Appendix

The Competitive Equilibrium

Each representative firm faces a different profit maximization problem according to its technological structure and constraints.

Given $\left(W_t^{fg}, R_t^{fg} = 1 + r_t^{fg} - \delta^{fg}, P_t^{en}\right)_{t=0}^{\infty}$, the final consumer goods firm aims at maximizing the following profit function:

$$\max_{N_t^{fg}, K_{t-1}^{fg}, E_t} \Pi_t^{fg} = A_t^{fg}\left(L_t^{fg}\right)^{\alpha}(EN)_t^{\gamma}\left(K_{t-1}^{fg}\right)^{1-\alpha-\gamma} + (1-\delta^{fg})\, K_{t-1}^{fg} - W_t^{fg} L_t^{fg} + \tag{A1}$$

$$-R_t^{fg} K_{t-1}^{fg} - P_t^{en}(EN)_t$$

with P_t^{en} representing the price of energy.

Thus, the demand curves for the productive factors of this firm read as follows:

$$W_t^{fg} = A_t^{fg}\alpha\left(L_t^{fg}\right)^{\alpha-1}(EN)_t^{\gamma}\left(K_{t-1}^{fg}\right)^{1-\alpha-\gamma} \tag{A2}$$

$$R_t^{fg} = A_t^{fg}(1-\alpha-\gamma)\left(L_t^{fg}\right)^{\alpha}(EN)_t^{\gamma}\left(K_{t-1}^{fg}\right)^{-\alpha-\gamma} + \tag{A3}$$

$$+ (1-\delta^{fg})$$

$$P_t^{en} = A_t^{fg}\gamma\left(L_t^{fg}\right)^{\alpha}(EN)_t{}^{\gamma-1}\left(K_{t-1}^{fg}\right)^{1-\alpha-\gamma} \tag{A4}$$

The energy producing firm, given $\left(P_t^{ef}, P_t^{er}\right)_{t=0}^{\infty}$, where P_t^{ef} is the price of fossil fuels and P_t^{er} is the price of RES, solves the following maximization problem:

$$\max_{(EF)_t,(ER)_t} \Pi_t^{en} = P_t^{en}\left(\eta(ER)_t^{-\varepsilon} + (1-\eta)(EF)_t^{-\varepsilon}\right)^{-\frac{1}{\varepsilon}} + \tag{A5}$$

$$-\left(P_t^{ef} + \tau\right)(EF)_t - P_t^{er}(ER)_t$$

with the following fossil fuels and RES demands:

$$P_t^{ef} + \tau = \left[P_t^{en}\left(-\frac{1}{\varepsilon}\right)\,(\eta(ER)_t^{-\varepsilon} + (1-\eta)(EF)_t^{-\varepsilon})^{-\frac{1}{\varepsilon}-1}\right] * (-\varepsilon)\,(1-\eta)(EF)_t^{-\varepsilon-1} \tag{A6}$$

$$P_t^{er} = \left[P_t^{en}\left(-\frac{1}{\varepsilon}\right)\,(\eta(ER)_t^{-\varepsilon} + (1-\eta)(EF)_t^{-\varepsilon})^{-\frac{1}{\varepsilon}-1}\right]_* * (-\varepsilon)\,\eta(ER)_t^{-\varepsilon-1} \tag{A7}$$

The fossil fuel representative firm, given the production factor prices $\left(W_t^{ef}, F_t, R_t^{ef} = 1 + r_t^{ef} - \delta^{ef}\right)_{t=0}^{\infty}$, maximizes its profit function (A8) subject to the constraint (A9) determined by the exhaustibility of the fossil fuel deposit, S_t:

$$\max_{N_t^{ef}, K_{t-1}^{ef}, S_t} \Pi_t^{ef} = \left(P_t^{ef} + \tau\right) A_t^{ef}\left(L_t^{ef}\right)^{\theta}(S_{t-1})^{\varsigma}\left(K_{t-1}^{ef}\right)^{1-\theta-\varsigma} + +(1-\delta^{ef})\,K_{t-1}^{ef} - W_t^{ef}L_t^{ef} - R_t^{ef}K_{t-1}^{ef} - F_tS_{t-1} \tag{A8}$$

$$S_t - S_{t-1} = -\delta^s S_{t-1} - (EF)_t \tag{A9}$$

:

$$\max_{N_t^{ef}, K_{t-1}^{ef}, S_t} E_0 \sum_{t=0}^{\infty} \rho^t\left(\Pi_t^{ef}\right) = \left(P_t^{ef} + \tau\right) A_t^{ef}\left(L_t^{ef}\right)^{\theta}\left(K_t^{ef}\right)^{1-\theta}(S_{t-1})^{\varsigma} + (1-\delta^{ef})\,K_{t-1}^{ef} + -W_t^{ef}L_t^{ef} - R_t^{ef}K_{t-1}^{ef} - F_tS_{t-1} \tag{A10}$$

$$s.t.\,[S_t - S_{t-1} = -\delta^s S_{t-1} - (EF)_t] \tag{A11}$$

The problem is solved using a dynamic programming technique that maximizes the Lagrangian function, L, i.e.:

$$L = \max_{N_t^{ef}, K_{t-1}^{ef}, S_t} E\left[\begin{array}{l}\sum_{t=0}^{\infty} \rho^t \left(\begin{array}{l}\left(P_t^{ef} + \tau\right) A_t^{ef} \left(L_t^{ef}\right)^{\theta} (S_{t-1})^{\varsigma} \left(K_t^{ef}\right)^{1-\theta-\varsigma} + \\ +(1-\delta^{ef}) K_{t-1}^{ef} - W_t^{ef} L_t^{ef} - R_t^{ef} K_{t-1}^{ef} - F_t S_{t-1}\end{array}\right) + \\ +\lambda_t (S_{t-1} - \delta^s S_{t-1} - (EF)_t - S_t)\end{array}\right] \tag{A12}$$

with the following necessary conditions:

$$\frac{\partial L}{\partial L_t^{ef}}: \quad \left[A_t^{ef} \theta \left(N_t^{ef}\right)^{\theta-1} (S_{t-1})^{\varsigma} \left(K_t^{ef}\right)^{1-\theta-\varsigma}\right] \left[\left(P_t^{ef} + \tau\right) - \lambda_t\right] - W_t^{ef} = 0 \tag{A13}$$

$$\frac{\partial L}{\partial K_{t-1}^{ef}}: \quad \left[A_t^{ef} (1-\theta-\varsigma) \left(L_t^{ef}\right)^{\theta} \left(K_t^{ef}\right)^{-\theta-\varsigma} (S_{t-1})^{\varsigma}\right] \left[\left(P_t^{ef} + \tau\right) - \lambda_t\right] - R_t^{ef} + (1-\delta^{ef}) = 0 \tag{A14}$$

$$\frac{\partial L}{\partial S_t}: \quad \left[\varsigma A_t^{ef} \left(L_t^{ef}\right)^{\theta} \left(K_t^{ef}\right)^{1-\theta-\varsigma} (S_{t-1})^{\varsigma-1}\right] \left[\left(P_t^{ef} + \tau\right) - \lambda_t\right] - F_t + \lambda_{t+1} \rho (1-\delta^s) = 0 \tag{A15}$$

The substitution of the condition (A14) into the (A15) leads to the relationship between the expected price of fossil fuels and the cost of fossil deposits, according to the Hotelling (1931) rule:

$$E_0 \rho \left(P_{t+1}^{ef} + \tau\right) = E_0 \left(\rho \frac{R_{t+1}^{ef} - (1-\delta^{ef})}{\underbrace{A_{t+1}^{ef} (1-\theta-\varsigma) \left(L_{t+1}^{ef}\right)^{\theta} \left(K_t^{ef}\right)^{-\theta-\varsigma} (S_t)^{\varsigma}}_{MP\ of\ capital}}\right) + \frac{F_t}{(1-\delta^s)} + \\ - \left(\frac{\underbrace{\varsigma A_t^{ef} \left(L_t^{ef}\right)^{\theta} \left(K_t^{ef}\right)^{1-\theta-\varsigma} (S_{t-1})^{\varsigma-1}}_{MP\ of\ fossil\ deposits}}{\underbrace{A_t^{ef} (1-\theta-\varsigma) \left(L_t^{ef}\right)^{\theta} \left(K_{t-1}^{ef}\right)^{-\theta-\varsigma} (S_{t-1})^{\varsigma}}_{MP\ of\ capital}}\right) \left(\frac{R_t^{ef} - (1-\delta^{ef})}{(1-\delta^s)}\right) \tag{A16}$$

which states that the expected discounted price of fossil fuels is an increasing function of:

- the expected ratio between the net interest rate on physical capital and marginal productivity of capital (the first addend of (A16));
- the net cost of the fossil fuel deposits (the second addend of (A17));

and a decreasing function of the ratio between the marginal productivity of fossil fuel deposits and the marginal productivity of capital.

The substitution of the condition (A13) into the (A15) also generates a relationship between the expected price of fossil fuels and the cost of fossil deposits, i.e. the Hotelling rule, but instead of marginal productivity of capital there is the marginal productivity of labor:

$$E_0 \rho\left(P_{t+1}^{ef} + \tau\right) = E_0 \left(\rho \frac{R_{t+1}^{ef} - (1-\delta^s)}{\underbrace{A_t^{ef} \theta \left(L_t^{ef}\right)^{\theta-1} \left(K_{t-1}^{ef}\right)^{1-\theta-\varsigma} (S_{t-1})^{\varsigma}}_{MP\ of\ labor}} \right) + \frac{F_t}{(1-\delta^s)} + - \left(\frac{\underbrace{\varsigma A_t^{ef} \left(L_t^{ef}\right)^{\theta} \left(K_{t-1}^{ef}\right)^{1-\theta-\varsigma} (S_{t-1})^{\varsigma-1}}_{MP\ of\ fossil\ deposits}}{\underbrace{A_t^{ef} \theta \left(L_t^{ef}\right)^{\theta-1} \left(K_{t-1}^{ef}\right)^{1-\theta-\varsigma} (S_{t-1})^{\varsigma}}_{MP\ of\ labor}} \right) \left(\frac{W_t^{ef}}{(1-\delta^s)} \right) \tag{A17}$$

where the subscript MP indicates the marginal productivity.

The conditions (A13) and (A14) can be solved for the co-state variable, λ_t, in order to obtain the first order conditions for capital, K_{t-1}^{ef}, and labor, L_t^{ef}:

$$W_t^{ef} = \underbrace{A_t^{ef} \theta \left(L_t^{ef}\right)^{\theta-1} \left(K_{t-1}^{ef}\right)^{\vartheta} (S_{t-1})^{\varsigma}}_{MP\ of\ labor} * \\ * \left[\left(P_t^{ef} + \tau\right) + R_t^{ef} - \left(P_t^{ef} + \tau\right) \underbrace{A_t^{ef} \vartheta \left(L_t^{ef}\right)^{\theta} \left(K_{t-1}^{ef}\right)^{\vartheta-1} (S_{t-1})^{\varsigma}}_{MP\ of\ capital} \right] \tag{A18}$$

$$R_t^{ef} = \underbrace{A_t^{ef} (1-\theta-\varsigma) \left(L_t^{ef}\right)^{\theta} \left(K_{t-1}^{ef}\right)^{-\theta-\varsigma} (S_{t-1})^{\varsigma}}_{MP\ of\ capital} * \\ * \left[\left(P_t^{ef} + \tau\right) + W_t^{ef} - \left(P_t^{ef} + \tau\right) \underbrace{A_t^{ef} \theta \left(L_t^{ef}\right)^{\theta-1} \left(K_{t-1}^{ef}\right)^{1-\theta-\varsigma} (S_{t-1})^{\varsigma}}_{MP\ of\ labor} \right] + (1-\delta^{ef}) \tag{A19}$$

Finally, the RES sector, given $(W_t^{er}, R_t^{er} = 1 + r_t^{er} - \delta^{er})_{t=0}^{\infty}$, faces the following maximization problem:

$$\max_{N_t^{er},K_{t-1}^{er}} \Pi_t^{er} = (P_t^{er} + \mu_t)\, A_t^{er} (L_t^{er})^{\iota} (K_{t-1}^{er})^{1-\iota} + (1-\delta^{er})\, K_{t-1}^{er} + \\ -W_t^{er} L_t^{er} - R_t^{er} K_{t-1}^{er} \tag{A20}$$

with the corresponding first order conditions:

$$W_t^{er} = (P_t^{er} + \mu_t)\, A_t^{er} \iota \left(L_t^{ef}\right)^{\iota-1} (K_{t-1}^{er})^{1-\iota} \tag{A21}$$

$$R_t^{er} = (P_t^{er} + \mu_t)\, A_t^{er} (1-\iota) \left(L_t^{ef}\right)^{\iota} (K_{t-1}^{er})^{-\iota} + (1-\delta^{er}) \tag{A22}$$

The Households

The representative household's problem is solved by maximizing the following dynamic Lagrangian function:

$$L = \max_{\left(C_t, L_t^i, K_t^i\right)_{t=0}^{\infty}} E \sum_{t=0}^{\infty} \rho^t \left[\begin{array}{l} \left(\begin{array}{l} \left(\Upsilon_t \dfrac{(C_t)^{1-q}}{1-q} \right) + \\ - \dfrac{\left(L_t^{fg}\right)^{1+\chi}}{1+\chi} - \dfrac{\left(L_t^{ef}\right)^{1+\omega}}{1+\omega} - \dfrac{(L_t^{er})^{1+\psi}}{1+\psi} \end{array} \right) + \\ +\varpi_t \left[\begin{array}{l} W_t^{fg} L_t^{fg} + W_t^{ef} L_t^{ef} + W_t^{er} L_t^{er} + \\ +\Pi_t^{y} + \Pi_t^{en} + \Pi_t^{ef} + \Pi_t^{er} + r_t^{fg} K_{t-1}^{fg} + \\ +r_t^{ef} K_{t-1}^{ef} + r_t^{er} K_{t-1}^{er} + F_t S_{t-1} - C_t - X_t^{fg} - X_t^{ef} - X_t^{er} \end{array} \right] \end{array} \right] \tag{A23}$$

Moreover we assume that:

- the initial values of the capital stocks, K_0^i with $i(fg, ef, er)$, and fossil fuel deposit, S_0, are given and positive;
- these inequality constraints hold: $C_t > 0, L_t^i > 0$ with $i(fg, ef, er) > 0$;
- this transversality condition holds: $\lim_{t\to\infty} \rho^t \varpi_t K_t = 0$, where ϖ_t is the dynamic Lagrange multiplier.

The corresponding first-order conditions are summarized below:

$$\frac{\partial L}{\partial C_t}: \quad \Upsilon_t (C_t)^{-q} = \varpi_t \tag{A24}$$

$$\frac{\partial L}{\partial L_t^{fg}}: \quad \left(L_t^{fg}\right)^{\chi} = \varpi_t W_t^{fg} \tag{A25}$$

$$\frac{\partial L}{\partial L_t^{ef}}: \quad \left(L_t^{ef}\right)^{\omega} = \varpi_t W_t^{\omega} \tag{A26}$$

$$\frac{\partial L}{\partial L_t^{er}}: \quad (L_t^{er})^{\psi} = \varpi_t W_t^{\psi} \tag{A27}$$

$$\frac{\partial L}{\partial K_t^{fg}}: \quad \rho E_t\left(\varpi_{t+1} R_{t+1}^{fg}\right) = \varpi_t \tag{A28}$$

$$\frac{\partial L}{\partial K_t^{ef}}: \quad \rho E_t\left(\varpi_{t+1} R_{t+1}^{ef}\right) = \varpi_t \tag{A29}$$

$$\frac{\partial L}{\partial K_t^{er}}: \quad \rho E_t(\varpi_{t+1} R_{t+1}^{er}) = \varpi_t \tag{A30}$$

$$\begin{aligned} \frac{\partial L}{\partial \varpi_t}: \quad & W_t^{fg} L_t^{fg} + W_t^{ef} L_t^{ef} + W_t^{er} L_t^{er} + r_t^{fg} K_{t-1}^{fg} + \\ & + F_t S_{t-1} + r_t^{ef} K_{t-1}^{ef} + r_t^{er} K_{t-1}^{er} \\ & = C_t + X_t^{fg} + X_t^{ef} + X_t^{er} - \Pi_t^{fg} - \Pi_t^{e} - \Pi_t^{ef} - \Pi_t^{er} \end{aligned} \tag{A31}$$

We are able to eliminate the Lagrange multiplier, substituting in each expression their values:

$$\frac{\partial L}{\partial C_t}: \quad \Upsilon_t (C_t)^{-q} = \varpi_t \tag{A32}$$

$$\frac{\partial L}{\partial L_t^{fg}}: \quad \left(L_t^{fg}\right)^{\chi} = \Upsilon_t (C_t)^{-q} W_t^{fg} \tag{A33}$$

$$\frac{\partial L}{\partial L_t^{ef}}: \quad \left(N_t^{ef}\right)^{\omega} = \Upsilon_t (C_t)^{-q} W_t^{ef} \tag{A34}$$

$$\frac{\partial L}{\partial L_t^{er}}: \quad (L_t^{er})^{\psi} = \Upsilon_t (C_t)^{-q} W_t^{er} \tag{A35}$$

$$\frac{\partial L}{\partial K_t^{fg}}: \quad \rho E_t\left[\Upsilon_{t+1} (C_{t+1})^{-q} R_{t+1}^{fg}\right] = \Upsilon_t (C_t)^{-q} \tag{A36}$$

$$\frac{\partial L}{\partial K_t^{ef}}: \quad \rho E_t\left[\Upsilon_{t+1} (C_{t+1})^{-q} R_{t+1}^{ef}\right] = \Upsilon_t (C_t)^{-q} \tag{A37}$$

$$\frac{\partial L}{\partial K_t^{er}}: \quad \rho E_t[\Upsilon_{t+1} (C_{t+1})^{-q} R_{t+1}^{er}] = \Upsilon_t (C_t)^{-q} \tag{A38}$$

$$\begin{aligned} \frac{\partial L}{\partial \varpi_t}: \quad & W_t^{fg} L_t^{fg} + W_t^{ef} L_t^{ef} + W_t^{er} L_t^{er} + r_t^{fg} K_{t-1}^{fg} + \\ & + r_t^{ef} K_{t-1}^{ef} + r_t^{er} K_{t-1}^{er} + F_t S_{t-1} \\ & = C_t + X_t^{fg} + X_t^{ef} + X_t^{er} - \Pi_t^{fg} - \Pi_t^{e} \\ & - \Pi_t^{ef} - \Pi_t^{er} \end{aligned} \tag{A39}$$

The relationships (A36), (A37) and (A38) are the Euler equations, which are very commonly explored in these models; in this case, those equations state a non-arbitrage condition among private capital rates: $R_{t+1}^{fg} = R_{t+1}^{ef} = R_{t+1}^{er}$

Calibration and Prior Distributions

The prior distributions and the calibrated values are shown in tables 3, 4 and 5.

The prior densities are consistent with the domain of the parameters. Following Del Negro and Schorfheide (2008), in the prior elicitation process we divided the parameters into three groups, on the basis of the information used to calibrate the priors.

The first group of parameters consists of those that determine the steady state [α, γ, σ, θ, ζ, ι, η, δ^{fg}, δ^{ef}, δ^{er}, δ^{s}] and whose calibration derives from macroeconomic ‘great ratios’ mainly referred to the sample information. In the second group there are parameters that are related to policy, households, production [$\Gamma^{(A)}$, τ, q, ψ, ω, χ, ρ], taken either from micro-level data or from the literature or from out-of-the-sample information. In the last group there are parameters describing the propagation mechanism of the stochastic shocks, such as standard deviations of them and autocorrelations [ϕ^{fg}, ϕ^{ef}, ϕ^{er}, ϕ^{Υ}, o_{ϵ}^{fg}, o_{ϵ}^{ef}, o_{ϵ}^{er}, o_{ϵ}^{Υ}]. These last parameters are calibrated looking at the second moments of the observable variables, which are also consistent with the results found by the literature.

Moreover, in the calibration phase, we assume that the energy sector’s production function elasticities have the same prior means as the corresponding means of final output. The final output production function elasticities with respect to labor, α and energy, γ, are distributed according to a beta random variable with means equal to the average shares of wages and energy in the GDP, with a standard deviation of 0.05. Fossil fuel and RES production function elasticities with respect to labor (θ, ι) follow a beta distribution with means equal to those of the final output, but with a slightly higher standard deviation of 0.1. The average production share of hydrocarbon extraction costs (ς) is calibrated at 0.20, with a standard deviation of 0.1 for all the countries (Nomisma, 2012). The capital depreciation rate for final output (δ^{fg}) is calibrated at a value of 0.10, which is consistent for all the countries considered, with the differences between the gross real interest rate for physical capital and the net one. The other capital depreciation rates (δ^{ef}, δ^{er}) are distributed according to a beta random variable with means equal to 0.10. For the fossil fuel deposits depreciation rate, δ^{s}, the prior mean is equal to 0.05 and it is distributed according to a beta random variable (Considine, 2000). The standard deviations for δ^{ef}, δ^{er}, δ^{s} are set at 0.10. The share of RES in the energy production function, η, follows a beta distribution with mean equal to the average share of RES and fossil fuels in energy production from 2006 to 2011 (World Bank Group, 2016). The elasticity of substitution between RES and fossil fuels follows a gamma distribution with a mean of 0.45 for the E.U.15 and 0.51 for China and the U.S. (Pelli, 2012).

The coefficient of relative risk aversion, q, which is the inverse of the intertemporal elasticity of substitution of consumption, is normally distributed with a mean of 1.1 for the E.U.15, 1.4 for the U.S. and 2.5 for China[1] (Gandelman and Murillo, 2015) and standard deviations of 0.5. According to Smets and Wouters (2003; 2007) and Dai et al. (2015), the inverse of the Frisch elasticities of labor supply, ψ, ω and χ, follow a gamma distribution with a mean equal to 2 and a standard deviation of 0.75 for all three countries. Following the real business cycle literature (Blanchard and Quah, 1989; King and Rebelo, 1999) and the second moments of the sample data, the persistence coefficients for the stochastic processes related to the TFPs, ϕ^{fg}, ϕ^{er}, ϕ^{ef} and taste shifter, ϕ^{Υ}, are beta distributed with a mean equal to 0.85, following the real business cycle literature (Blanchard and Quah, 1989; King and Rebelo, 1999; Smets and Wouters, 2003) and a standard deviation equal to 0.10.

The intertemporal discount factor ρ has been calibrated with the value of 0.90 for all the countries, which is consistent with the steady state values for private capital rentals for all the countries, according to Euler equations. The standard deviations of TFP and taste shifter shocks follow an inverse gamma distribution with a mean equal respectively to 0.4 (for final output and fossil fuel

[1]For China, we use the estimates for Taiwan.

TFP) and 0.2 (for the taste shifter) for the E.U.15 (Smets and Wouters, 2003), 0.10 (for final output and fossil fuels' TFP) and 0.10 (for the taste shifter) for the U.S. (Smets and Wouters, 2007), 0.40 (for final output and fossil fuels' TFP) and 0.70 (for the taste shifter) for China (Dai et al. 2015). In addition, in order to capture the higher volatility related to RES production, we calibrate, for all three countries, the mean of the RES TFP shock at a value of 1. The corresponding standard deviations are always equal to 2[2]. The mean of the effective excise tax rates (Euros/TOE) on gasoline is assumed as a proxy of the environmental tax rate, τ (American Petroleum Institute, 2016; European Commission, 2016; United Nations Environment Programme, 2015). This variable follows a gamma distribution with a standard deviation of 0.1.

Table 3: Prior Distributions of Structural Parameters

for the EU-15

Parameters	**Distribution**	**Mean**	**St. Dev.**
Final Output			
α	Beta	0.60	0.05
γ	Beta	0.02	0.10
δ^{fg}	Fixed	0.10	-
ϕ^{fg}	Beta	0.85	0.10
$\Gamma^{(A)}$	Normal	1.60	0.10
o_{ϵ}^{fg}	Inv.gamma	0.40	2.00
Fossil Fuels			
δ^{ef}	Beta	0.10	0.10
δ^{s}	Beta	0.05	0.10
θ	Beta	0.60	0.10
ζ	Beta	0.20	0.10
ϕ^{ef}	Beta	0.85	0.10
T	Gamma	583.18	0.10
o_{ϵ}^{ef}	Inv.gamma	0.40	2.00
RES			
δ^{er}	Beta	0.10	0.10
ι	Beta	0.60	0.10
ϕ^{er}	Beta	0.85	0.10
o_{ϵ}^{er}	Inv.gamma	1.00	2.00
Energy			

[2] The choice of these loose priors for the standard deviations, consistent with the literature (see Smets and Wouters, 2007, among others), resulted from our decision to 'let the data talk' in order to determine the role of each shock in explaining the model's volatility.

σ	Gamma	1.22	0.05
η	Beta	0.12	0.10
Demand			
q	Normal	1.10	0.50
Ψ	Gamma	2.00	0.75
Ω	Gamma	2.00	0.75
X	Gamma	2.00	0.75
P	Fixed	0.90	-
ϕ^{Υ}	Beta	0.85	0.10
o_{ϵ}^{Υ}	Inv.gamma	0.20	2.00

Table 4: Prior Distributions of Structural Parameters for China

Parameters	Distribution	Mean	St. Dev.
Final Output			
α	Beta	0.50	0.05
γ	Beta	0.02	0.10
δ^{fg}	Fixed	0.10	-
ϕ^{fg}	Beta	0.85	0.10
$\Gamma^{(A)}$	Normal	10.0	0.10
o_{ϵ}^{fg}	Inv.gamma	0.40	2.00
Fossil Fuels			
δ^{ef}	Beta	0.10	0.10
δ^{s}	Beta	0.05	0.10
θ	Beta	0.50	0.10
ζ	Beta	0.20	0.10
ϕ^{ef}	Beta	0.85	0.10
τ	Fixed	220.66	0.10
o_{ϵ}^{ef}	Inv.gamma	0.40	2.00
RES			
δ^{er}	Beta	0.10	0.10
ι	Beta	0.50	0.10
ϕ^{er}	Beta	0.85	0.10
o_{ϵ}^{er}	Inv.gamma	1.00	2.00
Energy			
σ	Gamma	0.96	0.05
η	Beta	0.18	0.20
Demand			
q	Normal	2.50	0.50
ψ	Gamma	2.00	0.75
ω	Gamma	2.00	0.75
χ	Gamma	2.00	0.75
ρ	Fixed	0.90	-
ϕ^{Υ}	Beta	0.85	0.10
o_{ϵ}^{Υ}	Inv.gamma	0.70	2.00

Table 5: Prior and Posterior Distributions of Structural Parameters for the US

Final Output			
α	Beta	0.60	0.05
γ	Beta	0.02	0.10
δ^{fg}	Fixed	0.10	-
ϕ^{fg}	Beta	0.85	0.10
$\Gamma^{(A)}$	Normal	2.00	0.10
σ_{ϵ}^{fg}	Inv.gamma	0.40	2.00
Fossil Fuels			
δ^{ef}	Beta	0.10	0.10
δ^{s}	Beta	0.05	0.10
θ	Beta	0.60	0.10
ζ	Beta	0.20	0.10
ϕ^{ef}	Beta	0.85	0.10
τ	Fixed	66.93	0.10
σ_{ϵ}^{ef}	Inv.gamma	0.10	2.00
RES			
δ^{er}	Beta	0.10	0.10
ι	Beta	0.60	0.10
ϕ^{er}	Beta	0.85	0.10
σ_{ϵ}^{er}	Inv.gamma	1.00	2.00
Energy			
σ	Gamma	0.96	0.05
η	Beta	0.08	0.10
Demand			
q	Normal	1.40	0.50
ψ	Gammma	2.00	0.75
ω	Gamma	2.00	0.75
χ	Gamma	2.00	0.75
ρ	Fixed	0.90	-
ϕ^{Υ}	Beta	0.85	0.10
$\sigma_{\epsilon}^{\Upsilon}$	Inv.gamma	0.10	2.00

Impulse Response Functions for Final Output TFP and taste shifter

A positive technology shock to final output (Figures 7b, 8b and 9b) generates an increase in production and consumption through a positive shift of final goods supply curves (Figures 7a, 8a and 9a) and productive factors demand curves in all three economies (Figures 7, 8 and 9). More specifically, in all countries, an increase in TFP generates different growth paths for energy demand (Figures 7c, 8c and 9c) and for both fossil fuel (Figures 7h, 8h and 9h) and RES prices (Figures 7i, 8i and 9i). This produces different quantitative responses. In the E.U.15 and China, the response of final output has almost the same shock size, whereas in the U.S., where the share of energy in the production function is higher than in China and the E.U.15, final output increases more than final output TFP. Moreover, a feature common to all countries is that the energy demand increase is mainly determined by the growth of fossil fuels rather than RES, due to the higher share of fossil fuels in the energy production function.

In the case of a demand shock to the preferences (Figures 10, 11 and 12), the dynamics of the variables is similar to the case of the final output TFP shock for all three countries. However, the growth of the productive factors demand curves is determined by tastes, the rise in which generates a positive shift of private consumption and, hence, higher production, through an increased input demand. Also, in this case there is an increase in RES quantity in all countries. However, there is a difference in the response of private consumption to the taste shifter (that is, a demand shock): very small for the U.S. and for China but larger for the E.U.15, where the persistence of taste shifter is greater.

Figure 10: EU-15 Impulse Response Functions for a Positive TFP Shock on Final Output Sector

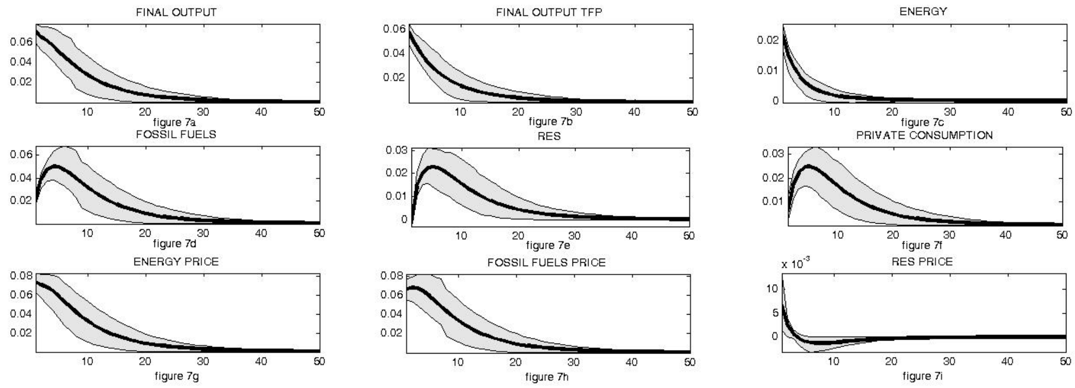


Figure 11: China Impulse Response Functions for a Positive TFP Shock on Final Output Sector

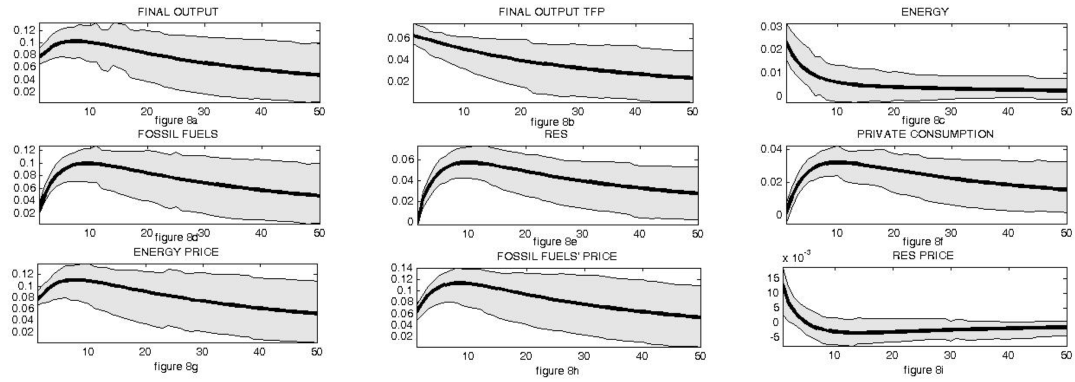


Figure 12: US Impulse Response Functions for a Positive TFP Shock on Final Output Sector

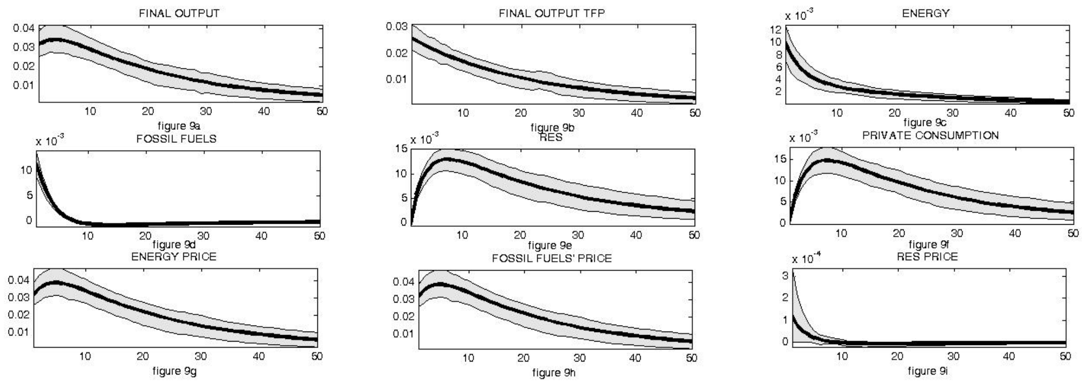


Figure 13: EU-15 Impulse Response Functions for a Positive taste shifter

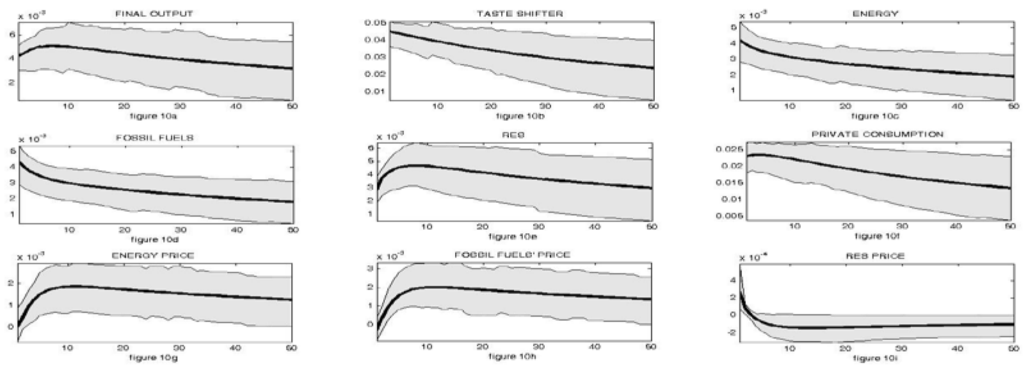


Figure 14: China Impulse Response Functions for a Positive taste shifter

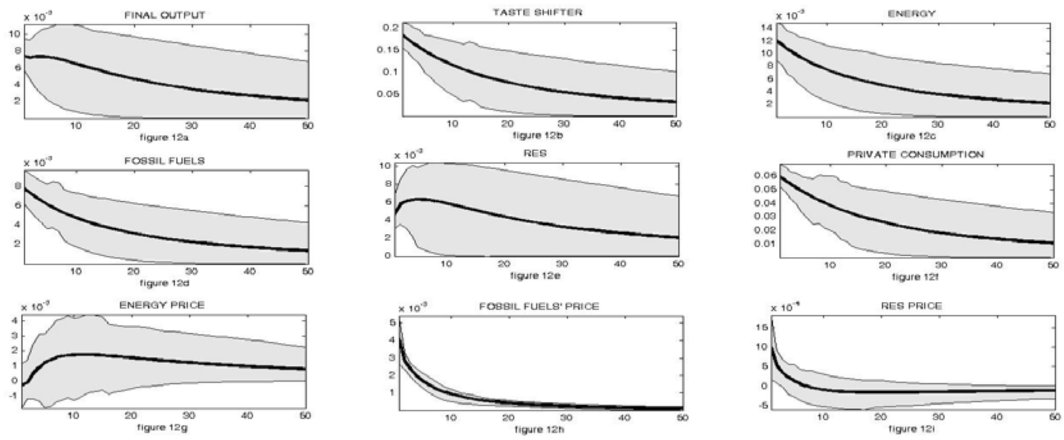
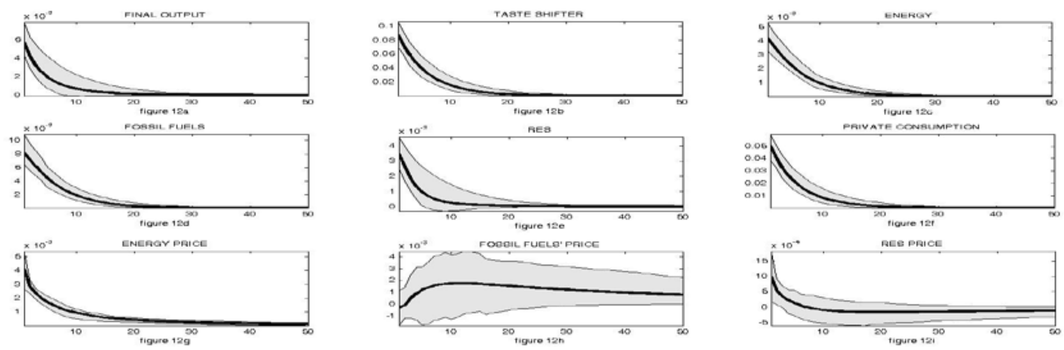


Figure 15: US Impulse Response Functions for a Positive taste shifter



The Model Diagnostics

In order to evaluate the model diagnostics, we used simulated data and oil (fossil) prices time series data from 1987 to 2015 (Table 6). For no region did we find a statistically significant difference in the means and in the variances ratio. To better compare our model with the real world we also tested the full distributions. Table 6 shows results of a Kolmogorov-Smirnov test for equality of distribution functions. Results confirm that our simulated series and the actual data have the same distribution function, given that we cannot reject this hypothesis at 5%.

Table 6: Moments and Distributions Tests [(a)] -Year 1987-2015 (Obs. = 28)-.

Test	Oil	Oil China	Oil U.S.	Oil E.U.15
mean	0.0243	0.0258	0.0232	0.0248
t-test	---	t = -1.1930 P = 0.2429 [(b)]	t = 0.7461 P = 0.4618 [(b)]	t = -0.9634 P = 0.3436 [(b)]
st. dev.	0.0118	0.0097	0.0095	0.0121
F-test	---	f = 1.4918 Prob = 0.2959 [(c)]	f = 1.5549 Prob = 0.2489 [(c)]	f = 0.9501 Prob = 0.8932[(c)]
Kolmogorov-Smirnov test	---	K-S = 0.3103 P-value = 0.079*	K-S = 0.1724 P-value = 0.703 [(d)]	K-S = 0.2759 P-value = 0.154 [(d)]

[(a)] Simulated regional oil prices do not include regional taxes (Euro/kWh).

[(b)] We do not find a statistically significant difference in the means.

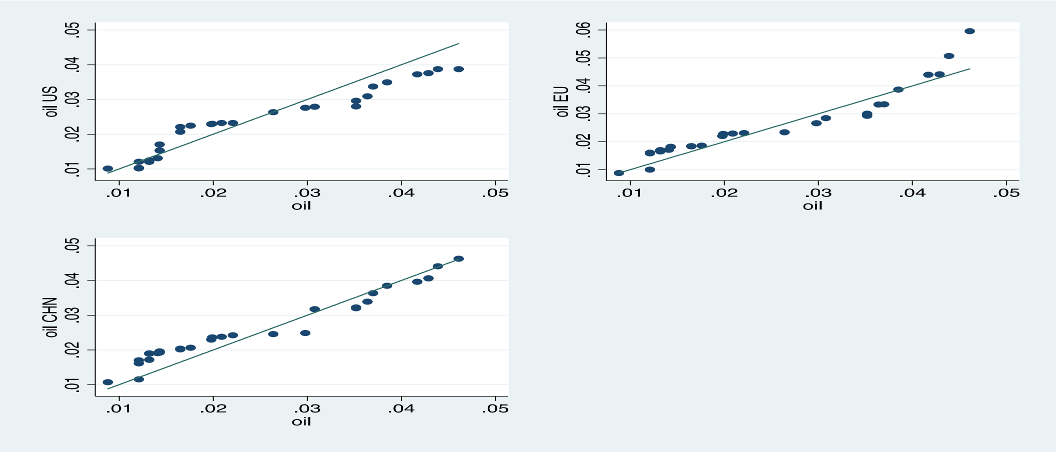
[(c)] We do not find a statistically significant difference in the variances ratio.

[(d)] We cannot reject that series do not have the same distribution function.

* Significant at 10%; ** significant at 5%; *** significant at 1%.

Finally, we have paired plotted quantiles of simulated series against actual data, finding that they are very similar (Figure 16).

Figure 16: Quantile – Quantile plot; Simulated Series *vs.* Actual Data.



Data are expressed in Euro/kWh for the period 1987–2015.

With regard to RES prices, no time series data are available for the regions considered. Accordingly, we compared only simulated prices with current single information. Simulated RES prices, expressed in Euro/kWh, lie in the forecasted price range according to major international organizations.