Energy Policy 106 (2017) 536–546

Contents lists available at ScienceDirect

Energy Policy

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

Prices versus policy: An analysis of the drivers of the primary fossil fuel mix

Tarek Atalla[a], Jorge Blazquez[a], Lester C. Hunt[a,b,*], Baltasar Manzano[a,c]

[a] King Abdullah Petroleum Studies and Research Center (KAPSARC), Saudi Arabia
[b] Surrey Energy Economics Centre (SEEC), University of Surrey, UK
[c] Universidade de Vigo, Spain

ARTICLE INFO

JEL Classification:
C68
E30
E37
Q43
Q48

Keywords:
Energy transition
Fossil fuel mix
Relative prices
DSGE modeling
Prices vs policy

ABSTRACT

Energy policymakers often attempt to shape their countries' energy mix, rather than leave it purely to market forces. By calibrating and simulating a Dynamic Stochastic General Equilibrium (DSGE) model, this paper analyzes the primary fossil fuel mix in the USA and compares it to Germany and the UK, given the different evolution of the mixes and the different roles played by relative prices and policy in North America and Europe. It is found that the model explains well the evolution of the primary fossil fuel mix in the USA for the period 1980–2014, suggesting that relative fossil fuel prices generally dominated in determining the mix during this time. However, this is not the case for Germany and the UK. For both countries, the model performs well only for the period after the market-oriented reforms in the 1990s. Additionally, the volatility of private consumption and output for the pre- and post-reform periods is evaluated for Germany and the UK and it is found that the liberalized energy markets brought about a transition from coal to natural gas, but with increased macroeconomic volatility.

1. Introduction

Policy makers see fuel price volatility as a risk to their economies. Consequently, they often attempt to use energy policies to shape an energy mix that leaves their economies less vulnerable to energy price shocks. Environmental concerns also add pressure in favor of a 'cleaner' energy mix. Accordingly, the observed energy mix is generally the result of the interaction of fuel prices, available technologies, and energy policies. In other words, the energy mix is determined by the relative costs of fuels, but also by local policies that address security, environmental, economic, and social aspects of the energy system. This paper aims to explain the role of fossil fuel prices relative to energy policy in driving the primary fossil fuel mix.

Fig. 1 illustrates the evolving primary fossil fuel shares for the USA, Germany, and the UK[1] from 1980 to 2014 and shows that the fossil fuel mix in the two European countries has changed far more than in the USA. From the beginning to the end of the period, the USA's oil share fell slightly from 46% to 42%, while the gas share increased from 30% to 34% and the coal share hardly changed (although it did increase slightly and then fall back again at the end of the period). In Germany, although the oil share did not change dramatically from the beginning to the end of the period (from 43% to 45%), the gas and coal shares did – from 15% to 25% and from 41% to 30%, respectively. A similar pattern emerged in the UK, with the oil, gas, and coal shares changing over the period from 42% to 43%, from 21% to 38%, and from 37% to 17%, respectively.

Generally, the USA had a relatively stable primary fossil fuel mix over the period 1980–2014, although there was an increase in the share of gas and a fall in the share of coal towards the end of the period (Fig. 1). This, by all accounts, was due to the development of shale gas in the USA; according to Joskow (2015), the share of shale gas in USA gas production increased from 7% in 2007 to 40% in 2015. In contrast, the primary fossil fuel mixes in Germany and the UK gradually shifted toward natural gas over the whole period, although from about 2010 onwards, it appears to decrease.

Therefore, it is interesting to analyze why the primary fossil fuel mix evolved so differently in the USA compared to Germany and the UK and to assess the factors behind the difference. In particular, are the differences the result of market forces and, hence, chiefly driven by relative fossil fuel prices? Alternatively, are the differences the result of

* Corresponding author.
E-mail addresses: Tarek.Atallah@outlook.com (T. Atalla), Jorge.Blazquez@kapsarc.org (J. Blazquez), Lester.Hunt@kapsarc.org, L.Hunt@surrey.ac.uk (L.C. Hunt), BManzano@uvigo.es, Baltasar.Manzano@kapsarc.org (B. Manzano).

[1] The spike in the UK fossil fuel shares in 1984 is due to the miners' strike that took place that year and into 1985 (see, for example, BBC, 2004).

http://dx.doi.org/10.1016/j.enpol.2017.03.060
Received 20 October 2016; Received in revised form 16 February 2017; Accepted 27 March 2017

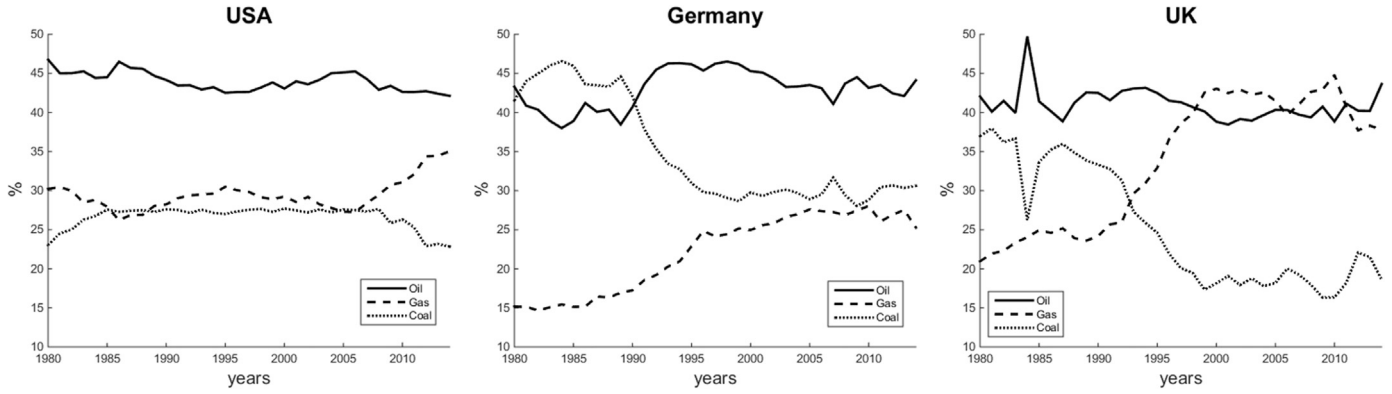

Fig. 1. Primary fossil fuel energy mix (relative shares).

the various energy policies of the countries considered in the analysis?[2] It is also interesting to analyze the impact of the changing primary fossil fuel mix on the two European countries' economies. In particular, are the German and British economies more or less volatile after the energy reforms of the 1980s and 1990s?

The analysis is undertaken by developing a Dynamic Stochastic General Equilibrium (DSGE) model for the USA and then simulating the model to assess the impact of relative prices on the primary fossil fuel mix over the period 1980–2014.[3] As a first step, we analyze the stability of the calibrated energy related parameters for the USA and compare them to those from similar production functions for Germany and the UK, where policy intervention is believed to have had a greater impact on primary fossil fuel demand. Furthermore, the DSGE models for all three countries are simulated in order to assess the importance of relative prices and policy in driving the primary fossil fuel mix. Additionally, the DSGE model is used to analyze the volatility of private consumption and output for the pre- and post-reform periods in Germany and the UK to assess the impact of the reforms on these economies.

Calibrated dynamic, either stochastic or deterministic, general equilibrium models have been at the core of macroeconomic analysis for the last few decades. Regarding energy, these models have mainly been used to analyze the macroeconomic effects of energy price shocks, particularly oil shocks (such as, Kim and Loungani (1992), Rotemberg and Woodford (1996)). More recently, DSGE models have been used to analyze optimal energy taxation (De Miguel and Manzano, 2006; Golosov et al., 2014), the behavior of the oil market (Nakov and Nuño, 2013), and the macroeconomic impact of the shale oil revolution (Mănescu and Nuño, 2015).

However, a DSGE model is used here for a different purpose. After initially analyzing the effects of fossil fuel prices and energy policies on the changes in the primary fossil fuel mix in the US, Germany, and the UK, we study the impact of the changing mix on the economic volatility of the two European countries.[4] Although some previous research has considered the energy mix (such as Dassisti and Carnimeo (2012) for Europe; Carraro et al. (2014) for the European power sector; Vidal-Amaro et al. (2015) for the Mexican power sector), this is, to our knowledge, the first attempt to analyze the drivers of the primary fossil fuel mix in this way. Moreover, the literature on analyzing the impact of fuel price shocks has focused on the impact of oil prices on economic activity (see for example, Hamilton (1983, 2003), Kilian (2008, 2009), De Miguel et al. (2003), Kesicki (2010), Herrera et al. (2015)). As far as we know, this is the first attempt to analyze the impact of fossil fuel prices on the fossil fuel mix and the consequences for the economy.

In summary, this paper uses a macroeconomic approach to assess the relative importance of fossil fuel prices and policy in determining the primary fossil fuel mix. This is undertaken initially for the USA, and then Germany and the UK where, *a-priori*, we expect policy to play a greater role than prices given the different energy policies in the USA and the European countries. The remainder of the paper is organized as follows. Section 2 presents the DSGE model followed by Section 3 that discusses the calibration of the model parameters and the simulation of the model for the USA. Section 4 presents the calibration of the parameters and simulation of the model for Germany and the UK, compares them to those for the USA, and considers the impact of the change in the fossil fuel mix on the volatility of private consumption and output. Section 5 presents a summary and conclusion.

2. The model

The economies of the USA, Germany, and the UK can each be represented by a stylized DSGE model. The models consist of an infinitely lived representative household and a representative firm producing final output. Given that the analysis aims to assess the effect of fossil fuel prices (relative to policy) on the primary fossil fuel mix, not the determination of prices, fossil fuel prices are assumed exogenous and stochastic.

2.1. The representative household

The representative household's preferences are characterized by a utility function:

$$U(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma} \tag{1}$$

where c_t is consumption at time t and σ is the inverse of the intertemporal elasticity of substitution of consumption. Given the analysis focuses on primary energy use, c_t is assumed to represent all

[2] In addition, technological change can increase the efficiency of the use of a primary energy source, potentially changing the fuel mix toward the fuel that has experienced the technology improvement. However, since there are technology diffusion flows among developed economies, technology should not play a major role in explaining differences in the energy mix among countries.

[3] The models were simulated using the software program DYNARE, a freely available software platform at http://www.dynare.org/.

[4] The focus of the paper is to assess the impact of international prices relative to energy policy on the primary fossil fuel energy mix, so renewable and nuclear energy are not taken into account. In the past, the deployment of energy from renewables and nuclear has generally been the result of governmental strategy pursuing objectives such as energy security, greenhouse emissions reduction, economic competitiveness, industrial development or even green jobs (see Dassisti and Carnimeo (2012) for a discussion concerning the European Union). Additionally, there are no 'international prices' for nuclear and renewable energy; hence, it is not possible to include them in the analysis. We considered the Levelized Cost of Electricity (LCOE) as a proxy for the international price of renewable or nuclear technology; however, this was not deemed appropriate given that the LCOE depends on factors such as leverage, the discount rate, taxes, cost of land, administrative permissions, etc. Therefore, LCOE does not allow for a homogeneous comparison.