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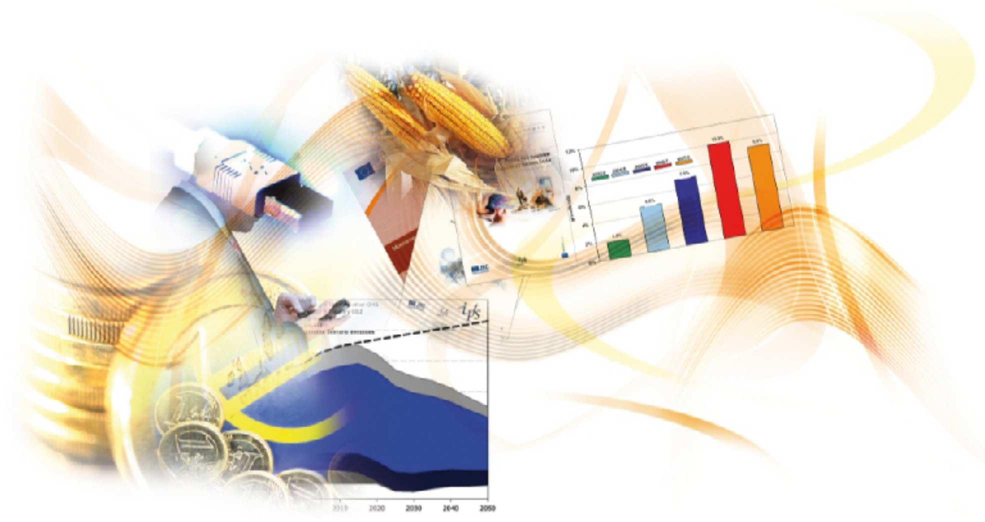
Does climate policy make the EU economy more resilient to oil price rises? A CGE analysis

Hélène Maisonnave, Jonathan Pycroft, Bert Saveyn and Juan-Carlos Ciscar



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Contact information
Address: Edificio Expo. c/ Inca Garcilaso, 3. E-41092 Seville (Spain)
E-mail: jrc-ipts-secretariat@ec.europa.eu
Tel.: +34 954488318
Fax: +34 954488300

http://ipts.jrc.ec.europa.eu
http://www.jrc.ec.europa.eu

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Abstract

The European Union has committed itself to reduce greenhouse gas (GHG) emissions by 20% in 2020 compared with 1990 levels. This paper investigates whether this policy has an additional benefit in terms of economic resilience by protecting the EU from the macroeconomic consequences due to an oil price rise.

We use the GEM-E3 computable general equilibrium model to analyze the results of three scenarios. The first one refers to the impact of an increase in the oil price. The second scenario analyses the European climate policy and the third scenario analyses the oil price rise when the European climate policy is implemented.

Unilateral EU climate policy imposes a cost on the EU of around 1.0% of GDP. An oil price rise in the presence of EU climate policy does impose an additional cost on the EU of 1.5% of GDP, but this is less than the 2.2% of GDP that the EU would lose from the oil price rise in the absence of climate policy. This is evidence that even unilateral climate policy does offer some economic protection for the EU.

Keywords: Climate policy; Oil prices; Computable general equilibrium (CGE)

1 Introduction

The European Union addresses the inter-related issues of climate change and energy security through its Climate and Energy Package, which commits the Union to reducing greenhouse gas (GHG) emissions by 20% in 2020 compared with 1990 levels (European Commission, 2008b). It is well-established that significant reductions in GHG emissions, such as those proposed, substantially reduces the risks of large damages from climate change (e.g. Mastrandrea and Schneider, 2004; Stern, 2007). By meeting these goals, the EU would directly reduce world GHG emissions, to which the EU is a large contributor, and, it is hoped, would encourage other regions to do likewise.

A second justification of the ambitious EU climate policy is energy security. The potential benefits for Europe in terms of energy security have been recently assessed in the Commission roadmap to a low-carbon economy (European Commission, 2011a, 2011b). Oil and gas imports could be halved compared to today thanks to the decarbonisation of the energy system, with an average annual reduction of average fuel costs estimated to be between 175 and 320 billion Euro. Without the proposed transformation of the energy system, the EU energy import bill could double by 2050, with additional expenditure of around 400 billion Euros, around 3% of the current EU GDP.

Historically, oil price rises have been a contributory cause to a number of economic recessions, perhaps including the current economic slowdown, which occurred following the 2007-2008 oil price shock (Hamilton, 2009). Intuitively, one might expect that adopting climate policies would make a region less susceptible to oil price changes. Climate policies, in general, reduce a region's reliance on fossil fuels, reducing its macroeconomic vulnerability to fossil fuel price shocks. Furthermore, if the sources of energy are more diversified, there would be more alternatives should there be a rise in the price of oil, or any particular energy commodity (see Toman, 2002). Nevertheless, the opposing case can be made by considering the elasticity of demand for oil. If the economy has already reduced the use of fossil fuels (to meet the climate policy objectives) in those areas where it can be done most easily, then the remaining demand may be less elastic in the face of rising fossil fuel prices. Were this to be the prevalent factor, climate policies could make an economy more vulnerable to oil prices. Therefore numerical simulation is required to examine both the sign and the magnitude of the net effect.

The remainder of the paper is structured as follows. The second section describes the theoretical framework, outlining the relevant literature. The third section shows the modelling framework, giving a description of the model, the model calibration and the scenarios implemented. The fourth section explains the results, and the final section concludes.

2 Theoretical Framework

This section reviews the literature surrounding climate policies and fossil fuel prices, after which our approach is outlined, explaining how it builds on previous work, and offers a new perspective.

There are a fair number of studies that investigate the two issues of oil prices and climate policy separately. To take two examples that are especially pertinent to this research, Ciscar et al. (2004) simulate the impact of high oil prices on the EU economy using an earlier version of the GEM-E3 model. *Inter alia*, they find that a rise in the price of oil of $30 per barrel would lead to a 2.56% decrease in EU GDP.[1] With respect to climate policy, Böhringer et al. (2009a) uses the PACE model (Policy Analysis based on Computable Equilibrium; Böhringer et al., 2009b) to investigate numerous aspects of the efficiency of EU climate policy, especially overlapping regulation (having both black quotas, i.e. emissions limits, and green quotas, i.e. renewable energy targets) and the differential emissions pricing between those sectors included in the Emissions Trading Scheme (ETS) and those that are not.

A few studies address the synergies between climate policy and oil prices, often in the context of energy security. Turton and Barreto (2006) investigate such synergies using a "bottom-up" multi-regional energy-systems optimisation model, ERIS (Energy Research and Investment Strategies; Turton and Barreto, 2004). They find that achieving emissions cuts does improve the security of oil supply; however the reverse is not true, which suggests that the synergies are weak. In terms of technologies, both energy security and GHG emission reduction encourage movements towards hydrogen fuel cells and nuclear energy. They emphasise keeping a flexible energy system in the face of "scientific, geopolitical and policy uncertainty" (p.2247).

Brown and Huntington (2008), in a study of energy technology options, also note certain technologies (e.g. cellulosic ethanol) are effective in pursuing both energy security and climate policy objectives. However, they also note that for many technologies there are trade offs rather than synergies. They argue that sometimes a given level of energy security and emission reduction is most efficiently achieved by a combination of policies (e.g. an enhanced strategic petroleum reserve combined with a renewable portfolio standards program) rather than seeking out technologies that move towards both goals at once.

Vielle and Viguier (2007) study the extent to which high oil prices have a positive side effect of reducing GHG emissions. Using a global CGE model, GEMINI-E3 (General Equilibrium Model of INternational Interactions between Economy, Energy and the Environment; Bernard and Vielle, 2008), they find some impact of higher oil prices reducing GHG emissions, however the benefits are much smaller than one might expect. The problem is that substitution occurs, especially towards coal, an even more intensive source of GHG emissions. They also note that high oil prices are a less equitable and less efficient manner of reducing GHG emissions than a well-designed climate policy.

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[1] Among the differences between this analysis and the OP scenario below is that this uses an earlier model version calibrated to 1995 data, and the method of implementing the scenario.

Protection against high fossil fuel prices is explicitly stated as a justification for the EC policies mentioned above in the Impact Assessment documents (European Commission, 2008a;2008c). This Assessment cites results from the partial equilibrium PRIMES model (Partial Equilibrium Model for the European Energy System; E3Mlab, 2010b) which investigated the cost of meeting the 2020 GHG targets under different fossil fuel prices. The additional cost required to meet the GHG targets fell if a higher fossil fuel price was assumed (though naturally, the total energy cost rose) pointing to a protection effect from climate policy.

Perhaps the most similar analysis to ours comes from Rozenberg et al. (2010). Using a hybrid simulation model of the world economy, IMACLIM-R, the paper compares the cost of implementing climate policy in a reference case, and when oil and gas production is very constrained. They estimate that climate policy implemented by all world regions costs 1.7% of gross world product (GWP) on average, and the constraint on fossil fuels alone costs 2.6% of GWP. Implementing climate policy, when fossil fuels are constrained, costs a total of 3.3% of GWP, i.e. the *additional* cost of climate policy fell to 0.7% of GWP. Alternatively, one could consider the *additional* cost of a high oil and gas price, which is 1.6% of GWP (3.3 less 1.7). This is good evidence that universally-adopted climate policies act as a partial shield to protect against high fossil fuel prices. The authors conclude that "Climate policies … can be considered as a hedge against the potential negative impact of oil scarcity on the world economy" (p.5).

3 The modelling framework

In this section we present the main features of the modelling framework, outlining (i) the model structure, (ii) the calibration of the base year and model baseline, and (iii) the scenarios implemented.

3.1 Model structure

This sub-section introduces the structure of the GEM-E3 model (E3M Lab, 2010a; Capros et al., 2012), in particular the behaviour with respect to production, domestic consumption and trade, and also the model closure choices. The GEM-E3 model is a world recursive dynamic computable general equilibrium (CGE) model, especially designed to evaluate GHG emissions policies.

Producers are assumed to maximise profits subject to their technology, which is represented in a four-level production structure. Producers are able to partially substitute between inputs at each level, subject to constant elasticity of substitution (CES) functions. At the top level, capital can be substituted with an aggregate (or composite factor) of labour, energy and materials. At the second level, this aggregate is split between electricity and an aggregate of labour, materials and fuels, which can again be substituted subject to a CES function. At the third level, this aggregate is split into its components: labour, materials and fuels, which are partially substitutable (CES). Finally, at the lowest level, the substitution between types of materials is defined by a CES function, as is (separately) the substitution between types of fuels (coal, oil and gas). We assume full labour mobility between sectors but no international mobility. Capital is region-specific and fully mobile for all sectors with the exception of oil sector.

Total domestic demand is constituted by the demand of products by government, producers and consumers. Households maximize their utility according to a Stone-Geary function (Stone, 1954), whose arguments are leisure and consumption. In other words, the household determines the amount of leisure it is willing to give away to get the desired amount of income. In a second stage, total consumption is decomposed into demand for specific consumption goods. The split refers to demand for durable and non durable goods, following Conrad and Schröder (1991).

Total demand is allocated between domestic and imported products, following the Armington (1969) specification. According to this specification, products are imperfect substitutes given their origin.

Each region buys and imports at the prices set by the supplying regions following their export supply behaviour.

As explained in detail in the GEM-E3 manual (E3M Lab, 2010a), the environment module contains two parts: the "behavioural" module and the "state of the environment" module. The former represents the response of economic agents to different policy instruments, whereas the latter converts the emissions information into values for deposition, air-concentration and damage.

To meet its 2020 emissions reduction obligations, the EU established the Emissions Trading System (ETS).[2] The ETS is a traditional cap and trade system, only applied to European countries, that determines an absolute quantity limit on greenhouse gases for Europe as a whole, and tradable permits are distributed to firms. The ETS is only applied to specific energy-intensive industrial sectors (see list in section 3.2 below). These sectors represent about half of the EU CO_2 emissions and around 40% of the GHG emissions covered by the Kyoto protocol (Ellerman and Joskow, 2008).

There are three methods by which permits are allocated to firms under the ETS: grandfathered allocation (GFA), output-based allocation (OBA) and auctioning. While GFA represents a wealth transfer to firms, OBA provides an implicit output subsidy to them that could help them to lower the negative competitiveness impact of GHG mitigation policy caused by an increase in production cost (see Dissou and Robichaud, 2003, Dissou, 2005, Fischer, 2001, and Fischer and Fox, 2004). In the model, the energy intensive sectors face an OBA of emissions permits whereas non-energy intensive sectors have a GFA system. Lastly, the electricity sector uses auctioning to allocate permits. These methods are consistent with the EU policy directives (European Commission, 2009).

[2] For a more detailed description of the ETS, please refer to Ellerman and Joskow (2008).

3.2 Model calibration

The model is calibrated on 2004 data using the GTAP-7 data base (Global Trade Analysis Project). The model features a disaggregation of the economy into 20 industries, among which are 5 energy intensive industries that are included in the ETS (electricity, ferrous and non ferrous metals, chemical products, other energy intensive and petroleum products). The remaining non-ETS sectors are agriculture, coal, crude oil, natural gas, electric and other equipments goods, transport equipment, food industries, textile industries, other industries, construction, transport, credit and insurance services, gas distribution, other market services and non market services.

The regional disaggregation of the model covers 21 regions, setting apart the main actors and negotiating groups at the United Nations Climate Change Conference in Copenhagen in 2009 (COP 15): EU27, USA, Japan, Canada, Australia and New Zealand, China and Hong Kong, India, Mexico, Turkey, Russian Federation, Brazil, South Africa, South Korea, Ukraine and Belarus, Commonwealth of Independent States, Middle East and North Africa, East Asia, Rest of Latin America, Rest of Asia, Rest of Europe and the rest of sub-Saharan Africa.

The model baseline (or business-as-usual, BAU), with which we compare the scenario results, runs to the year 2030. The baseline does not assume any climate policy in any region of the model. The baseline has been built using projections for total population, active population, GDP and GHG emissions. For total population, UN projections are used (United Nations, 2004), and ILO data for active population (International Labour Organisation, 2004). The future GDP path is calibrated to data from the World Economic Outlook report (International Monetary Fund, 2008), which takes into account the current economic crisis. Finally, the regional GHG emission projections are based on the emission trajectories from the POLES model (Prospective Outlook for the Long term Energy System model; Russ et al., 2007). This model computes projected levels of GHG emissions for all the regions given assumptions about efficiency improvement and other determinants of emissions, such as GDP and population, which are consistent with those of the GEM-E3 model.[3] Factor productivity parameters in the production function and other model parameters are adjusted to attain the baseline scenario.

3.3 Description of the scenarios

Our scenarios build on earlier work, and specifically focus attention on the idea of the EU pursuing climate policies unilaterally. Three scenarios are investigated: a rise in the oil price alone (OP), the introduction of climate policy within the EU (CP), and both together (OP&CP). The world CGE framework allows us to analyse not only the direct impacts of these changes, but also the subsequent, general equilibrium impacts, especially the key trade linkages between economic regions. The nature of the model also considers the role of oil within each economy, and hence, the differing effects that a price change would bring about.

For the rise in oil price (OP), we wanted to consider the likely scenario of oil prices rising to 2030. The magnitude of the increase was informed by the literature for energy price forecasts. For example, the recent IEA World Energy Outlook (International Energy Agency, 2010:6) suggest that there will be "growing insensitivity of both demand and supply to price". In one of the key scenarios in this report, the New Policies Scenario, the price of oil is expected to roughly double between 2009 and 2035. This is already a dramatic increase, however others would consider this optimistic as the scenario in question assumes that peak oil production is not reached during this time. Other research, such as Aleklett et al. (2010), argues that peak oil may have already been reached. Hirsch et al. (2006) offer a list of 12 estimates for the peaking of world oil supply, of which 9 out 12 suggest that peak oil will

[3] In order to reconcile the GDP and GHG emission paths, adjustments in the model baseline are made to factor productivity parameters, investment function parameters, consumption category parameters and to the emission coefficients per unit of production.

occur by 2016. Were peak oil to be reached earlier than assumed in the IEA Scenario, the oil price would be expected to rise even more steeply.

With this issue in mind, we decided to implement somewhat higher price rises than that the IEA New Policies Scenario. Specifically, we cause a rise in oil price of 50% in 2020, rising to 100% in 2025 and 150% in 2030 compared with the model baseline (BAU) values. Clearly, these values ought not to be taken as precise predictions. The purpose of our study is not to predict such prices, but rather to investigate how high oil prices interact with climate policy. Nevertheless, we do contend that the magnitudes introduced are plausible based on the literature.

To implement the price increases in the model, we restrict the capital stock for the crude oil sector across the world (as in Ciscar et al., 2004). The capital scarcity induces an increase in the production price and therefore in the sale price. We assume that all the regions face the same oil price shock. This shock should have a major impact on all the economies, notably through an intermediate consumption effect as most sectors in all regions use oil as an input.

The second scenario (CP) represents a unilateral EU climate policy. This involves a commitment to decrease GHG emissions by 20% in 2020 compared to their level in 1990. The policy starts in 2015, beginning the restriction of EU emissions so as to hit the 2020 commitment in the next time period. In 2025 and 2030, no further GHG reductions are made with emissions being maintained at the 2020 target. As the EU policy is unilateral, no restrictions are placed on the GHG emissions of other regions.

The model implements the scenario by restricting the "supply" of emissions. This leads to an increase in the production prices (depending on the emission intensity of the production). In effect, emissions become an input into the production function, and as producers now need to pay for emissions, the production price increases. As noted, some economic sectors are subject to the ETS, and this group of sectors has a specific emission reduction target to meet. The remaining non-ETS sectors must collectively make the remaining emission reductions.

The only direct impact of this policy is on the EU, however a reduction of or shift in economic activity in the EU will impact on other regions through international trade channels. In particular, the more other regions export to the EU, the greater this effect is likely to be.

The third scenario, OP&CP, combines OP and CP. The purpose of this is to investigate whether climate policy is cheaper to implement if there are high oil prices. This involves comparing the differences between OP and OP&CP versus the differences between BAU and CP. Alternatively, one could ask whether climate policy offers protection against a high oil price. This involves comparing the differences between CP and OP&CP versus the differences between BAU and OP.

4 Results

In our presentation of the main results, we focus on the EU, the USA, China[4] and the world economy. Firstly, we focus on the impact of the scenarios on production. Secondly, we look at the impact on trade. As all scenarios have significant trade impacts, summary statistics for the main trading partners of the key regions are included in the Appendix (Table 7 and Table 8). Then we explore the implications of the scenarios in terms of household welfare changes. Finally, we analyse the GHG and CO_2 emissions changes in the different scenarios.

[4] Note that the China region in our model is inclusive of Hong Kong (which is separate in the GTAP database).

Impact on GDP

As shown in Table 1 below, the simulated rise in the world oil price (OP) negatively impacts the three key regions of interest (the EU, the USA and China) and the world economy as a whole. Recall that the scenario implements a 50% price rise in 2020, 100% in 2025 and 150% in 2030 (with respect to the BAU prices). A price rise of this magnitude contracts the world economy by 2.7% in 2030. The contraction is slightly smaller for the EU and the USA (2.2% and 1.9% respectively).

Table 1: Impact on real GDP (percentage difference with respect to the BAU)

	EU		USA		CHINA		WORLD	
	2020	2030	2020	2030	2020	2030	2020	2030
OP	-1.06%	-2.23%	-0.90%	-1.95%	-1.28%	-2.63%	-1.27%	-2.73%
CP	-1.09%	-0.97%	-0.21%	-0.27%	-0.28%	-0.36%	-0.44%	-0.46%
OP&CP	-1.73%	-2.48%	-0.92%	-1.91%	-1.30%	-2.58%	-1.45%	-2.76%

The introduction of a unilateral EU climate policy (CP) imposes a constraint on EU firms. In effect, the production price for EU firms rises as they need to take account of the cost of emitting GHGs (see section 3.3 above for an explanation of how this is implemented). This is the main cause of the reduction in EU GDP of 1.1% in 2020 and 1.0% in 2030.

Though other regions are not directly affected by the EU climate policy, there are two indirect effects. Firstly, there is a substitution effect as one expects the extra burden on EU firms to make them somewhat less competitive in export markets, which would generally benefit other regions. Secondly, the smaller EU economy reduces the size of the export market for other regions (income effect), which would reduce the production in other regions. Our results show that the second channel dominates for the USA and China (a 0.3% and 0.4% GDP loss respectively), noting the importance of the trade transmission mechanism.

The OP&CP scenario combines the oil shock and the EU climate policy. For the EU, facing both impacts together causes a fall in GDP of 1.7% in 2020 and 2.5% in 2030. That the fall is the largest of the three scenarios is expected, however the interesting point is by how much extra GDP falls. To emphasis a key result, Table 2 presents the GDP figures for the EU in 2030 in a different format.

Table 2: EU GDP losses under different scenarios in 2030 (percentage difference with respect to the BAU)

	No Oil Price Rise	Oil Price Rise	Cost of oil price rise
No climate policy	BAU	- 2.23% (OP)	2.23%
Climate policy	- 0.97% (CP)	- 2.48% (OP&CP)	1.51%
Cost of climate policy	0.97%	0.25%	

What Table 2 clearly shows is that the oil price rise is less costly when a climate policy is in place. As already noted, without climate policy, an oil price rise costs 2.2% of GDP. With a climate policy in place, the same oil price rise costs 1.5% of GDP, approximately one-third less. In this respect, the results demonstrate that the climate policy does offer some protection against an oil price rise.

An alternative way of viewing these results is to look at the cost of implementing the climate policy. As previously shown, with no oil price rise, climate policy costs 1.0% of GDP to implement. However, if oil prices are high, the climate policy is more easily implemented, costing only an additional 0.3% of GDP.

Impact on Trade

The export and import changes are shown in Table 3 and Table 4. A rising oil price (OP) reduces world trade by 5.7% in 2030 below the BAU level. The impact on exports is mixed, with EU exports only falling by 1.0%, compared with those of the US (falling by 3.2%) and those of China (by 6.2%). The fact that EU and US exports hold up relatively well in the face of high oil prices is a key reason why they experience a lower GDP fall than China in this scenario (recall Table 1 above). With respect to imports, the percentage falls are more similar across the three regions with the EU, the USA and China falling by 5.5%, 6.2% and 6.1% in 2030 respectively.

Table 3: Impact on exports (percentage difference with respect to the BAU)

	EU		USA		CHINA		WORLD	
	2020	2030	2020	2030	2020	2030	2020	2030
OP	-0.48%	-1.00%	-1.38%	-3.20%	-2.60%	-6.22%	-2.80%	-5.68%
CP	-1.23%	-0.26%	-0.75%	-0.83%	-0.63%	-0.85%	-0.67%	-0.68%
OP&CP	-2.38%	-2.49%	-1.57%	-3.16%	-2.71%	-6.11%	-3.17%	-5.85%

Table 4: Impact on imports (percentage difference with respect to the BAU)

	EU		USA		CHINA		WORLD	
	2020	2030	2020	2030	2020	2030	2020	2030
OP	-2.96%	-5.47%	-3.06%	-6.21%	-2.66%	-6.13%	-2.77%	-5.66%
CP	-3.64%	-3.63%	0.09%	0.03%	0.04%	0.03%	-0.72%	-0.70%
OP&CP	-5.14%	-6.39%	-2.95%	-6.18%	-2.55%	-6.05%	-3.18%	-5.84%

Under the EU climate policy scenario (CP), EU exporters are somewhat less competitive, driving the reduction in EU exports in 2020. However, with regard to trade demand, the direct effect of the policy is on the EU economy itself, not its export markets. For this reason by 2030, EU exporters are only mildly affected by the policy relative to the BAU. On the other hand, the EU is a key market for many exporters accounting for 27% of US exports and 26% of Chinese exports (2004 data; see Appendix for more details). This accounts for the falls in exports from the US and China of 0.8 and 0.9% in 2030 respectively. On the import side, the introduction of EU climate policy alone was of little consequence for the non-EU regions. As such, the modest changes for the US and China are as expected. The overall fall in world imports is almost entirely driven by the EU reduction.

The OP&CP scenario shows the highest drop in trade for the EU. Other regions have trade changes similar to those of the OP scenario. Even on the export side, despite the significant fall in EU imports, the US and China maintain a level of overall exports similar to that in the OP scenario. This shows that, as the EU exports fall, a share of these markets become supplied from the US or China.

Impact on household welfare

The welfare index is computed from the consumer's utility function and an environmental welfare base index based on the valuation of the damage generated by the policy (E3M Lab, 2010:27). One would expect a decrease of the welfare index in the first scenario, as every region faces the oil price increase. The loss is mainly driven by the drop in households' consumption (leisure levels remain almost the same). Note that net oil exporting regions, such as Middle East and North Africa (MENA) and Russia, experience welfare increases, as they benefit from the increase in the price of oil.

The results for the EU (Table 5) are similar as those already noted on GDP. In 2030, the oil price rise scenario (OP) would lead to a 4.0% fall in EU welfare. The unilateral climate policy (CP) would induce a 1.5% welfare loss, which is partially driven by the higher costs of production being passed onto consumers. If an oil price rise also occurs (OP&CP), the welfare loss would rise to 4.0%, meaning that the additional cost of the oil price rise is only 2.5% of GDP. This is significantly less than the 4.0% cost of the oil price rise without climate policy.

Table 5: Impact on household welfare (percentage difference with respect to the BAU)

	EU		USA		CHINA		WORLD	
	2020	2030	2020	2030	2020	2030	2020	2030
OP	-2.08%	-3.99%	-1.05%	-2.10%	-1.59%	-3.19%	-0.92%	-2.10%
CP	-1.42%	-1.48%	-0.11%	-0.16%	-0.11%	-0.17%	-0.29%	-0.33%
OP&CP	-2.61%	-4.03%	-1.04%	-1.59%	-1.54%	-3.14%	-1.02%	-2.10%

Note that in the EU climate policy scenario (CP), the impact on welfare is hardly perceptible for the USA and China. The slight fall in welfare loss is driven by the fall in consumption. Finally, in the combined scenario (OP&CP) for the world as a whole, we obtain almost the same results as in the OP scenario, meaning that if the oil price rises, there is no additional world welfare loss from EU climate policy in 2030.

Impact on emissions and the marginal abatement cost

Before analyzing the impact on GHG emissions, it is worth considering the BAU scenario. In the absence of shock or policy, the model baseline (BAU) estimates that world emissions would rise from 37.0 Gt in 2005 to 67.6 Gt in 2030. China is predicted to have the largest rise from 7.0 to 18.2 Gt over the period. The USA would increase from 7.0 to 9.7 Gt, and the EU would also increase from 5.2 to 6.0 Gt.

All scenarios, as expected, show a fall in emissions compared with the BAU scenario, as shown in Table 6. World emissions fall by 6.3% in 2030 in the case of the oil price rise (OP). The fall is not distributed evenly however, with the EU and the USA showing falls of around 9%, while China shows a fall of only 0.7%.

Table 6: Impact on GHG emissions (percentage difference with respect to the BAU)

	EU		USA		CHINA		WORLD	
	2020	2030	2020	2030	2020	2030	2020	2030
OP	-4.20%	-9.17%	-4.08%	-9.00%	-0.13%	-0.68%	-2.88%	-6.25%
CP	-23.89%	-24.39%	0.60%	0.42%	0.00%	-0.02%	-2.20%	-1.99%
OP&CP	-23.89%	-24.39%	-3.57%	-6.37%	-0.12%	-0.64%	-4.68%	-7.49%

In the second and third scenarios (CP and OP&CP), the level of EU emissions is fixed at 20% below 1990 levels. This represents 23.9% below BAU in 2020 and 24.4% below BAU in 2030. The total world emissions fall by 2.0% in 2030 in the CP scenario, which is almost entirely due the emission reductions in the EU, which represents 9% of total world GHG emissions in 2030 in the BAU. The combination of the oil price rise and the policy causes world emissions to fall by 7.5% overall in 2030. Again the additional fall beyond the OP scenario is almost entirely due to the extra efforts of the EU.

Comparing the OP and CP reductions for the EU, one notes that despite the oil price rise being twice as costly in GDP terms, it causes just over one-third of the GHG reductions. This suggests that whilst an oil price rise does cut emissions, it do so in a much less efficient fashion than a well-designed climate policy.[5]

A final result of interest relates to the marginal cost of reducing GHG emissions. The GEM-E3 model calculates the marginal abatement cost (MAC), which equals the overall economic loss to the EU were it to reduce its GHG emissions by one more tonne of CO_2-equivalent. This statistic is only calculated for regions who are implementing a climate policy, therefore in this paper, only for the EU in scenarios CP and OP&CP. The average[6] MAC for the EU under CP rises to \$111/tCO_2e (measured in 2004 prices) in 2020, before falling slightly to \$99/tCO_2e. For the case of a high oil price, OP&CP, the average MAC is \$90/tCO_2e in 2020, falling to just \$49/tCO_2e in 2030, once the full extent of the oil price rise has been entered. The fact that by 2030 the MAC halves in the face of a much higher high oil price is another way of recognising the synergies between climate policy and oil prices.

5 Conclusion

The decision by the EU to unilaterally reduced GHG emission in 2020 by 20% (with respect to 1990 levels), according to our results, carries an economic cost of around one percent of GDP. Among the list of benefits that this decision may bring, our findings suggest an additional one: that the climate policy offers some protection against the macroeconomic consequences of an oil price rise. In

[5] This finding mirrors that of Vielle and Viguier (2007; see section 2 above).

particular, we find this result when climate policy is adopted unilaterally. A rising oil price over the coming decades is widely anticipated, making increased energy security a potentially relevant side-benefit of climate policy.

In terms of magnitude, our results suggest that for a plausible increase in the oil price, climate policy reduces the additional cost to the economy from 2.2% to 1.5%, meaning that the cost falls by approximately one-third. This can be interpreted as the extent of the protection offered by EU climate policy against a rising oil price. An alternative way of reading the results is to look at how expensive it is to introduce EU climate policy. With baseline oil prices, the cost of climate policy was 1.0% of GDP in 2030. However, with high oil prices the additional cost is merely 0.3% of GDP, suggesting that with high oil prices, climate policy is much cheaper to implement. Note that for both interpretations of the results, the same stories can be told in terms of EU welfare.

A number of caveats should be noted, which also suggest future directions for research. Firstly, in light of the projections of rising oil prices, economic agents would be expected to change their investment behaviour, focusing more on less oil-intensive technology. An intertemporal CGE model would be one method of incorporating this idea. Secondly, the introduction of oligopolistic modelling of the oil production would more accurately portray that sector. Thirdly, another interesting study would be to analyse the situation where many, or all, regions commit to a reduction in emissions. This would presumably occur primarily because of a multi-lateral commitment to tackle climate change, but may also be encouraged by the side-benefits of pursuing climate policies, such as increased economic resilience to oil price rises.

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[6] As the GHG reductions are made separately for the ETS and non-ETS sectors, there are two MACs. The reported figure is a weighted average of these two.

Disclaimer

The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

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6 Appendix: Trade Partners for Major Regions

The following tables show the main trade partners for the EU, USA and China. The destinations of exports (Table 7) and origin of imports (Table 8) are split according to the 21 regions within the GEME3 model.[7] In each case, the largest four regions (out of 20 destinations/origins) are shown.

Table 7: Four main export destinations for selected regions

from EU		from USA		from China	
Destination	% of total	destination	% of total	destination	% of total
USA	25%	EU	27%	USA	27%
non-EU Europe	12%	Canada	18%	EU	26%
M. East & N. Afr.	11%	Mexico	11%	Japan	14%
China	7%	China	7%	East Asia	9%

Source: Authors computation from base data.

Table 8: Four main import origins for selected regions

to EU		to USA		to China	
Origin	% of tot	origin	% of total	origin	% of total
USA	18%	EU	23%	East Asia	26%
China	13%	Canada	15%	EU	17%
non-EU Europe	11%	Mexico	11%	S. Korea	12%
E. Asia	10%	China	6%	USA	10%

Source: Authors computation from base data.

[7] The 21 regions are: EU27, USA, Japan, Canada, Australia and New Zealand, China and Hong Kong, India, Mexico, Turkey, Russian Federation, Brazil, South Africa, South Korea, Ukraine and Belarus, Commonwealth of Independent States, Middle East and North Africa, East Asia, Rest of Latin America, Rest of Asia, Rest of Europe and the rest of Sub Saharan Africa.

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Abstract

The European Union has committed itself to reduce greenhouse gas (GHG) emissions by 20% in 2020 compared with 1990 levels. This paper investigates whether this policy has an additional benefit in terms of economic resilience by protecting the EU from the macroeconomic consequences due to an oil price rise.
We use the GEM-E3 computable general equilibrium model to analyze the results of three scenarios. The first one refers to the impact of an increase in the oil price. The second scenario analyses the European climate policy and the third scenario analyses the oil price rise when the European climate policy is implemented.
Unilateral EU climate policy imposes a cost on the EU of around 1.0% of GDP. An oil price rise in the presence of EU climate policy does impose an additional cost on the EU of 1.5% of GDP, but this is less than the 2.2% of GDP that the EU would lose from the oil price rise in the absence of climate policy. This is evidence that even unilateral climate policy does offer some economic protection for the EU.

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