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Are green hopes too rosy? Employment and welfare impacts of renewable energy promotion

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ABSTRACT

In view of pressing unemployment problems, policy makers across all parties jump on the prospects of renewable energy promotion as a job creation engine which can boost economic well-being. Our analytical model shows that initial labor market rigidities in theory provide some scope for such a double dividend. However, the practical outcome of renewable energy promotion might be sobering. Our computable general equilibrium analysis of subsidized electricity production from renewable energy sources (RES-E) in Germany suggests that the prospects for employment and welfare gains are quite limited and hinge crucially on the level of the subsidy rate and the financing mechanism. If RES-E subsidies are financed by labor taxes, welfare and employment effects are strictly negative for a broad range of subsidy rates. The use of an electricity tax to fund RES-E subsidies generates minor benefits for small subsidy rates but these benefits quickly turn into significant losses as the subsidy rate exceeds some threshold value.

1. Introduction

Over the last decades policies to promote renewable energy have become increasingly popular in OECD countries. Policy makers across all parties embrace support schemes for renewable energy as a panacea to cure socio-economic problems ranging from anthropogenic climate change to lack of innovation and persistent unemployment. As a prime example, the European Union has committed itself to increase the share of energy from renewable sources in overall energy consumption to 20 percent in 2020 (EU, 2009). The ambitious target across EU Member States is justified as a means for "promoting the security of energy supply, promoting technological development and innovation and providing opportunities for employment and regional development" while at the same time constituting an "important part of the package of measures needed to reduce greenhouse gas emissions and comply with the Kyoto Protocol" (EU, 2009, p.16).

Standard economic theory warrants caution against the magic cure through renewable promotion policies and policy assertions of unambiguous win-win outcomes. While market imperfections generally provide an efficiency rationale for policy intervention, regulatory measures should address the market failure as source-specific as possible. For example, environmental externalities such as anthropogenic greenhouse gas emissions are best targeted through Pigouvian emission taxes—additional targets for renewable energy are either redundant or costly (Böhringer and Rosendahl, 2011). If policy makers pursue multiple targets, efficient regulation calls for the equalization of the number of policy instruments with the number of policy targets.[1] It is therefore obvious that renewable energy promotion in general will fall short of a perfect policy response to the multiple market failures they are claimed to cure. Yet, from the perspective of applied policy analysis, the relevant yardstick for the assessment of renewable energy promotion might not be an idealized second-best outcome. The crucial question is rather to what extent the implementation of renewable support policies will increase or relax the pressure along important problem dimensions. A key prerequisite for coherent evaluation is that the framework for impact assessment takes into account the multiple forces in the economy that interact and can lead to synergies or trade-offs with respect to multiple policy targets.

Against this background our paper investigates how policies to promote renewable energy affect economic performance in the

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[1] While more targets than instruments make targets incompatible, more instruments than targets make instruments alternative, i.e., one instrument may be used instead of another or a combination of others (Tinbergen, 1952).

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presence of labor market rigidities. We start with a stylized analytical general equilibrium model to show that subsidies to domestic energy production (not necessarily restricted to renewable energy) can help to reduce involuntary unemployment and increase overall welfare. We then proceed with a computable general equilibrium analysis of subsidized electricity production from renewable energy sources (RES-E) which is the predominant channel of renewable energy promotion in OECD countries (Fischer and Preonas, 2010). Our empirical analysis focuses on Germany that stands out for its massive subsidization of green power production (Frondel et al., 2010) and is often cited as a shining example for the advancement of renewable energy. We find that welfare and employment effects of RES-E subsidies hinge crucially on the choice of financing mechanisms: whereas a labor tax has strictly negative impacts on employment and consumption levels, an electricity tax exhibits positive effects for small subsidy rates and negative effects for high subsidy rates. While the positive impacts are rather small, the losses in employment and consumption welfare become substantial for high subsidy levels.

Our paper contributes to the literature on economic impact assessment of renewable energy support policies in two ways. Firstly, previous analyses of employment effects of RES-E policies typically neglect important general equilibrium interactions. An early contribution by Kammen et al. (2004) finds that more renewable generation can lead to job creation, but the approach boils down to calculating the job impacts of replacing one unit of electricity generation from conventional technologies by renewable technologies.[2] Potential impacts of an increasing electricity price or the subsidies needed to stimulate the renewables sector are not considered. As to Germany, which takes a world-wide lead in renewable energy promotion, reports by the ministry of environment refer to renewables as an engine for green job creation (BMU, 2009). These reports, however, do not account for indirect employment impacts in conventional energy generation and upstream industries. More comprehensive studies of the labor market impacts that build on economy-wide input-output analysis provide mixed findings on the net employment effect of renewable promotion policies.[3] Yet, the standard input-output analysis does not incorporate more subtle substitution and income effects that are captured through the general equilibrium approach used for our impact assessment. Furthermore, computable general equilibrium analysis allows for the use of established welfare metrics such that we can assess the potential trade-offs between economic efficiency and labor market impacts: even with a net growth in jobs, overall welfare might be reduced due to potential production distortions triggered by green subsidies. Secondly, our analysis highlights the importance of alternative subsidy financing mechanisms. We investigate four policy-relevant options to finance the subsidy to renewable electricity production: a lump-sum tax, a labor tax, an electricity tax, and a revenue-neutral replacement of German coal subsidies. We show that the choice of the financing option not only affects the magnitude but also the sign of employment and welfare impacts.

The remainder of the paper is organized as follows. In Section 2, we use a stylized analytical model to illustrate how subsidies to domestic energy production can alleviate labor market imperfections and thereby induce net economic gains. In Section 3, we provide a non-technical summary of the computable general equilibrium model which is used to quantify the economic impacts of RES-E subsidies in Germany for alternative financing options. In Section 4, we lay out the characteristics of our core policy scenarios and present our simulation results. In Section 5, we conduct sensitivity analyses with regard to selected key parameters of our modeling framework. We conclude in Section 6.

[2] "The renewable energy sector generates more jobs than the fossil fuel-based energy sector per unit of energy delivered (i.e., per average megawatt)" (Kammen et al., 2004, p. 2).

[3] While Hillebrand et al. (2006) show negative employment effects of renewable energy support policies in Germany, Lehr et al. (2008) find the opposite.

2. Analytical model

In this section, we employ a stylized theoretical model to derive our main propositions on how (renewable) energy subsidies will affect employment and welfare.

Our analytical model describes a small open economy that takes world prices as given. The economy produces a final good Y with inputs labor L_Y and energy E. Energy in turn is a composite of domestic (possibly renewable) energy D and foreign energy F. Domestic energy is produced using intersectorally mobile labor L_E and some fixed factor K.[4] We denote the quantity for each good by Q and its price by P. Production in each sector takes place according to a Cobb–Douglas production function[5]:

$$Q_i^s = \left(Q_j^d\right)^{\theta_j} \cdot \left(Q_{-j}^d\right)^{1-\theta_j}, \tag{1}$$

where superscripts s and d denote supply and demand, respectively. Here, $i \in \{Y,E,D\}$. For $i = Y$, j and $-j$ are inputs energy E and the amount of labor in final good production L_Y, respectively. For $i = E$, j and $-j$ are domestic energy D and foreign energy F, respectively. Finally, for $i = D$, j and $-j$ are the fixed factor K and labor in domestic energy production L_E. The $\theta_j \in (0,1)$ denote the cost shares of inputs. Firms in all sectors are price takers, and we normalize the price of the final good Y to unity. The first order conditions for each input $n \in \{j,-j\}$ are:

$$\theta_n P_i Q_i^s = P_n Q_n^d. \tag{2}$$

Foreign energy F is imported at a given world price P_F. Trade is balanced by exporting the final good. We assume that total labor supply $\bar{L}^s$, which is allocated over domestic energy and final goods production, is inelastic. Consumers receive income from supplying labor at the wage rate P_L, and from supplying the fixed factor K at the rate of return P_K. Consumer income is spent on consumption C of the final good, which corresponds to the Hicksian equivalent variation and is our measure of welfare.[6]

We assess the welfare and employment impacts of energy subsidies for three alternative labor market settings. The first setting takes wages as fully flexible such that the labor market clears. The second and third settings adopt a nominal wage rigidity with pre-existing unemployment, which reflects empirical evidence on labor market imperfections (see e.g. Fehr and Goette, 2005; Nickell and Quintini, 2003). First, we take this wage rigidity to the extreme and assume full downward wage rigidity (see also Babiker and Eckaus, 2007). Next we look at the more realistic case where the wage rate is related to the unemployment rate through a wage curve (Blanchflower and Oswald, 1995). In all settings, the subsidy is financed through a lump-sum tax on the consumer.[7]

For the perfectly competitive economy without labor market frictions we find (not surprisingly) that subsidizing domestically produced energy implies a welfare loss.[8]

Proposition 1. Suppose we have a perfectly competitive economy without market failures. Then, a small increase in the subsidy on domestic

[4] K can be thought of as land for biomass production or sites for wind and solar energy.

[5] While the model and all derivations in the appendix are formulated using Cobb–Douglas production functions, the propositions also hold when using constant elasticity of substitution (CES) production functions.

[6] The Hicksian equivalent variation in income denotes the amount necessary to add to (or subtract from) the benchmark income of the representative consumer so that she enjoys a utility level equal to the one in the counterfactual policy scenario on the basis of ex-ante relative prices.

[7] More specifically, the tax is raised on total labor income. Since in our analytical model, both the downward rigid wage and the wage curve apply to the gross wage rate, this tax on labor income is non-distortionary and equivalent to a lump-sum tax.

[8] The results in this section are based upon the model in relative changes, which is presented in Appendix A.