Stockpiling to Contain OPEC

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Overview

I maximize present valued world GDP over the stockpile of petroleum used to contain price shocks administered by OPEC. Long run price elasticity of demand and non-OPEC supply exceed those in the short run, so OPEC profits from sudden, as opposed to gradual, increases in price. These shocks damage the world economy. I simulate interaction among consumers, non-OPEC producers, a profit-maximizing, monolithic OPEC, and an International Energy Agency that punishes OPEC by releasing oil from stockpiles onto the market during upward shocks to price. A stockpile of 6 billion barrels would add much more to world GDP than the cost of holding it and the lost profits to OPEC under a range of assumptions, though private actors do not have incentive to maintain and use stocks to maximize GDP. Authority over stockpiles should be shielded from the influence of the energy industry, whose profits may not be maximized at oil prices that maximize GDP. Prices equal to marginal costs would be low into the 2030's, then rise rapidly with costs. World consumption of petroleum reaches a peak of 67 bbl/yr in 2045, and declines quickly thereafter.

Methods

I model an integrated world oil market with centralized IEA authority over the stockpiles of petroleum used to counter OPEC's price shocks. I assume that the world market for petroleum is fully integrated in the sense that any grade of crude will be made available at any location to the buyer willing to pay the most for that oil at the wellhead plus a competitively determined delivery charge.

Agents in the model include the world's consumers of oil, non-OPEC producers, OPEC, and the IEA. Consumers and non-OPEC producers are non-strategic price-takers. I model their behavior using reduced form econometric specifications. OPEC maximizes the present discounted value of future profits by choosing a path over time for the price of oil, and the IEA maximizes the present value of world GDP over the size of its stockpile and the price that triggers releases from the stockpile. The price path includes price shocks whose size and number are of OPEC's choosing. The IEA puts oil on the market so as to discourage OPEC from including shocks in its chosen price path. The oil the IEA puts on the market displaces some of OPEC's sales and reduces OPEC's profits, inducing OPEC to choose a smaller price shock. The IEA is endowed with a stockpile of crude oil. The larger the initial stockpile, the more oil it puts on the market in response to any given price shock, and the larger the reduction in OPEC's profits. Similarly, given some stockpile of crude, the larger the price shock OPEC chooses, the more oil the IEA puts on the market. OPEC adjusts its price path taking account of how the IEA, consumers, and non-OPEC producers will respond. OPEC then supplies the market with the difference between consumption on the one hand and non-OPEC output and releases from stockpiles on the other.

I model the market for $T = 60$ years, with the initial conditions set in 2005, before the current run-up in price began. OPEC chooses the path of price at time $t = 0$ to maximize the present value of future profits, discounted to $t = 0$ in 2005:II. I let OPEC choose a price path in the absence of an IEA stockpile. I then adjust the level of petroleum stockpiles held by the IEA by 1 bbl increments and the size of shock that triggers IEA intervention by $5 increments to maximize the present value of world GDP.

Results

The price of petroleum was $45/bl in 2005:II. In the base case, a jump from $45 to $79 at $t = 0$ and subsequent annual growth at 7% roughly mimics the actual run-up in price since then. The optimal time for OPEC to effect the next shock is in 2020. The price of petroleum at the end of the oil age is in the thousands of dollars per barrel. World consumption of petroleum reaches a peak of 67 bbl/yr in 2045, and declines quickly thereafter. Increases in demand are largely met through additional production by OPEC; non-OPEC production is steady at about 17bbl/yr. OPEC's average costs begin to rise quickly after about 30 years. World GDP grows at 4.13% annually over the 60-year period, at 4.01% over the first 30 years and 4.24% over the latter 30 years.

The optimal IEA stockpile is 6 bbl and the optimal trigger for IEA intervention is a shock of $10/bl. OPEC limits shocks to $10, so the IEA does not actually intervene in the market, but contains shocks by the threat of intervention alone. The net social benefits of IEA's stockpiling and threatening to intervene are $856 billion, in 2005 dollars. Currently, drilling and storage capacity in non-OPEC countries are not adequate to conduct such a program,even when government stocks are included.

I run sensitivities to size of the IEA stockpile, IEA and OPEC discount rates, OPEC's costs and remaining recoverable resources, non-OPEC remaining recoverable resources, growth in GDP, and a total breakdown in the OPEC cartel. The benefit/cost ratio in the base case is 10.51. It is not much different given a stockpile of 1.5 bbl, which represents current IEA government stocks plus a small fraction of industry stocks, but the absolute net benefits are much lower. The highest net benefits occur when IEA's real discount rate is 6%. The lowest net benefits occur when OPEC's remaining recoverable resources are 2.1 trillion barrels, when net gains from the IEA program are $138 billion. When OPEC's lifting costs are high, net benefits are $560 billion, and, when they are low, $1095 billion.

The sensitivities overall show a lot of variability in net benefits, but substantial net benefits in every case. Base case net benefits plus the average deviation from the base case are $652 billion. In four of the scenarios the stockpiling is internally profitable to the IEA, but in none of these four is it profitable for the IEA to punish OPEC if it reverts to the price path it would choose absent IEA stockpiling. Under none of these scenarios, then, would private activity maximize present valued world GDP.

The final scenario, "Bertrand Competition", is one in which OPEC completely breaks down and produces where price equals marginal cost. Prices for the first couple of decades are reminiscent of the pre-OPEC era. Oil consumption peaks somewhat earlier than in the presence of OPEC, at a much higher level, and the age of oil comes to a more abrupt end, with prices skyrocketing in a matter of a few years. This massive, final oil shock is terribly damaging to the world economy.

Conclusions

If the IEA managed government-held petroleum to maximize the present value of world GDP, stocks of 6 billion barrels could be used to cut $25 price shocks (2005$) to $10, though shocks would become more frequent. This would generate $946 billion in additional present valued world GDP, and cost OPEC $55 billion in lost profits and the IEA $35 billion to buy and hold the stocks for about half a century. Net benefits are substantial under a variety of assumptions, though private actors do not have incentive to maintain and use stocks in a way that maximizes world GDP. To insure that stockpiles are used to maximize world GDP, authority over stockpiles should be incented to do so and, in particular, shielded from the influence of the energy industry.