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Climate Policy in the Shadow of National Security

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Abstract:
Recent events have clarified the interdependence of national security and energy supply. Specifically, it has become increasingly evident that heavy reliance on foreign fossil fuel supply may come at a national security cost. The present study derives the optimal policy of a net fossil fuel importing economy with a binding climate target, when fossil fuel imports are associated with national security costs. The study shows that optimal carbon taxes are differentiated across fossil fuels and that domestic fossil fuel production should be subsidized. Further, carbon capture and storage should be taxed, while no subsidies should be granted to green energy production. These results contrast the typical climate policy recommendation of uniform carbon taxation.

Keywords: Climate policy, National security, Energy security, Environmental taxes and subsidies
JEL: F52, H23, H56, Q43, Q54

1 Introduction

The interdependence of national security and energy supply has become increasingly apparent following the outbreak of the war in Ukraine in February 2022. The EU now hastens to reduce its energy dependency on Russia, where the dependency on natural gas is an especially hard nut to crack.

The issue is closely linked to EU climate policies like the EU ETS. These policies incentivize fuel switching from coal to natural gas. Thus, the EU's current dependency on Russian natural gas is, at least partly, driven by the EU's climate ambitions. Meanwhile, it has long been recognized that the EU's dependency on Russian fossil fuels poses a national security issue (e.g., Cornell, 2009).

The present study examines this trade-off between climate change ambitions and national security issues using an economic model. Specifically, the study derives the optimal climate policy for an economy that is a net fossil fuel importer with a binding climate target, and where the imports of different fossil fuels are associated with national security costs. These security costs reflect that a sole economic understanding of energy supply is insufficient, as a growing dependency on foreign energy supply may result in insecurity issues, as emphasized by Baumann (2008).

The optimal allocation can be achieved using two instruments: carbon taxes and subsidies for domestic energy production. However, the carbon taxes must be differentiated across fossil fuels, i.e. higher carbon taxes for fuels associated with stronger national security concerns. The domestic energy production subsidies are only granted to fossil fuels, as the carbon taxes provide sufficient incentive for green energy production. These policy implications contrast the typical climate policy recommendation of uniform carbon taxation.

This is – to my knowledge – the first study to derive an optimal climate policy that incorporates a national security dimension in a formal economic model. The present study contributes to an extensive literature on energy security (see Ang et al. [2015] for a survey). These studies often quantify energy security, while optimal policies are seldom derived. The closest related study is Griffin and Steele (1986), who argue that market prices for oil do not reflect the security premium that follows from the risk of an oil embargo. They show that this market failure can be corrected using import tariffs. Yet, they do not consider any climate-related issues.

The present study also relates to the carbon leakage literature. Optimal unilateral climate policies affect carbon leakage indirectly through international markets using border carbon adjustments (Hoel, 1996) or a variety of policy instruments like consumption taxes and green energy subsidies (Kruse-Andersen and Sørensen, 2022). In the present study, it is also optimal to affect international markets, but the concern links directly to net imports, whereas carbon leakage concerns the behavior of the foreign economy.

Finally, the present study contributes to a fast-developing literature on the EU's energy dependence on Russia following the war in Ukraine (e.g., Bachmann et al., 2022). Yet, the insights presented here are more general and apply to any economy with climate ambitions and national security issues linked to fossil fuel imports.

2 Model analysis

2.1 Overview

The general model structure borrows from Kruse-Andersen and Sørensen (2021) but adds multiple fossil fuel types.

Production of final goods requires labor and energy services, and private consumption consists of energy services and final goods. Energy services result from a combination of fossil-based and green energy goods. These energy goods are produced domestically and traded internationally. Final goods are used as an intermediate input in energy production, as a final consumption good, or sold on the international market.

The domestic economy is a net importer of fossil fuels, and the government has an aversion to this import, as it results in an undesirable dependency on foreign powers. Furthermore, the government is committed to a domestic emissions target in line with the Paris Agreement.

The objective of the government is to balance the domestic welfare from consumption and the national security cost stemming from fossil fuel imports while achieving the carbon emissions target.

2.2 Market economy

Final goods are produced under perfect competition by a representative firm that maximizes profits, π^x:

$$\max_{n,b_1^x\dots,b_J^x,g^x} \pi^x = f\left(n, e^x\left(b_1^x, \dots, b_J^x, g^x\right)\right) - nw - \sum_{j=1}^{J} b_j^x\left(p_j^b + \tau_j^{bx}\right) - g^x\left(p^g - s^{gx}\right), \qquad j = 1,2, \dots, J$$

where f is the production of final goods, the price of final goods is normalized to one, n is the labor input, e^x is the energy service input, b_j^x is the fossil-based energy input of type j (e.g., natural gas, oil, coal), g^x is the green energy input, w is the wage rate, p_j^b is the unit price of fossil-based energy input j, p^g is the unit price of the green energy input, the τ variables are emission taxes, and s^{gx} is a unit subsidy to green energy consumption. The functions f and e^x are increasing and concave in each argument.

Units are chosen such that burning one unit of fossil energy input results in one unit of emission, and thus, τ_j^{bx} is the unit emission tax on fossil-based input j.

A representative household maximizes utility, u, subject to a budget constraint:

$$\max_{x^h,b_1^h,\dots,b_J^h,g^h} u\left(x^h, e^h\left(b_1^h, \dots, b_J^h, g^h\right)\right)$$

$$st. \quad wn + T = x^h + \sum_{j=1}^{J} b_j^h\left(p_j^b + \tau_j^{bh}\right) + g^h\left(p^g - s^{gh}\right),$$

where x^h and e^h measure final goods and energy service consumption, b_j^h is the fossil-based energy service of type j, g^h is green energy service, T is government transfers and profit earnings, the τ variables are carbon taxes, and s^{gh} is a unit subsidy to green energy consumption. The functions u and e^h are increasing and concave in each argument.

To capture the capital-intensive nature of energy production, all energy types are produced using final goods. Production occurs competitively, and representative firms solve the problems

$$\max_{x_j^b}\left(p_j^b + s_j^b\right)b_j\left(x_j^b\right) - x_j^b\,,\ j = 1, \dots, J \ \text{ and } \ \max_{x^g}(p^g + s^g)g(x^g) - x^g,$$

where b_j and g are increasing and concave functions measuring the domestic supply of energy, x_j^b and x^g are final good inputs, and s_j^b and s^g are subsidies to energy production.

Finally, the economy is endowed with a fixed labor supply, $\bar{n}$, implying the equilibrium relationship:

$$n = \bar{n}.$$

2.3 Objectives of the government

The government has three objectives. Firstly, it is concerned about the welfare of its citizens measured by u.

Secondly, the government has a domestic emissions target:

$$\bar{E} = \sum_{j=1}^{J}\left(b_j^x + b_j^h\right), \tag{1}$$

where the government is committed to reducing domestic emissions to $\bar{E} > 0$.

Finally, to capture the national security cost associated with fossil fuel imports, the government's objective function is

$$U = u\left(x^h, e^h\left(b_1^h, \dots, b_J^h, g^h\right)\right) - \sum_{j=1}^{J}\eta_j \cdot \left(m_j^b - \bar{m}_j\right), \tag{2}$$

where $m_j^b \equiv b_j^x + b_j^h - b_j(\cdot)$ is the net fossil fuel import of type j, and η_j measures the national security cost of this import above the exogenous level $\bar{m}_j$.

The objective of the government is to maximize (2) while achieving (1).

2.4 Implementing the optimal allocation

In the appendix, it is shown how the government can implement the optimal allocation in the market economy. The optimal policy presented in the main text ignores terms-of-trade effects designed to manipulate international prices, which has nothing to do with the issues investigated here. Thus, the main text considers a near-optimal allocation, while all effects are considered in the appendix.

The (near) optimal set of instruments is:

$$\tau_j^{bx} = \tau_j^{bh} = \frac{\eta_j}{\lambda} + \frac{\kappa}{\lambda} \qquad \forall j \tag{3}$$

$$s_j^b = \frac{\eta_j}{\lambda} \qquad \forall j \tag{4}$$

$$s^g = s^{gx} = s^{gh} = 0, \tag{5}$$

where κ is the shadow price of domestic emissions, and λ is the shadow price of net imports.

The optimal tax-subsidy scheme is intuitive. If there is no national security concern, $\eta_j = 0$, we are back at the classic result: carbon emissions should be taxed uniformly across sectors, cf. (3). No further regulation is required in that case.

However, when there is a national security concern associated with fossil-based input j, $\eta_j > 0$, the carbon tax should be higher for emissions caused by that input, cf. (3). Intuitively, the consumption of fossil fuel j has a national security cost in addition to its environmental cost. This motivates a higher carbon tax compared to a fossil fuel j' without a national security concern, $\eta_{j'} = 0$.

Additionally, the national security concern motivates a production subsidy for domestic fossil energy production, cf. (4). The intuition is that there is a societal benefit in terms of less foreign energy dependence when domestic production increases.

There is no need for green energy subsidies, cf. (5). The carbon tax provides sufficient incentive to use and produce green energy. Meanwhile, the differentiation of the carbon tax together with the subsidies to domestic fossil production is sufficient to ensure the right fossil-based energy mix.

All in all, the results suggest that – in contrast to conventional wisdom – carbon taxes should be differentiated across fuels and domestic fossil fuel production should be subsidized.

3 Carbon capture and storage

We now consider a situation where production firms may abate emissions using the carbon capture and storage (CCS) technology from Kruse-Andersen and Sørensen (2021):

$$a_j\left(x_j^a\right) \in (0,1], \quad a_j' < 0, \quad a_j'' > 0, \quad a_x(0) = 1, \quad \lim_{x_j^a \to \infty} a_j\left(x_j^a\right) = 0,$$

where $(1 - a_j)$ is the share of emissions from fossil input j abated, and x_j^a is the final good input. The function captures that: (i) CCS is capital intensive, (ii) it becomes increasingly difficult to abate emissions, and (iii) it is impossible to capture all emissions.

Production emissions from fossil input j are now given by $a_j\left(x_j^a\right)b_j^x$ and production firms receive the unit CCS subsidy s_j^a.

The following set of instruments implements the (near) optimal allocation:

$$\tau_j^{bh} = \frac{\eta_j}{\lambda} + \frac{\kappa}{\lambda} \qquad \forall j \tag{6}$$

$$\tau_j^{bx} = \frac{\eta_j}{\lambda}\frac{1}{a_j} + \frac{\kappa}{\lambda} \qquad \forall j \tag{7}$$

$$s_j^b = \frac{\eta_j}{\lambda} \qquad \forall j \tag{8}$$

$$s^g = s^{gx} = s^{gh} = 0 \tag{9}$$

$$s_j^a = -\frac{\eta_j}{\kappa}\frac{1}{a_j} \qquad \forall j. \tag{10}$$

Equations (7) and (10) differ from the system without CCS. CCS introduces a discrepancy between emissions and fuel consumption in the production sector. One emission unit from fuel j now results from $1/a_j$ units of fuel consumption and thereby a $1/a_j$ unit increase in net imports. Hence, the national security cost per unit of emission increases, resulting in a higher tax rate, cf. (7). However, as the emission tax increases, so does the incentive to conduct CCS. To correct this, the government must introduce a negative subsidy (a tax) on CCS, cf. (10).

4 Concluding remarks

This study shows that national security concerns can motivate fuel-differentiated carbon taxation and subsidies to domestic fossil-based energy production. These policy implications contrast the typical climate policy recommendation of uniform carbon taxation. Nonetheless, the optimal policy can be close to uniform taxation depending on the national security costs attached to fossil-based imports. These costs are difficult to quantify, but they are certainly present in some cases.

Retrospectively, these results suggest that the EU should have placed a higher carbon price on natural gas and subsidized domestic natural gas extraction to limit its Russian energy dependency. The same might be true about oil.

Infrastructure like oil and natural gas pipelines is an important aspect of energy supply. As the model does not feature infrastructure investments, the model equilibrium is best interpreted as a long-run equilibrium. Thus, the model shows what to do in times of peace. It can also provide advice on what the EU under the current circumstances should aim for in the medium and long run, while it is less suited for short-run policy analysis.

Parallel to results from the carbon leakage literature, the optimal allocation can also be implemented in the market economy using a uniform carbon tax and import tariffs on fossil fuels associated with national security issues. The tariffs increase domestic fossil fuel prices, increasing domestic production and reducing domestic consumption, thereby working as both production subsidies and carbon taxes. The implication is still a differentiated treatment of fossil fuels. Although the carbon tax is uniform, effective carbon taxation is differentiated across fuels. Nevertheless, we find it unlikely that import tariffs on fossil fuels motivated by national security concerns can be implemented in times of peace under the General Agreement on Tariffs and Trade, Article XXI (see Reinsch, 2019).[1] Thus, this policy option is probably incompatible with WTO rules.

A limitation of the analysis is the one-dimensionality of the foreign economy. National security costs associated with fossil fuel imports differ depending on the characteristics of the supplying country. However, the fossil fuel types used in the model developed here (the j's) could represent different fuels from different countries as long as they are not perfect substitutes. Although fuels of a specific type (e.g., natural gas) originating from different countries are perfect substitutes in the final burning process, they are inherently different further up the supply chain for instance due to transportation costs. This is why Spain mostly imports natural gas from Algeria, while Germany mostly relies on Russian gas. Importantly, the fossil fuel prices in the model only cover the fuel purchases, while domestic transportation costs are hidden in the production function of the representative firm. Within this interpretation, the immediate implication is that fossil fuel consumption should be taxed differently depending on the country of origin, which seems to violate WTO rules. These issues are worth exploring further in future research.

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[1] In the ruling on 5 April 2019 on the Russia-Ukraine dispute, the WTO dispute settlement panel defined "war or other emergency in international relations" to be "a situation of armed conflict, or of latent armed conflict, or of heightened tension or crisis, or of general instability engulfing or surrounding a state" which the panel considered an objective state that the panel can assess (Reinsch, 2019). This implies a significant level of tension necessary before Article XXI can be invoked.

Appendix

A.1 Deriving the optimal allocation

The social planner maximizes (2) subject to (1) and a trade balance constraint. The Lagrangian associated with the social planner's problem is

$$\mathcal{L}(\cdot) = u\left(x^h, e^h\left(b_1^h, \dots, b_J^h, g^h\right)\right) - \sum_{j=1}^{J} \eta_j\left(b_j^x + b_j^h - b_j\left(x_j^b\right) - \bar{m}_j\right) + \kappa\left(\bar{E} - \sum_{j=1}^{J}\left(b_j^x + b_j^h\right)\right)$$
$$+\lambda\Bigg[f\left(\bar{n}, e^x\left(b_1^x, \dots, b_J^x, g^x\right)\right) - x^h - x^g - \sum_{j=1}^{J} x_j^b + \sum_{j=1}^{J} p_j^b\left(b_j\left(x_j^b\right) - b_j^x - b_j^h\right)$$
$$+ p^g\left(g(x^g) - g^x - g^h\right)\Bigg],$$

where κ is the shadow price of domestic emissions, and λ is the shadow price of net imports.

Before deriving the first-order conditions, it is useful to define the current account and variables capturing terms-of-trade effects. Let the current account, CA, be defined as

$$CA \equiv f\left(\bar{n}, e^x\left(b_1^x, \dots, b_J^x, g^x\right)\right) - x^h - x^g - \sum_{j=1}^{J} x_j^b + \sum_{j=1}^{J} p_j^b\left(b_j\left(x_j^b\right) - b_j^x - b_j^h\right)$$
$$+ p^g\left(g(x^g) - g^x - g^h\right),$$

and let the terms-of-trade effect variables be defined as

$$\Delta_i \equiv \sum_{j=1}^{J} \frac{\partial CA}{\partial p_j^b} \cdot \frac{\partial p_j^b}{\partial i} + \frac{\partial CA}{\partial p^g} \cdot \frac{\partial p^g}{\partial i}, \qquad i = b_j^x, g^x, b_j^h, g^h, x^h, x^g, x_j^b.$$

The first-order conditions associated with the social planner's problem can be rewritten as:

$$\lambda\left(1 - \Delta_{x^h}\right) = u'_{x^h} \tag{A.1}$$

$$\lambda\left(1-\Delta_{x_j^b}\right)=\left(\lambda p_j^b+\eta_j\right)b_j'\left(x_j^b\right)\ \forall j \tag{A.2}$$

$$\lambda(1-\Delta_{x^g})=\lambda p^g g'(x^g) \tag{A.3}$$

$$u_e' e_{b_j^h}^h=\eta_j+\kappa+\lambda\left(p_j^b-\Delta_{b_j^h}\right)\ \forall j \tag{A.4}$$

$$\lambda f_e' e_{b_j^x}^x=\eta_j+\kappa+\lambda\left(p_j^b-\Delta_{b_j^x}\right)\ \forall j \tag{A.5}$$

$$u_e' e_{g^h}^h=\lambda\left(p^g-\Delta_{g^h}\right) \tag{A.6}$$

$$\lambda f_e' e_{g^x}^x=\lambda\left(p^g-\Delta_{g^x}\right) \tag{A.7}$$

The interpretation of the first-order conditions is mostly standard. However, the appearance of η_j changes the interpretation slightly in some of the formulas. As an example, consider (A.5) disregarding the terms-of-trade effect:

$$\lambda f_e' e_{b_j^x}^x=\eta_j+\kappa+\lambda p_j^b\ \forall j. \tag{A.8}$$

Equation (A.8) shows that in optimum, the marginal benefit of using fossil-based energy input j in the business sector (left-hand side) must equal the marginal cost (right-hand side). The marginal cost consists of three terms: (i) the shadow cost of emissions, κ, (ii) the cost of increased imports, λp_j^b, and (iii) a national security cost, η_j. Only the last cost term, η_j, is non-standard and should be understood as follows. Using one additional unit of fossil fuel j in production increases the net imports of fossil fuel j by one unit. This has the national security cost η_j measured in utils.

A.2 Implementing the optimal allocation in the market economy

This appendix derives the market equilibrium of the domestic economy and shows how the optimal allocation may be implemented.

The representative firm maximizes profits, π^x, subject to the labor input, n^x, and energy inputs, $\left(b_1^x, \dots, b_J^x, g^x\right)$, taking prices and regulation as given:

$$\max_{n, b_1^x \dots, b_J^x, g^x} \pi^x = f\left(n, e^x\left(b_1^x, \dots, b_J^x, g^x\right)\right) - nw - \sum_{j=1}^{J} b_j^x\left(p_j^b + \tau_j^{bx}\right) - g^x(p^g - s^{gx}), \qquad j = 1,2, \dots, J.$$

The resulting first-order conditions are:

$$f_e' \, e_{b_j^x}^x = p_j^b + \tau_j^{bx} \;\; \forall j \tag{B.1}$$

$$f_n' = w \tag{B.2}$$

$$f_e' \, e_g^x = p^g - s^{gx} \tag{B.3}$$

The representative household maximizes welfare given its budget constraint:

$$\max_{x^h, b_1^h, \dots, b_J^h, g^h} u\left(x^h, e^h\left(b_1^h, \dots, b_J^h, g^h\right)\right)$$

$$st. \quad wn + T = (1 + \tau^{xh})x^h + \sum_{j=1}^{J} b_j^h\left(p_j^b + \tau_j^{bh}\right) + g^h(p^g - s^{gh}),$$

where the consumption tax τ^{xh} is added compared to the problem presented in the main text. This tax is necessary to implement the optimal allocation in the market economy, but it becomes redundant if terms-of-trade effects are ignored.

Let the shadow price of the budget constraint be denoted ξ. The resulting first-order conditions may be rewritten as:

$$u_{x^h}' = \xi(1 + \tau^{xh}) \tag{B.4}$$

$$u_{e^h}' e_{b_j}^h = \xi\left(p_j^b + \tau_j^{bh}\right) \;\; \forall j \tag{B.5}$$

$$u'_{e^h} e_g^h = \xi\left(p_g - s^{gh}\right) \quad \text{(B.6)}$$

The domestic energy suppliers solve the problems:

$$\max_{x_j^b}\left(p_j^b + s_j^b\right)b_j\left(x_j^b\right) - x_j^b \quad \forall j \text{ and } \max_{x^g}(p^g + s^g)g(x^g) - x^g.$$

The resulting first-order conditions are:

$$1 = \left(p_j^b + s_j^b\right)b_j'(x_j^b) \;\; \forall j \quad \text{(B.7)}$$

$$1 = (p^g + s^g)g'(x^g) \quad \text{(B.8)}$$

To implement the optimal allocation, we need the system of equations (A.1)-(A.7) to match the system (B.1)-(B.8). Firstly, we insert the equilibrium condition $n = \bar{n}$ and eliminate (B.2). Then it is clear that the two systems of equations are the same if the following instruments are implemented:

$$\tau_j^{b_x} = \frac{\eta_j}{\lambda} + \frac{\kappa}{\lambda} - \Delta_{b_1^x} \;\; \forall j \quad \text{(B.9)}$$

$$\tau_j^{b_h} = \frac{\eta_j}{\lambda} + \frac{\kappa}{\lambda} - \Delta_{b_1^h} \;\; \forall j \quad \text{(B.10)}$$

$$s^{gx} = \Delta_{g^x} \quad \text{(B.11)}$$

$$s^{gh} = \Delta_{g^h} \quad \text{(B.12)}$$

$$s_j^b = \frac{\eta_j}{\lambda} + \frac{\Delta_{x_j^b}}{b_j'(\cdot)} \;\; \forall j \quad \text{(B.13)}$$

$$s^g = \frac{\Delta_{x^g}}{g'(\cdot)} \quad \text{(B.14)}$$

$$\tau^{xh} = -\Delta_{x^h} \tag{B.15}$$

We note that all equations will be the same except that λ is denoted ξ in the market economy. Thus, the instruments (B.9)-(B.15) implement the optimal allocation. Ignoring the terms-of-trade effects results in the instruments (3)-(5).

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