years. The emergency scenarios show that with the emission permit price exceeding the historical maxima, the overall impact of the environmental package can reach 0.4% of GDP. Despite the low overall impact on GDP, the implementation of climate and energy policy has a more pronounced effect on manufacturing and mining sectors, that generates a fall in the labour demand and unemployment. On the other hand, the drop in private consumption resulting both from the changes in relative prices and disposable income is significant. Our results show, that while the direct transfer to the households may partially alleviate the adverse effect on consumption, it is more effective to recycle the revenues from emission permits in a way that permits a reduction of the level of distortionary taxation in the economy, namely reduction in the labour taxation, as it has a similar effect on consumption with a better impact on the overall economic activity through improvements in competitiveness.

# References


Barker T. (2008), 'The Macroeconomic Effects of the Transition to a Low-Carbon Economy', The Climate Group, Briefing Paper, University of Cambridge and Cambridge Econometrics

Böhringer C. , T.F. Rutherford and R.S.J. Tol (2009), 'The Eu 20/20/2020 Targets: An Overview of the Emf22 Assessment', ESRI Working Paper No. 325

Bukowski, M., and P. Kowal (2010), 'Modelling the Transition to a Low Carbon Economy with a Large Scale DSGE Model of Poland', IBS Technical Paper, Institute for Structural Research, Warsaw,

Capros P., L. Mantzos, V. Papandreou, N. Tasios (2008), ' Model-based Analysis of the 2008 EU Policy Package on Climate Change and Renewables', Report to the European Commission - DG ENV, Brussels

Dannenberg A., T. Mennel, and U. Moslener (2007), 'What Does Europe Pay for Clean Energy? – Review of Macroeconomic Simulation Studies', ZEW Discussion Paper No. 07-019.

European Commission (2008), 'Impact Assessment. Document accompanying the Package of implementation measures for the EU's objectives on climate change and renewable energy for 2020', Commission Staff Working Document, Brussels

European Commission (2011), ‘A Roadmap for moving to a competitive low carbon economy in 2050’, Brussels.

Gradzewicz M., Griffin P., Zólkiewski Z. (2006), ‘An Empirical Recursive-Dynamic General Equilibrium Model of Poland’s Economy. Including Simulations of the Labor Market Effects of Key Structural Fiscal Policy Reforms’, Document of the World Bank and National Bank of Poland, Warsaw.

Hagemejer J., Jędrzejowicz T., Żółkiewski Z. (2011) ‘Fiscal tightening after the crisis. A scenario analysis for Poland’, Bank i Kredyt, National Bank of Poland, Economic Institute, vol. 42(3), pages 33-66.

ILO (2009), ‘The Double Dividend and Environmental Tax Reforms in the European Union’, International Labour Organization, International Institute for Labour Studies, EC-IILS Joint Discussion Paper Series No. 13

Łyziak T. (2009a), ‘Is Inflation Perceived by Polish Consumers Driven by Prices of Frequently Bought Goods and Services?’, Comparative Economic Studies, 2009, 51, pp. 100–117.

Łyziak T. (2009b), ‘Measuring consumer inflation expectations in Europe and examining their forward-lookingness’, MPRA Paper No. 18890 (Online at http://mpra.ub.uni-muenchen.de/18890/)

Ministry of Economy (2009), ‘Projection of Demand for Fuels and Energy Until 2030. Appendix 2 to draft “Energy Policy of Poland until 2030”, Warsaw

Morley B. and S. Abdullah (2010), ‘Environmental Taxes and Economic Growth: Evidence from Panel Causality Tests. Working Paper. Bath, UK: Department of Economics, University of Bath. Available at: http://www.bath.ac.uk/economics/research/workingpapers.html

NBP (2012), ‘Krótkookresowe skutki makroekonomiczne pakietu energetyczno-klimatycznego w gospodarce Polski’ (Short-run macroeconomic effects of Cllimate and Energy Package for the Polish economy), National Bank of Poland, Warsaw

Pissarides C. (2008), 'Assessment of macro-economic transmission mechanisms of carbon constraints through the UK economy. Report for the Committee on Climate Change. Available at: http://www.theccc.org.uk/reports/building-a-low-carbon-economy/supporting-research

Schöb R. (2003) 'THE DOUBLE DIVIDEND HYPOTHESIS OF ENVIRONMENTAL TAXES: A SURVEY', Otto-von-Guericke-University Magdeburg and CESifo, Munich

Specner T., A. Korppoo , K-O. Lang and M. Kremer (2011), 'Linking an EU Emission Reduction Target Beyond 20 % to Energy Security in Central and Eastern Europe', FIIA Working Paper Nr. 69

Tol R.S.J. (2010), 'The Costs and Benefits of EU Climate Policy for 2020', Copenhagen Consensus Center

World Bank (2011), 'Transition To A Low-Emissions Economy In Poland', The World Bank, Washington DC 20433

Zagame P., P. Le Mouel, Gharbi O., P. da Costa, D. Schirman-Duclos, F. Pratlong (2009), 'Macroeconomic assessment for the EU Climate Action and Renewable Energy Package', ERASME, Ecole Centrale Paris