University of Basel

Exploring Possible Futures

Video Transcript

From system to firms

All our modelling work so far has described the system perspective. We asked how much should be invested in different technologies to meet a set of objectives, such as satisfying demand, limiting emissions, or having low costs. For answering these questions, we assumed a system perspective where we acted like a benevolent dictator and decided how much to invest or deploy when. In most applications, such decisions are not made by politicians or public administration, but by firms. Firms decide when to invest in which technology and under which conditions they will produce with a given technology. Policy can influence these decisions. For example, by using taxes or subsidies. But it can usually not force firms to make specific investments.

The next step in building our model of future energy systems will take this into account. Thus, we will now leave the system perspective and start with a new model paradigm describing firm behaviour. As you will see, this kind of model differs substantially from what we did before. We will use different approaches to describe technological options and have actors in our model that pursue their own objectives. They approach us based on what we call building blocks. The model will consist of blocks that describes the behaviour of different actors and blocks that link these actors. As a first step, let us look at different building blocks that can be used to describe firm behaviour.

Let us use information from our more general modelling introduction and then discuss how this relates to our modelling work here. For describing firm behaviour, we can choose among three standard models the Emission Choice Model, the Output Abatement Choice Model, and the Input Choice Model.

These models have an increasing complexity, and we will start with the simplest one: the Emission Choice Model. The Emission Choice Model describes how much a firm emits of a pollutant given environmental policy. The firm maximises its benefit from emitting such as gaining profits minus the costs induced by the regulation like a tax that has to be paid for emissions. This model is very simple because it does not describe how a firm reduces the emissions. Will the firm produce less? Will it use different inputs? Will it invest in new production equipment? These questions remain open. We simply focus on how much a firm emits if it is regulated in a certain way.

Second choice among our building blocks is somewhat more complex. In the Output Abatement Choice Model, a firm chooses how much it produces and how carefully it produces. This behaviour is modelled by assuming that a firm maximises its profit, which consists of its revenues from selling the output minus the cost of production minus the cost induced by the regulation, such as a tax paid for remaining emissions. This building block focuses on the effects of regulation on production versus environmental quality. It is useful whenever the amount of production is important. For example, because we want to regulate a firm that has market power on its product market. The third and final choice of a building block is the Input Choice Model.

This model describes how a firm chooses between different inputs when it is subject to an environmental regulation. A typical example is agricultural production where firm needs to choose how much labour, how much equipment, and how much fertiliser is to be used in production. The model describes, again, a profit maximising firm. The profit consists of the revenue raised by selling the output, which is described via a production function minus the costs paid for the different inputs minus the costs induced by the regulation.

These three types of models can also be used to describe firm behaviour in our setting. The emission choice model is helpful if all we are concerned with are emissions.

A typical example would be a model where we only want to describe the effects of a CO2 tax on emissions, and are not concerned with production or the use of different inputs. The Input Choice Model is the most complex one. If we want to describe how a firm owning different power plants, uses resources like coal and natural gas, labour, and capital for different types of environmental policy, this is a model to use. A typical example would be a model that is used to assess the employment effects of climate policy. For our purpose, the sweet spot is in between the output abatement choice model. This model describes how much a firm produces and how carefully it produces.

And thus, how much it emits of a pollutant. Thus, this model links nicely to the setting that we discussed before, where we were concerned with supplying electricity, and thus, the produced quantity and with emissions. For the remainder of this course, we will thus focus on this model. It will allow us to describe the behaviour of firms and in particular, their reaction to environmental and energy policy.