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Chapter Author(s): Kala Krishna

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Wolak, F. 2010. "An Experimental Comparison of Critical Peak and Hourly Pricing: The PowerCentsDC Program." Stanford University, Unpublished Manuscript.

Comment Kala Krishna

The goal in this very interesting chapter by Bushnell is to analyze some issues related to the implementation of carbon offsets in an overall plan to reduce emissions through the use of tradeable emissions permits.

There has been considerable discussion in the literature on such offsets. The main problem with offsets is in their implementation. While emissions levels are possible for a government to keep track of and penalize, changes in emissions levels require more effort to keep track of and are subject to potentially more manipulation by agents. Not only do past emissions need to be verified, but strategic manipulation by agents also needs to be policed. For example, agents will find it worthwhile to raise or misreport their emissions at the baseline to gain more from "reductions" in the future. Ted Gayner, in an article in the *American,* June 23, 2009, entitled "Offsets Chipping away at the Cap" illustrates this difficulty using the following example:

> In 2007, the House of Representatives launched its "Green the Capitol" initiative, which took on the goal of making House offices carbon neutral. After purchasing compact fluorescent light bulbs and shifting its electricity production from coal towards natural gas, the House still found itself far short of reaching its goal. To make up the difference, it bought 24,000 metric tons of carbon offsets [and] spent $14,500 to pay farmers for carbon-reducing "no-till" farming, even though the practice was started prior to the purchase of the offsets.

This example is related to the issues raised in Bushnell's chapter, which points out that offsets are more likely to be taken up by fake emissions reducers, as in the preceding, than by real emissions reducers because fake ones find it less costly to take up offsets than real ones. Why might this be so? This comes out most clearly if we model the technology behind emissions and work out a simple example, which is what I do in the following. I will first explain intuitively where the demand for emissions comes from and then try and embed what Bushnell does in a very simple example that might help the reader come to grips with what lies behind the slightly more abstract setting that is dealt with in the chapter.

Kala Krishna is the Liberal Arts Research Professor and professor of economics at the Pennsylvania State University, and a research associate of the National Bureau of Economic Research.

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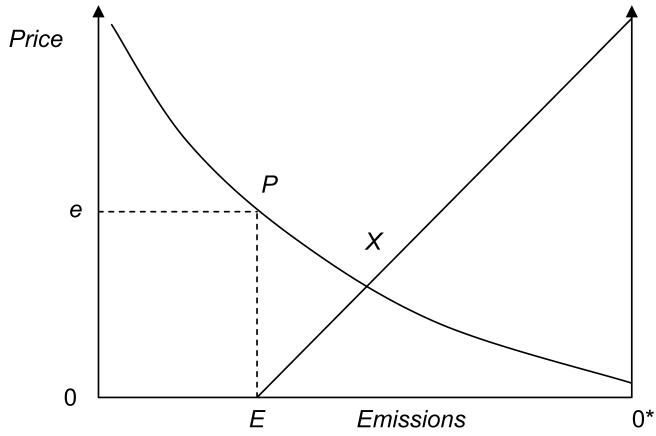

Fig. 12C.1 Offsets: Room to trade

Think of emissions as an input into production. Then the demand for emissions will be a derived demand; that is, it will be derived from the demand for the final good produced by the firm just like the demand for any other factor of production. Suppose there are two countries, H and F. H has binding emissions permits, and F does not. Figure 12C.1 depicts the demand for emissions from firms in H from the left-hand-side origin, while the demand for emissions from firms in F are measured from the right-hand-side origin. Emissions from H are depicted as a downward sloping curve and are limited at OE so that the price of emissions is e. Note that the demand for emissions will also represent the firm's willingness to pay for a permit or the marginal cost of abatement. Emissions are not regulated in F so that their price is zero, and, as a result, F emits a total of O^*E. The basic idea is that the marginal cost of abatement is lower in F than in H so that a Pareto improvement is possible if F could be made to reduce its emissions, while H raises its own. This is what offsets could do. A firm in H could pay a firm in F to reduce its emissions by a unit allowing the firm in H to raise its own by the same as total emissions would not be affected by this action. If unlimited offsets were allowed, the marginal cost of abatement would be equalized by trade in offsets at the intersection of the two curves at X, and the gain in efficiency of EPX would ensue.

Bushnell focuses on an adverse selection issue that may arise in this area. To get more particular about where this might come from, consider an example. Suppose the final good uses emissions, E, which has a price e, and an aggregate input, which we can call L, with price w. Assume each firm can produce a single unit of output that can be sold at a given price p after investing I to begin with, in one of two techniques with which to make the good. Moreover, assume both are fixed coefficient techniques. Technique

C, for clean, uses five units of L and one unit of E, while technique D, for dirty, uses five units of E and one unit of L. Changing technologies costs I.

We could think of firms as *actually* being of two types, C and D. However, they may be *perceived* by the authorities as being of a type other than their true one. For example, the authorities may know of the emissions and output and, hence, emissions per unit of output, for a firm in 2000, but, in 2010, unbeknownst to the authorities, this firm may have chosen a different technology. Thus, firms may be one of four "types": CC, CD, DC, DD. A type DC firm is one that had a dirty technology in 2000, but has a clean one in 2010 and who is thus wrongly classified by the authorities based on their 2000 information as a D firm in 2010. If such a DC firm chose to, it could reclassify itself as a DD firm and sell offsets for four emissions units without investing I as it has already done so. Note that there would be no reduction in emissions. If a DD firm chose to, it could reclassify itself as a DC firm and sell offsets for four emissions units, but it would have to invest I to change its technology. Note that there would be a reduction in emissions in this case.

Suppose that the price of an offset is e. Let us see what the *private gain* is from taking up this offer for each type of firm. A DC firm is already using the clean technology so that it will gain $4e$ from taking up the offer as it has already invested I. A DD firm will have costs of $5e + w$ versus costs of $e + 5w + I$ if it changes its technology, and its profits will change by:

$$[p - (e + 5w + I)] - [p - (5e + w)].$$

It profits will rise if:

$$e > w + \frac{I}{4}.$$

DC firms will always gain more from taking up this offer than DD firms and will always take up the offer. But only if $e > w + I/4$ will both DD and DC firms will take up the offer. A CC firm or a CD firm cannot gain from taking up this offer on offset sales.

What is the actual reduction in their own emissions from each type of firm taking up the offset? Type DC firms do not actually reduce their emissions but are paid as if they did. Type DD firms do actually reduce their emissions as the authorities expect. Thus, if we allowed offsets that were taken up by type DD firms only, total world emissions would be unchanged, but if they were taken up by type DC firms, world emissions would rise!

The government could be wrong about the distribution of types of firms. For example, it might think all firms are type DD, while firms are really all type DC, in which case it would overestimate baseline emissions and, thus, overestimate the extent of emissions reductions due to allowing offsets. This case corresponds to the expected baseline emissions exceeding the actual levels in Bushnell's terminology so that actual emissions reductions fall short of expected ones. On the other hand, the government might think all firms

are type *DC* or *CC*, while firms are actually type *DD*. In this case, no firms would be willing to take up the offsets, but this would not lead to any increase in global emissions from allowing offsets.

Even if the government knows the true distribution of firms, it need not know the type of each firm. As argued in the preceding, if e is below $w + I/4$, only type *DC* firms will take up offsets, and world emissions will rise by the full amount of the offsets. If e is above $w + I/4$, then both *DD* and *DC* firms will take up the offsets, and world emissions will rise, but by less than the full amount of the offsets.

The issues raised in the chapter may thus be very real. But the question to ask is how to deal with them! Because the problem arises from an information distortion, the principle of targeting would suggest improving the information of the goverment. In the preceding example, this would involve sending inspectors out to verify the technology used in 2009 and not rely on information from 2001! Another way to deal with them is to implement a policy that does not requre government to have such information. Here I think that it is worth noting that allocating the rest of the world tradeable emissions permits of O^*E in figure 12C.1, on condition that emissions require a permit abroad as well as at home, would have the same outcome as perfectly implemented offset trade. They may also be easier to implement as government would not need to have information on the technology used by firms.