Energy Policy 42 (2012) 1–3

Contents lists available at SciVerse ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Viewpoint

Developing macroeconomic energy cost indicators ☆

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ARTICLE INFO

Article history:
Received 11 May 2011
Accepted 27 October 2011
Available online 5 January 2012

Keywords:
Energy policy
Energy prices
Policy indicators

ABSTRACT

Indicators are more and more drawn on for policy making and assessment. This is also true for energy policy. However, while numerous different energy price figures are available, subordinate energy cost indicators are lacking. This paper lays out a general concept for such indicator sets and presents a flexible framework for representative and consistent energy cost indicators with an underlying weighting principle based on consumption shares. Their application would provide interesting new insights into the relationship between energy cost burdens of different sectors and countries. It would allow for more rigorous analysis in the field of energy economics and policy, particularly with regard to market monitoring and impact assessment as well as ex-post-policy analysis.

1. Introduction

In many countries, energy policy has three central aims: economic efficiency/competitive energy prices, security of supply and environmental compatibility (for Germany, see, e.g., BMWi/BMU, 2010). It is moreover true that in many cases, these objectives are more and more tackled within an indicator based policy approach, often, but not always, driven by international policy processes, international agreements and initiatives taken by international organisations.

This foundation on indicators is most obvious for the environmental compatibility goal of energy policy. The Kyoto Protocol and the subsequent international climate policy process have rendered GHG emissions a central energy policy indicator. Related indicator-based goals such as EU targets for energy efficiency and renewable energies within the EU 20–20–20 strategy (EP/EC, 2009) have at least partly entailed corresponding goals at the national level. For example, in Germany, the “Energy Concept for an Environmentally Sound, Reliable and Affordable Energy Supply” of the federal government (BMWi/BMU, 2010) has set indicator-based energy policy pathways for the next 40 years that shall be, from now on, monitored on a scientific basis.[1] Moreover, the International Energy Agency IEA has recently been very active in developing sets of indicators on sustainable energy in order to assess the developments in its member countries, e.g., in the field of energy efficiency (e.g., IEA, 2011).

Also with regard to the energy security concern, indicators are increasingly used for target setting and monitoring issues. In the past, basic figures such as energy import dependence have been predominant here. Due to their oversimplicity, however, they could be used only to a certain extent as meaningful policy indicators. Recently, more complex indicators such as Frondel and Schmidt’s (2008) energy security indicator have been developed. Those measures go beyond the statistical illustration of import dependence, but actually tackle the issue of energy security and risk of supply disruption. Specifically for electricity supply security, further indicators such as SAIDI (System Average Interruption Duration Index) and SAIFI (System Average Interruption Frequency Index) are popular, which measure average outage duration and units of interruptions per customer, respectively.[2]

In contrast, the purely economic perspective of energy policy – often interpreted as the need for competitive energy prices – still lacks meaningful macroeconomic and aggregate measures.[3] This is the fact, although – or rather because? – numerous different energy price figures, often differentiated by fuel and customer groups, are listed by national and international companies, agencies and organisations. In this sense, in their study on energy costs, Seeliger et al. (2011) express their regret that no uniform and easily interpretable indicator was available for the objective of energy price competitiveness. In this line, they further argue

☆ The author thanks Rainer Görgen as well as two referees for their helpful comments and suggestions. This article represents the personal opinion of the author and does not reflect the official position of the German Federal Ministry of Economics and Technology.

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[1] In the light of the accelerated implementation of the German energy concept against the background of the nuclear accident in Fukushima on and following March 11, 2011, this monitoring approach has been substantiated within the “Energy for the Future”-process of the German government (BMWi, 2011).

[2] For an overview, see Löschel et al., 2010a, 2010b.

[3] To be more precise, many countries – such as Germany – have formulated goals with regard to the economic perspective of energy policy in the line of “economic efficiency”. The economic efficiency of an energy system, however, is indeed difficult to express in terms of indicators or figures.

0301-4215/$ - see front matter
doi:10.1016/j.enpol.2011.10.051

that such an indicator or indicator set "should be developed in order to efficiently control the objective of price competitiveness and to boost its public recognition".

In this sense, the impact of policies on energy costs is difficult to evaluate as long as no meaningful respective indicator (set) exists. Therefore, this paper develops a simple but general framework for macroeconomic energy cost indicators inspired by Frondel and Schmidt's (2008) energy security indicator that, if applied, could provide insights into the competitiveness of energy prices that sectors and/or countries are facing.[4] It makes use of an underlying weighting principle based on energy and fuel consumption shares. The next section lays out the methodology in more detail. Section 3 discusses the framework and concludes.

2. Methodology

The share of fuel j of total final energy consumption in sector i of country k (FEC_{ik}) is defined as

$$s_{ijk} = FEC_{ijk}/FEC_{ik},$$

with FEC_{ijk} representing the absolute usage of fuel j in country k's sector i.

Based on this definition, the equation

$$s_{i1k} + s_{i2k} + \cdots + s_{iJk} = 1; j = 1,\ldots,J,$$

i.e., the sum of all fuel shares of any sector equals unity, needs to hold.[5]

Moreover, we define p_{ijk} as the comparative price ratio for fuel j that country k's sector i is facing:

$$p_{ijk} = P_{ijk}/P_{j\text{MAX}}; j = 1,\ldots,J.$$

Here, P_{ijk} gives the real price, taxes included,[6] per energy unit country k's sector i is facing with regard to fuel j, while $P_{j\text{MAX}}$ is the maximum price per unit of fuel j from an international comparison amongst all sectors $i=1,\ldots,I$ analysed in all countries $k=1,\ldots,K$:

$$P_{j\text{MAX}} = \max(P_{j1\text{MAX}}, P_{j2\text{MAX}},\ldots,P_{jK\text{MAX}}),$$

with country-specific maximum fuel prices

$$P_{jk\text{MAX}} = \max(P_{1jk}, P_{2jk},\ldots,P_{Ijk}).$$

Therefore, $p_{ijk} \leq 1$ always holds.

Accordingly, the sector specific energy cost burden for country k's sector i is defined as

$$\text{cost}_{ik} = \Sigma(j = 1,\ldots,J)s_{ijk}p_{ijk}.$$

It can be shown easily that cost_{ik} is normalised:

$$0 \leq \text{cost}_{ik} \leq 1.$$

It is non-negative, as it is a sum of non-negative sector-specific fuel shares – such share can never become negative, as this would imply negative consumption – multiplied by non-negative price ratios – such ratio can never become negative, as this would imply negative prices. Moreover, cost_{ik} does not exceed unity, as by definition[7]

$$p_{ijk} \leq 1, s_{ijk} \leq 1 \text{ and } \Sigma(j = 1,\ldots,J)s_{ijk}p_{ijk} \leq \Sigma(j = 1,\ldots,J)s_{ijk} \leq 1.$$

Following Frondel and Schmidt (2008), an extension of the above developed sectoral indicator to an economy-wide energy cost indicator is possible. Such an indicator can be built as

$$\text{cost}_k = \Sigma(i = 1,\ldots,I)w_{ik}\text{cost}_{ik}$$

where w_{ik} gives the sectoral final energy consumption share for country k's sector i of country k's economy-wide final energy consumption (FEC_k), defined as[8]

$$w_{ik} = FEC_{ik}/FEC_k, \text{ with } w_{1k} + w_{2k} + \cdots + w_{Ik} = 1, i = 1,\ldots,I.$$

3. Discussion

The above developed framework for macroeconomic energy cost indicators makes use of an underlying weighting principle based on energy and fuel consumption shares. It should provide the basis for such – unit-free – indicators over sectors, countries and time. The above developed framework offers several convenient features in this regard.

- Flexibility: The framework is flexible as it allows for respective adjustments if relevant data are not available.
- Representativeness: The above developed framework gives a representative picture of the energy cost burden due to the underlying weighting principle based on consumption shares. Energy consumption adjustments in the form of energy efficiency improvements and fuel switching are implicitly taken into account as they affect the respective consumption shares.
- Consistency and possible refinement: The framework for macroeconomic cost indicators is consistent as it represents a weighted average of subordinate sectoral indicators. This also implies that the aggregated economy-wide indicator can be refined and broken down on a sectoral basis. Sectoral indicator sets would allow for cross-sectoral comparisons at the national level as well as for international comparisons for specific sectors. Although the relevance of an economy-wide indicator is obvious, also sectoral indicators' features can prove to be highly relevant indeed as in many countries, prices significantly differ between customer groups, e.g., because of scale effects and energy tax differentiation.

Of course, also several disclaimers have to be made with regard to the framework developed in this paper.

- External costs: External costs are taken into account within the approach only in terms of internalised external costs, i.e., as far as they are actually incorporated in the respective energy

[4] It cannot, however, measure directly the general economic efficiency of energy policy. It is possible that one market is more efficient than another although costs are higher; moreover, it could be even discussed whether an economic efficiency-goal of energy policy, literally taken, does not already take into account environmental compatibility and possibly also energy security via the consideration of market failures.

[5] If the equation does not hold, FEC_{ik}, FEC_{ijk} for $j=1,\ldots,J$ and, as a consequence, the respective shares s_{ijk} ($j=1,\ldots,J$) are adjusted so that FEC_{ik} only represents the energy consumption in country k's sector i, which can be broken down into energy sources j ($j=1,\ldots,J$), i.e., for which necessary data is available.

[6] The use of nominal prices could bias the indicator particularly for countries facing high inflation rates. Taxes should be included so that the indicator can reflect the actual energy cost burden of the sectors analysed. Nevertheless, the use of prices excluding taxes could come closer to spot macroeconomic costs if, e.g., high energy taxes are accompanied by reduced other taxes such as labour taxes as put forward by the double dividend hypothesis.

[7] In contrast to the energy security indicator proposed by Frondel and Schmidt (2008), the energy cost indicator developed here is linear and not of quadratic form. In their case, Frondel and Schmidt (2008) argue in favour of a quadratic indicator as they build on Herfindahl's (1950) – quadratic – concentration index. This indicator class, however, incorporates the aspect of diversification, which is not relevant for this cost indicator. Therefore, no quadratic form is assumed here. Nevertheless, the general framework proposed here could also be expanded in a way that it considers, e.g., quadratic price ratios p_{ijk}^2. All propositions laid down here would then still hold.

[8] If the equation does not hold, FEC and, as a consequence, its sectoral shares w_i ($i=1,\ldots,I$) are adjusted so that FEC only represents the energy consumption that can be broken down on sectors i ($i=1,\ldots,I$), i.e., for which necessary data is available.