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# THE OPTIMAL PATH OF ENERGY AND $CO_2$ TAXES FOR INTERTEMPORAL RESOURCE ALLOCATION AND IMPROVED ENERGY EFFICIENCY

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When proposing to tax energy, environmental economists have several objectives in mind: (i) the control of CO2 emissions, one of the principal greenhouse gases to global warming; (ii) to raise the scarcity price of an exhaustible resource (fossil fuel), the burning of it is a major source of CO2; (iii) to improve energy efficiency by enhancing R&D activities for a more efficient use of energy; (iv) to reduce other air pollutants like SO2, NOX or particulates by using less energy or by investing in abatement measures if SO2 is the tax base. Much of the literature on an energy or carbon tax has been concerned with the question of what level of a tax is required to achieve a given goal (e.g. a reduction of CO2 emissions by 20% in 2008). However, in view of the exhaustion of fossil fuel and the tendency towards a dramatic $CO_2$ accumulation in the atmosphere (whatever comes first), the time path of the tax is of more interest than just its level. The CO2 problem presents a classical problem in intertemporal choice. Should we start with a high CO2 tax to delay depletion and CO2 emissions and then reduce it over time, or should we start with a lower tax level which then should rise over time, or maybe the tax should rise first and then fall.

There is a substantial literature on resource use and economic activity with accumulative pollution. In the prototype of pollution control models, economic benefits depend positively on emissions (via production and consumption) and negatively on the pollution stock level. Of interest are time paths that maximize the present value of welfare taking into account the effects of accumulative pollution on production possibilities and utility from consumption. Some papers look at pollution and optimal capital accumulation and others at pollution and optimal investment in cleaning-up activities. Since pollution is essentially a problem of missing markets, the emission fee corresponds to the value of the co-state variable, i.e. to the social price of an additional unit of pollution. Most studies address only the stock externality (CO2) and not the exhaustibility of a resource (fossil fuel). In those studies economic activity and pollution converge to a steady state in which the (constant) flow of additions to the pollution stock is offset by the environment’s assimilative capacity. In all studies the shadow price of the resource is interpreted as a pollution tax. The government controls quantities but not the path of a tax to achieve optimal allocation. The price mechanism is not at work to influence producer and consumer behavior.

Our approach differs from the standard approach which can be found in the literature. First, it is not the kind of macro-approach, where the utility of energy enters into a government's objective function and where the country incurs cost of exploration. We consider a profit maximizing industry which uses energy as one of its inputs to produce sectoral output. The firm is therefore not a mining company nor does the government own the mine. The firm has to buy energy from a resource country and has to pay taxes on it to its domestic government. The government maximizes a welfare function where consumer and producer surplus, environmental damage and tax revenues are part of the welfare function. Second, its control variable is not a good like consumption or energy use but an energy tax. The components of the energy tax and its path depend on the constraints the economy faces. One constraint is that energy use contributes to exhausting the CO2-fill capacity of the atmosphere. Although this is a global problem, the government does not take a free-rider position but favors unilateral actions. Third, we add the constraint to our model that fossil energy is also a non-renewable resource.