THE IMPACT OF HIGHER RETAIL ENERGY PRICES ON INTERGENERATIONAL WELFARE IN SAUDI ARABIA

by

FRÉDÉRIC GONAND

UNIVERSITY PARIS-DAUPHINE - PSL RESEARCH UNIVERSITY (FRANCE) AND KAPSARC (SAUDI ARABIA)

FAKHRI HASANOV

KAPSARC (SAUDI ARABIA) AND INSTITUTE OF CONTROL SYSTEMS (AZERBAIJAN)

LESTER C. HUNT

KAPSARC (SAUDI ARABIA) AND UNIVERSITY OF SURREY, UK.

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INTRODUCTION (1/3)

- In December 2015, the Saudi Arabian government raised most of its administered retail energy prices.

  For example, the price of automotive diesel fuel increased from 0.25 Saudi Arabian Riyal (SAR) per liter (l) to 0.45 SAR/l (resp. 0.07US$/l and 0.12US$/l). Price of 95 gasoline from 0.60 SAR/l to 0.90 SAR/l (resp. 0.16US$/l and 0.24US$/l)(Platts, 2015). Price of natural gas was increased from $0.75/MMBtu to $1.25/MMBtu (resp. 2.81 SAR/MMBtu and 4.69 SAR/MMBtu)(Platts, 2015).

- The rationale for raising retail energy prices at the end of 2015 is closely related to the plummeting price of oil on world markets from 2015 onwards.

INTRODUCTION (2/3)

This paper assesses how the aggregate effects of raising Saudi retail energy prices, as in Dec 2015, might affect the welfare of Saudis…

- … through a direct increase in energy expenditures;
- … through an indirect rise in Saudi public income stemming from a lower domestic demand for oil that fosters oil exports at a given level of domestic oil production;
- … through a direct increase in the turnover of the public energy sector.

Given that the two latter effects can be redistributed by public authorities through higher current public spending or investments, the different effect of the different redistributions are considered.

INTRODUCTION (3/3)

- We develop a dynamic energy model with overlapping generations (called MEGIR-SA, *Model with Energy, Growth and Intergenerational Redistribution – Saudi Arabia*), which we believe is the 1st model of this type to be developed for a Gulf region country.

- It compares **the costs of the policy** (higher end-use price of energy) with **its economic gains** (lower oil domestic consumption from higher energy prices, thus higher oil exports, energy sector turnover and public income recycled in the economy) and computes **the net effect** on Saudi's intertemporal welfare.

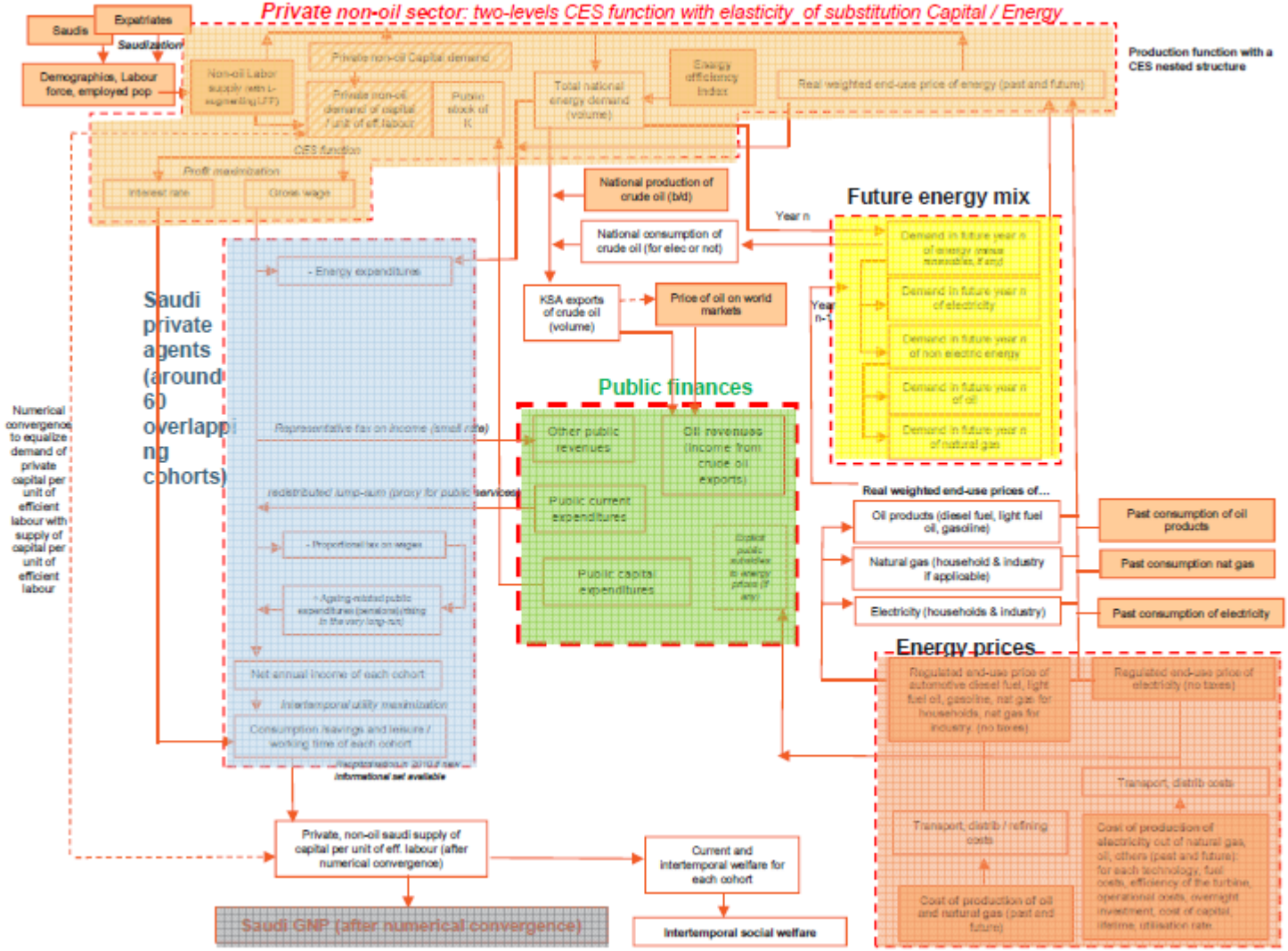
- Simulations, not forecasts.

THE MODEL (1/3)

- Literature review: although some macro models have been developed for the KSA, there has been little published work using such models to analyze the impact of the recent increased administrative prices of energy.
  Moreover, none, as far as we are aware, has addressed intergenerational wealth effects of the changes.

- Our model:
  - A detailed overlapping generation framework (ar.60 cohorts)
  - Saudi economic specificities
    - Demographics
    - Energy module: oil production sector, end-use prices of different energies, production function, Saudi public finances…

THE MODEL (2/3)


Private non-oil sector: two-levels CES function with elasticity of substitution Capital / Energy
Saudis
Expatriates
Saudization
Demographics, Labour force, employed pop
Production function with a CES nested structure
Total national energy demand (volume)
Energy efficiency index
Real weighted end-use price of energy (past and future)
CES function
Profit maximization
Interest rate
Gross wage
National production of crude oil (bld)
National consumption of crude oil (for elec or not)
Future energy mix
Year n
Year n-1
Demand in future year n of energy minus renewables, if any
Demand in future year n of electricity
Demand in future year n of non electric energy
Demand in future year n of oil
Demand in future year n of natural gas
KSA exports of crude oil (volume)
Price of oil on world markets
Saudi private agents (around 60 overlapping cohorts)
- Energy expenditures
Representative tax on income (small rate)
redistributed lump-sum (proxy for public services)
- Proportional tax on wages
- Ageing-related public expenditures (pensions) rising in the very long-run
Net annual income of each cohort
Intertemporal utility maximization
Consumption /savings and leisure / working time of each cohort
Public finances
Other public revenues
Oil revenues (income from crude oil exports)
Public current expenditures
Public capital expenditures
Real weighted end-use prices of...
Oil products (diesel fuel, light fuel oil, gasoline)
Natural gas (household & industry if applicable)
Electricity (households & industry)
Past consumption of oil products
Past consumption nat gas
Past consumption of electricity
Energy prices
Regulated end-use price of automotive diesel fuel, light fuel oil, gasoline, nat gas for households, nat gas for industry (no taxes)
Regulated end-use price of electricity (no taxes)
Transport, distrib costs
Transport, distrib / refining costs
Cost of production of electricity out of natural gas, oil, others (past and future): for each technology, fuel costs, efficiency of the turbine, operational costs, overnight investment, cost of capital, lifetime, utilisation rate
Cost of production of oil and natural gas (past and future)
Numerical convergence to equalize demand of private capital per unit of efficient labour with supply of capital per unit of efficient labour
Private, non-oil saudi supply of capital per unit of eff. labour (after numerical convergence)
Current and intertemporal welfare for each cohort
Saudi GNP (after numerical convergence)
Intertemporal social welfare

THE MODEL (3/3)

Production function

$$Y_t = [a(B_t E_t)^{\gamma_{en}} + (1-\alpha)[C_t]^{\gamma_{en}}]^{\frac{1}{\gamma_{en}}}$$

$$C_t = K_{KSA\,pub,t}^{\varsigma}\left[\alpha\left(K_{KSA\,priv,t}\right)^{1-\frac{1}{\beta}} + (1-\alpha)[A_t\bar{\varepsilon}_t\Delta_t L_t]^{1-\frac{1}{\beta}}\right]^{\frac{1}{1-\frac{1}{\beta}}}$$

$$r_t = k_{KSA\,pub,t}^{\varsigma}\left[\alpha\left(k_{KSA\,priv,t}\right)^{\frac{\beta-1}{\beta}} + 1-\alpha\right]^{\frac{1}{\beta-1}}\left[\alpha k_{KSA\,priv,t}^{\frac{-1}{\beta}}\right]$$

$$w_t = k_{KSA\,pub,t}^{\varsigma} A_t\left[\alpha\left(k_{KSA\,pub,t}\right)^{1-\frac{1}{\beta}} + 1-\alpha\right]^{\frac{1}{\beta-1}}[1-\alpha]$$

Public finances

$$Y_{oil,t} + Y_{others,t} = \Theta_{current,t} + \Theta_{capital,t}$$

60+ Overlapping generations

$$U_{t,0}^{*} = \frac{1}{1-\sigma}\sum_{j=\alpha}^{\Psi_{t,0}}\left[\frac{1}{(1+\rho)^j}\left[\left(\left(c_{t+j,j}^{*}\right)^{1-1/\xi} + \varkappa\left(H_j\left(1-\ell_{t+j,j}^{*}\right)\right)^{1-1/\xi}\right)^{\frac{1}{1-1/\xi}}\right]^{1-\sigma}\right]$$

$$\ell_{t,0}^{*}\omega_{t,0} + \sum_{j=1}^{\Psi_{t,0}}\left[\ell_{t+j,j}^{*}\omega_{t+j,j}\prod_{i=1}^{j}\left(\frac{1}{1+r_{t+i}}\right)\right] = c_{t,0}^{*} + \sum_{j=1}^{\Psi_{t,0}}\left[c_{t+j,j}^{*}\prod_{i=1}^{j}\left(\frac{1}{1+r_{t+i}}\right)\right]$$

$$\frac{c_{t,a}^{*}}{c_{t-1,a-1}^{*}} = \left(\frac{1+r_t}{1+\rho}\right)^{\kappa}\left(\frac{1+\varkappa^{\xi}\omega_{t,a}^{1-\xi}}{1+\varkappa^{\xi}\omega_{t-1,a-1}^{1-\xi}}\right)^{\frac{\kappa-\xi}{\xi-1}}$$

$$c_{t,0}^{*} = \frac{\omega_{t,0} + \sum_{j=1}^{\Psi_{t,0}}\left[\omega_{t+j,j}\prod_{i=1}^{j}\left(\frac{1}{1+r_{t+i}}\right)\right]}{1+\varkappa_{t,0}^{\zeta}\omega_{t,0}^{1-\zeta} + \sum_{j=1}^{\Psi_{t,0}}\left[\Xi_{t+j,j}\left(1+\varkappa_{t+j,j}^{\zeta}\omega_{t+j,j}^{1-\zeta}H_j^{-1}\right)\right]}$$

$$\text{avec } \Xi_{t+j,j} = (1+\rho)^{-j\kappa}\left(\frac{1+\varkappa^{\zeta}\omega_{t+j,j}^{1-\zeta}}{1+\varkappa^{\zeta}\omega_{t,0}^{1-\zeta}}\right)^{\frac{\kappa-\zeta}{\zeta-1}}\prod_{i=1}^{j}(1+r_{t+i})^{\kappa-1}.$$

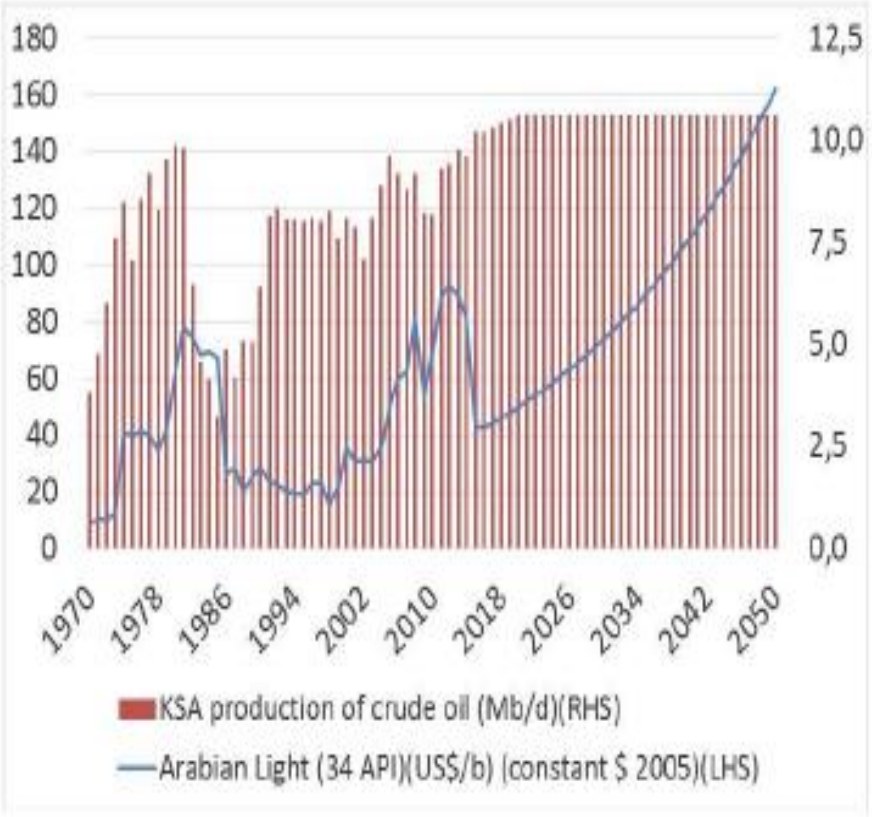
POLICY SCENARIOS (1/2)

	$\bar{y}$	
	0%	*100%*
Future oil prices increasing + future oil production stable	B_0	B_{100}
Future oil prices and oil production declining	C_0	C_{100}

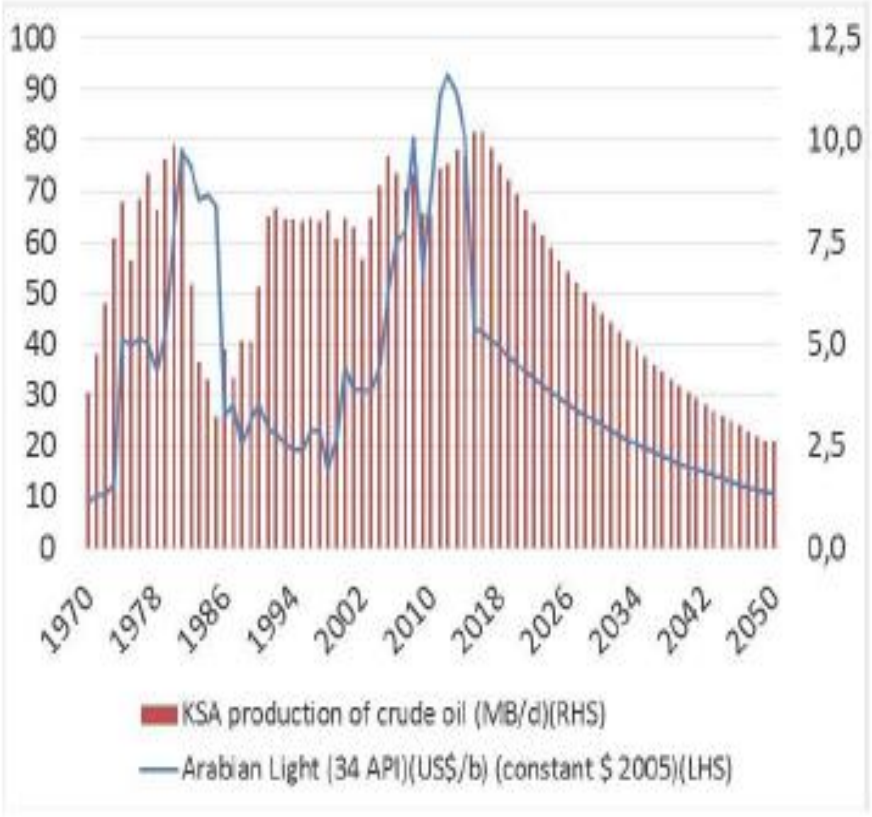
$\bar{y}$ = fraction of the increase in the future total public income associated with energy price hikes that is recycled through higher **public capital spending**.
Exogenously set by public authorities.

POLICY SCENARIOS (2/2)

Scenarios B (*i.e., scenario B_0 and scenario B_{100}*)



Scenarios C (*i.e., scenario C_0 and scenario C_{100}*)



RESULTS (1/2)

- **Result 1:** In KSA, the permanent increase in end-user energy prices implemented in Dec. 2015 triggers a net overall favorable effect on the intertemporal welfare of all households.

- **Result 2:** The additional oil income associated with the increase in energy domestic prices tends to be relatively more beneficial to future generations if it is recycled through public investments ($\bar{y}$= 100% as in B_{100} and C_{100}) and relatively more to currently living cohorts if it is recycled through current spending.

- **Result 3**: The lower the future price of oil and Saudi oil income (as in in C_0 and C_{100}), the more the future cohorts benefit relatively from a recycling of the additional oil income through public investments.

Figure 1: Impact on the intertemporal welfare of Saudi cohorts of higher retail energy prices (with higher future oil prices and immediate recycling of the additional oil income)

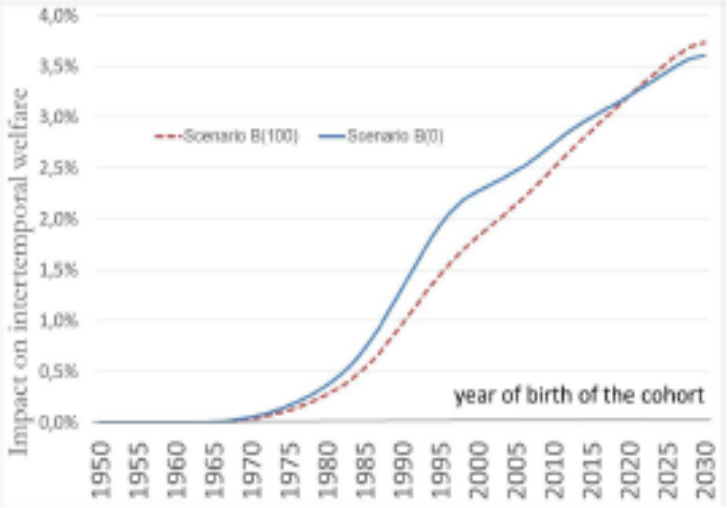
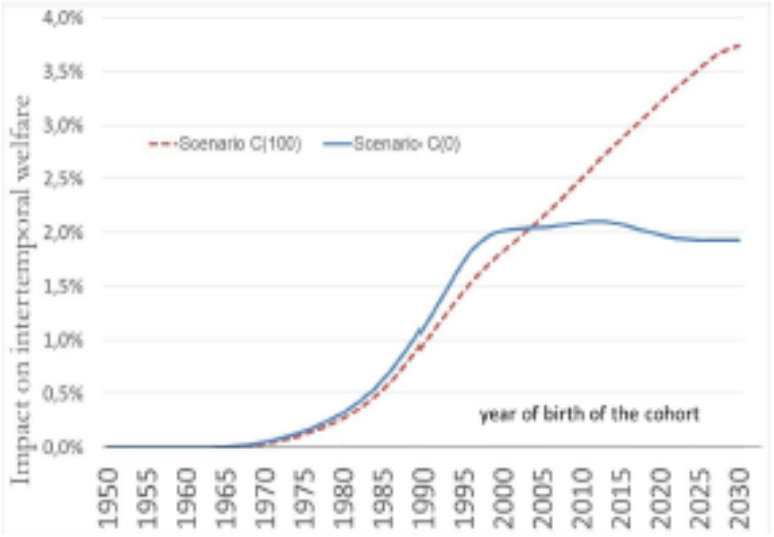


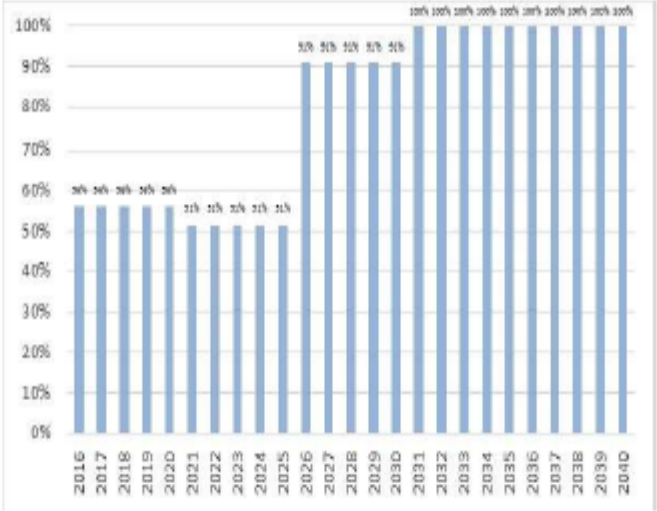
Figure 2: Impact on the intertemporal welfare of Saudi cohorts of higher retail energy prices (with lower future oil prices and production, and immediate recycling of the additional oil income)



RESULTS (2/2)

Result 4: *In case of declining future oil prices and domestic production of oil*, a desirable policy may consists of increasing gradually the fraction of the additional oil income stemming from lower domestic demand up to 100% in the future.

Figure 5: Optimized percentage of recycling the additional oil income through public capital spending (assuming declining future oil prices and domestic production – Scenario C)



In case of future higher oil prices and high Saudi production of oil, a desirable policy may consists in recycling the additional oil income stemming from lower domestic demand mainly through current public spending.

CONCLUSION

- This paper investigates the intergenerational welfare impact of raising retail energy prices in Saudi Arabia – a major oil-exporting country.
- Our analysis suggests that this choice may trigger important intergenerational redistributive effects (NB: in KSA, currently 81% of the population are under 40).
- Another policy implication is that the anticipations about future oil prices significantly influence the definition of current recycling policies.
- It is noteworthy to the policymakers – in this case, in the KSA – to have evidence to show that energy price changes increase welfare.
- This is in line with the partial equilibrium analysis of welfare of price reforms (Davis, 2017) but our paper confirms that the result holds in general equilibrium + it provides with additional insights as concerns intergenerational redistributive effects that are especially useful for oil-exporting countries with young and fast growing populations.

THANK YOU FOR YOUR ATTENTION

Contact: frederic.gonand@dauphine.fr