University of Basel

Exploring Possible Futures

Video Transcript

How to complete a model

The model that we discussed so far consists solely of firms. And these firms act independently of each other. To make this model useful, we have to connect some dots. Firms should interact with consumers and each other, and we need to describe the effects of emissions on the natural environment. How we do this depends on how we model firm behaviour. Let us go back to our three building blocks of firm behaviour and connect the dots. Remember the blocks we discussed to describe firm behaviour?

In addition to these blocks, we need three more types of building blocks for our construction consumer: behaviour, markets, and the natural environment. These blocks serve to connect the dots left open by our model of firm behaviour. Thus they have to be chosen so that they fit to each other and to the model of firm behaviour that we have selected. Let us start with building blocks describing consumer behaviour. In general, economic models describe consumers as choosing between different goods while being subject to a budget constraint. However, in environmental economic models, we focus on emissions so that the choice among different goods is not that important.

But we rarely need much sophistication for the consumer side and thus usually extend the model of firm behaviour in the simplest possible way. If we have selected the emission choice model for firm behaviour, there's very little to do for depicting consumer behaviour. The emission choice model describes only emissions, not the production of conventional goods. Thus consumers are obsolete, except for being subject to damage caused by emissions. But in the case of the emission choice model, we only add a damage function to our description of firm behaviour. If we selected the output abatement choice model, firms produce output and emissions.

On the consumer side, we thus have to describe the well-being derived from consuming the product and the damage caused by emissions.

To this end, we describe the benefit of consumption by the consumer end that is the area below the demand curve. And again, use a damage function. In case of the Input Choice Model, we have also to describe where the inputs come from. Thus we will usually need a model that describes labour supply, capital supply, and the supply of all other factors. In the simplest case, we take the supply as being exogenously given. For example, we could assume that there is a fixed amount of labour and capital available to the firms that we model. In addition, we need to describe the utility gain from consumption and the damage caused by emissions.

Both can be done in the same way as in the output abatement choice model. Finally, we have to describe markets and the natural environment. In most cases, we can use balancing equations to both ends. A market is modelled by assuming that what flows into the market, that is supply, has to equal what is drawn from the market, that is demand. To describe the natural environment, we have to link the emissions of all firms to the total emissions that cause damage to consumers. In the simple case of a perfectly mixing pollutant, the total emissions are simply the sum of individual emissions.

However, we could also use a model where the total emissions are a weighted sum of firm emissions with a weight corresponding to the distance between emitting firms and the location where people live. Finally, we often have to account for accumulation of emissions. For example, climate change is not only caused

by current, but also by past emissions. Thus the damage is not a function of only current emissions, but rather a function of current and past emissions. With these building blocks, we have everything that we need to build the main structure of a model. Thus we combine our model of firm behaviour with models of consumers, markets, and the natural environment.

For our purpose in exploring future energy systems, we will again be able to focus our approach more strongly than more general environmental, economic models. Regarding consumers, we will simply use a demand function that is the relation that describes how much electricity consumers want to use in total at a given price of electricity. Regarding the natural environment, we will assume a perfectly mixing pollutant. And thus simply add the emissions of all firms. This is a very reasonable approach for greenhouse gas emissions, which are the main concern in most energy systems. Finally, regarding markets, we only have to model the electricity market as we use the output abatement choice model that connects only to this market.

Usually we will assume perfect competition on this market. Thus we derive consumer and firm behaviour for a given but not yet derived price. And then use the balancing equation to explain the market clearing price. In contrast, if we want to model imperfect competition, we could assume that a firm or consumer anticipates his or her influence on the market clearing price, and optimises firms or consumers behaviour under this assumption. Overall, we now have everything that we need to build and use our first model that describes firms as actors in the energy system.