The Washington Post recently had a column arguing that even climate advocates and scientists are in denial, for thinking that we can have economic growth and still fight climate change. is that true?

It's useful to take some time to think through what we mean by economic growth and how that relates to carbon emissions.

Economists talk about economic growth in terms of changes in real GDP, and there are a lot of complications in making those calculations. But when you get down to it, the basic concept of economic growth is a lot simpler. When we say that the economy has grown from one year to another, we mean that the goods and services produced by economic activities in the later year are more valuable than the those in the earlier year. And since economists don't have any outside measure of value, "more valuable" basically just means that people prefer the later bundle to the earlier one.

Obviously, this is somewhat limited as a measure of whether people are really better off in year 2 than they were in year 1. It ignores distributional issues. It doesn't take into account all the good things in life that aren't part of economic transactions. It also leaves out the possible harms caused by economic activities to third parties or to the environment. There are some significant efforts to improve on "economic growth" as a measure of improved well-being, but let's put those aside for now.

Time to bring carbon into the picture. Carbon emissions come primarily from energy production and secondarily from destruction of tropical forests. It's hard to see an argument why economic growth *necessarily* requires destruction of tropical forests, so let's focus on energy. If we want people in year 2 to have more highly valued goods and services, what happens to carbon?

In the abstract, it's very difficult to say. We really have two linkages between the bundle and carbon emissions: the linkage between carbon and energy, and the linkagen between energy and goods and services. Much of the argument about growth and climate change is about the first linkage — that is, how fast can we decarbonize the energy system? That's obviously a key factor, but it's not the only one.

Let's take a deeper look at the second linkage, which connects energy with goods and services. Can we decrease the energy intensity of the economy? There seem to be two ways to doing that. First, we could reduce the amount of energy it takes to provide any given good or service — improving energy efficiency. Second, we could shift the bundle of goods and services to those requiring less energy. People talk about that in terms of

"sustainable consumption," which may imply a kind of environmental virtue on the part of consumers. Sustainable consumption may have nothing to do with environmentalism. People who would otherwise have bought an off-road vehicle but instead spend their time playing video games, have also reduced their energy footprint.

Let's hone in on this shifting consumption bundle. Why might people shift their consumption toward less energy-intensive goods and services? First, their preferences may have changed, maybe because they've become more environmentally aware, maybe for entirely different reasons. Second, the quality of low-energy goods and services might improve more rapidly. (Of course, the quality improvement won't help if it requires too much additional energy.) Third, the lower-energy goods and services might not have existed previously — they might be the result of technological change.

Thus, we could have economic growth combined with lower carbon emissions in five different ways:

1. **Reductions in the carbon intensity of energy production**. This could involve more solar or wind, more nuclear, or more hydropower.

2. **Reductions in the energy intensity of processes for producing goods and services.** Or in other words, greater energy efficiency.

3. **A change in consumer choices toward less energy-intensive goods and services.** Maybe people decide to stay home and watch TV more often rather than driving somewhere in their leisure time, or maybe they decide to take a walk instead.

4, **Quality improvements for less-energy-intensive goods and services.** For example, the quality of phones and computers has increased much more rapidly than the quality of cars. And many of the improvements in cars such as safety features don't involve corresponding increases in energy use. These quality improvements produce growth — more valuable goods and services — without increased energy use.

5. **Introduction of new goods and services that are less energy intensive than average.** Again, this doesn't have to be environmentally motivated. Consider the introduction of anti-depressants or more effective chemotherapy, which are expensive (replacing various other forms of consumption) but themselves require relatively little energy to produce.

Some combination of these five factors would allow economic growth but decreased carbon

emissions. It's a factual question whether these factors actually could operate at a high enough level to allow rapid carbon increases combined with continued improvements in the level of goods and services. But I can't see any reason why growth and climate mitigation are incompatible in principle.

Tomorrow, I want to get a little more concrete and use the example of a "fee plus dividend" scheme to explore the problem more deeply.