Short- and long-run dynamics of energy demand

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Reduction of CO2 emissions could be achieved either via decrease in consumption or via a change in production towards methods that does not involve combustion of fossil fuels. If only the first option is available, any climate policy will lead to a significant negative impact on wages, employment and welfare, and thus might not be acceptable from a sociopolitical point of view. On the contrary, if adjustment of production methods can counterbalance the negative effect of climate policy on consumption, then such a policy might gain more social acceptability.

The desired changes in methods of production do not happen immediately. Climate policy, such as carbon tax is a signal for firms to invest in new technologies which are characterized by better efficiency and lower use of fossil fuels. These new technologies will be gradually implemented. However, the old technology which is embodied in older vintages of capital will stay in the economy until its use brings profit for firms. This implies that the short-run effect of climate policy will differ from the long-run effect.

In this paper we conduct analyses of climate policies using tools that differentiate between the short-run, immediate effects of a carbon tax and the structural adjustments which take place only in the long run. Using tools that do not take this into account can lead to the overestimation of long-run costs of decarbonisation or to the underestimation of the short-run effects.

The study contributes to the literature on energy economics in three ways. First, we apply Le Chatelier principle (Samuelson 1960) to show that the rebound effect associated with improvement of energy efficiency (see e.g. Sorrell and Dimitropoulos 2008) cannot lead to an increase in energy demand if that improvement is induced by an increase in energy prices.

Second, we show that if firms cannot adjust their choice of technology for vintages of capital installed in the past, then energy demand approaches its long-run level at the exponential rate given by the sum of the depreciation rate of capital and the growth rate. We derive this result from an analytical dynamic model which combines the insight of the putty-clay vintage model and technology frontier framework (Caselli and Coleman (2006) and Growiec 2013).

Third, we investigate the impact that long-run technological adjustments related to energy efficiency have on the dynamics of macroeconomic variables such as GDP, employment and wages. To do so we incorporate the framework of dynamic demand described above in a large-scale, numerical multi-sector Dynamics Stochastic General Equilibrium model.