Cost Benefit - Costs and Benefits

Benefits
Costs

Benefits

Method:

Deriving the economic benefit of oil extraction is relatively straightforward in the simplest case: take the expected recovery of oil, multiply it by the market price of oil, and then multiply that revenue value by the Keynesian Multiplier to find the total economic benefit to society. This value represents the benefit not to the oil companies - which may or may not profit by implementing the proposed drilling strategy - but to society as a whole in the form of an increase in the Gross Domestic Product (GDP), which stimulates economic growth.

Expected Recovery:

ANWR has been designated as federally-protected land that cannot be developed for any reason. Only the 1002 portion of ANWR could potentially be open by the Federal Government to development. As a consequence of these restrictions on exploration and drilling, insufficient data exists on the amount of oil in ANWR. However, from a government-approved seismic study conducted in the mid-1980s, we have a crude estimate of the extractable oil within the undeformed area of the 1002 region of ANWR.

USGS data and analysis from that study concluded that the amount of oil in the undeformed region had a 95% chance being at least 3.771 billion barrels and a 5% chance of there being more than 10.974 billion barrels, with a calculated mean of 6.993 billion barrels (source 1). More information on these values and their derivation can be found in the geology section of this report.

Value of the Oil:

To determine the world oil price under which oil from ANWR would be sold, the years in which the oil is actually on the market need to be considered. Assuming that drilling is initiated in 2010, the oil from ANWR would be on the world market between 2020 and 2070, reaching a production peak at around 2030. Those years, however, seem to be difficult years for which to determine the oil price since they occur after most modern predictions of the world oil production peak. The level of peak production estimated by experts ranges from 68 to 90 million barrels per day and is predicted to occur within the next decade (source 2). On the other side of the market, there is a projected rise in demand for oil of 1.6 percent per year over the next thirty years (source 3). With current demand at about 75 million barrels per day, this increase in demand would set the demand in 2030 to 120 million barrels per day. The change in the intersection of the demand and supply curves over the fifty year producing period of ANWR (and the ten to twenty year time lag) represents the price at which ANWR oil would be sold as it becomes available.

As a resource in shrinking supply, the value of the extracted oil seems likely to increase in the future leaving many to argue that development in ANWR ought to be delayed a few more decades or longer to maximize the total gain. What these arguments fail to consider, however, is that the existing infrastructure in Prudhoe Bay is critical to the development of 1002. Should development in 1002 be significantly delayed, other North Slope production will finish, forcing the closure of the pipeline and the removal of support facilities and infrastructure and a flight of the critical development skills and associated human capital. The environmental cost of restarting North Slope development, the repair or replacement of TAPS, and the reconstruction of the support infrastructure will greatly increase the environmental cost of the development of 1002 and might overwhelm the increased benefit brought on by distant oil prices. Furthermore, the advances in renewable energy sources, fuel cell vehicles, green plastics, and other oil-use mitigation technologies could have the opposite effect in the future and considerably lower the demand for oil. Our model therefore focuses on the present or near term exploitation of hydrocarbons in the undeformed region. Therefore we assume that the price of oil will follow a simple linear-growth pattern over the given time period which may seem an unreasonable assumption, but it does provide a baseline value for the total revenue that could be potentially generated.

There is also the issue of oil production from ANWR affecting the world oil price. Research has shown that the world oil price tends to increase along a roughly straight line, with variations being caused primarily by decisions made by OPEC (Organization of the Petroleum Exporting Countries). The oil in ANWR is orders of magnitude smaller than the global supply of oil, and therefore the world oil price is independent of any sort of activity in ANWR. The only threat to the linear growth model is a major policy shift by OPEC or an international conflict that would spur such a shift. In these regards, this model falters because it assumes an era of relatively small conflicts (this era which does not need to begin until about 2020, which provides for enough time for the oil prices to return to the linear-growth model). Furthermore, peaks in the world oil price are precipitated by steeper growth, and this is not being seen today, so the assumption that there will not be a large peak in the oil price is reasonable.

Ignoring shifts in the equilibrium price, a simple procedure of extending oil prices along their linear pattern give the average value of the price of oil from 2025 to 2045, the major years of production, as $34.8 per bbl, with an uncertainty of $2.60 (sources 4, 5, 6). We are predicting that even with the development of alternative sources of energy that the dwindling oil supply and increasingly unstable situation overseas will maintain this price for oil. The real value will depend on technology, discovery, and politics, but it will most likely be greater and apt to increase from that value over the projected time of production. Using the baseline price above, the value of the oil extracted from the undeformed region therefore has a 95% probability of being $131 ± $9.8 billion and a 5% probability of being $382 ± $29 billion, with a mean value of $243 ± $18 billion.

Multiplier:

When the oil enters the American economy, the value above is injected into the economy as the profits are reinvested and wages are given to households which in turn spend part of their increased income on consumer goods, which is re-spent in the same manner by the subsequent recipients. This process continues until the entire injection has 'leaked' out of the economy by way of savings. This is called the Keynesian Multiplier and we have accounted for this augmentation by calculating the multiplier for this situation.

According to one source, the multiplier (in the United States) is estimated at a value around 2.0 (source 7). According to another source, a study of the Alaska dividend where the state distributes the economic rewards of its ownership of land and mineral resources to citizens, households increase their spending in anticipation of this annual income receipt. They space their expenditures from the anticipated dividend fairly evenly over the year (Hsieh 2000). The main finding with respect to the marginal propensity to consume out of tax refunds is that, across all households, almost two-thirds of every extra dollar of refund is spent within a quarter (Souleles 1999, 955). The multiplier is equal to 1/MPS or 1/(1-MPC) where MPS = marginal propensity to save and MPC = marginal propensity to consume. MPC and MPS summed should be one.

If households spend two-thirds of every dollar of income, their MPC = 2/3. Hence, the value of the Multiplier is 1/(0.33) = 3. Another source we used, said the multiplier usually fluctuates between 1.6667 and 3. This averages out to 2.3333. From these three values, the average value of the Multiplier is 2.444.

This multiplier might be disproportionately tilted towards the Alaskans. However, since the oil revenues fund the Alaskan government and the social services it provides, the benefits of drilling are also disproportionately felt by Alaskans.

When the total projected revenue from the oil is amplified by the multiplier, a mean total of 594 billion dollars ± 7.4% is obtained. This represents the total benefit to society should drilling occur.

Some would argue that if the multiplier is to be used to augment the value of the extracted hydrocarbons, then it must also be used in regard to the environmental costs below. However, the trickle down effects accounted for by the multiplier do not apply to the environmental costs. The economic benefit of the oil revenue enters the economy in a few places, mainly in the form of wages and other liquid assets, and expands by the multiplier into total social benefit. Conversely, the environmental costs represent the social impact directly and therefore further expansion would be redundant and logically incoherent.

Sources

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3. "IEA: World Energy demand to grow briskly to 2030." Gas and Oil Journal. 14 Oct. 2002: 36-38.

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6. Fossil Fuel History. http://envstudies.brown.edu/Thesis/2002/Dyer/Residential%20History%20OPEC.htm. 2002.

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Costs:

Method:

Calculating the social cost of environmental damage is a considerably harder and less tangible task than determining the economic benefit of development. While numbers can be assigned to many representative quantities, much of ANWR's worth to many is fundamentally priceless and borders on the sacred. We recognize the inadequacy of quantitative methods in accounting for such intangibles as the social worth of "wilderness" but we will nevertheless attempt to assign a representative number.

ANWR in its current state is a great national environmental resource and drilling in the region, despite precautions, will inevitably decrease the value of that resource. To attempt to quantify this, we will assume ANWR has an "existence value," a method of quantifying the environmental worth of natural places coined by John Krutilla of Resources for the Future in 1967. More recent ideas attempt to treat environmental assets as being "natural capital" which, like all capital holdings - industrial, human, financial, etc, are prized for their annual benefit. We have used these theories to declare that ANWR's existence bestows on American society a benefit each year, much the way in which capital assets can be valued by their annual yield. The punch line is that that annual benefit for ANWR will decrease in value if oil is extracted and we can attempt to quantify that loss in value integrated over time.

As soon as we commence human activity in 1002, ANWR (or at least the undeformed region) will loss its social value as being "pristine" wilderness. This loss in annual value will last for throughout the construction, production, and reconstruction phases and only begin to return as once the ecology of the undeformed region has been fully repaired and the memory of human disruption attenuates with time.

Once construction begins, the undeformed region will lose further value as the physical environment itself is destroyed. As long as the human footprint remains, the annual value of ANWR's existence will have decreased by a fixed value based on the state of the land. Since this damage represents a drop in environmental value, its worth should be equal to the annual cost of returning the environment to its untouched state. This is the restoration cost.

In addition to somehow accounting for the loss of the pristine and the planned physical damage, there must also be a way to account for unplanned damage, namely in the form of oil spills which likely are the most environmentally damaging aspect of the proposed oil development strategy.

Like the cost of environmental damage, the annual cost of oil spill damage can be found by determining the annual cost of oil spill clean up and restoration - the cost required to undo, insofar as it is possible, the loss in existence value brought about by an oil spill.

Once the value of these cost can be determined, we can make a graph of the annual benefit derived from the existence of ANWR versus time. Along the x axis we have the phases of damage - construction, production, restoration, and the time which ANWR requires to regain its initial wilderness value. The function of the annual benefit starts at the initial existence value of ANWR (which thankfully does not need to be calculated) and immediately drops by a value A equal to the "wilderness" value as soon as the ground has been broken. Through the construction periods the function will decay by a further value B (calculated via the restoration cost) and then at some point - let us say the start of production - by a further value C (the cost of oil spill damage). Once the production period has ceased, the value should, after a short fall due to the deconstruction activities, steadily rise to the initial value minus A. At this point the ecosystem is functionally equivalent to its pre-construction state though certain aspects of it will naturally be different. What remains is for ANWR to recover its complete value (by regaining A) and this we are proposing it will regain with the lengthy passage of time.

The construction period is predicted to last 20 years, with the first wells coming on line after the first ten. This phase includes what exploration needs to be done, the construction of the platforms, and the building of the pipelines.

The production phase is slightly more difficult to estimate. Mission has decided that the best way to estimate the length of time between the first drop of oil flowing through the ANWR pipeline and the last would be to look at the production rates of Prudhoe Bay and compare. Supposing this was a feasibly comparison, ANWR would take slightly longer than Prudhoe Bay because there will be many less wells producing in ANWR than in Prudhoe Bay. However, pressure should be increased due to the amount of wells flowing into the single wellbore at the surface. Looking at Prudhoe Bay as a rough estimate on a lower range, first oil flowed from the bay in 1977. Eleven years later, Prudhoe hit peak production at 2.02 million barrels a day. Since then, it has decreased approximately 6% over the past ten years. Production will continue decrease at a rate of approximately 3-4% per year; currently Prudhoe Bay is producing 85,000 barrels per day. Since the lowest possible capacity of TAPS, with current modifications, is 28,000 barrels per day. If the 1002 area produces at a comparable rate to Prudhoe Bay, this means it will produce for approximately 30 years after peak production. Therefore total current production will last approximately 41-50 years, allowing for the ten years to reach peak production and a longer producing time due to less wells. Ten years into the construction phase production will commence and peek production, by this model, will be reached right when the construction phases is complete and all the wells are online. The production phase after that point will then last, on the high side, around forty years.

(sources: http//www.alyeska-pipe.com/Inthenews/Monthlynews/2003News.html; http//www.qv3.com/policypete/domesticoil.htm).

Analysis of the literature in the environmental restoration area determined that the restoration period will last 30 years.

To find the total value of the environmental damage, then, it is necessary to integrate the existence value of ANWR through the interval of disturbance and from that value subtract the initial value of ANWR multiplied by the same value, that is to integrate the loss in annual value over time.”

Wilderness factor:

This is the least tangible aspect of this analysis and up front it is worth saying that a superior method ought to be found to derive this value before any decision regarding ANWR should be made. The value of an undisturbed 1002 region simply cannot be quantified by direct methods. What is agreed on is that any type of disruptive exploration or construction will greatly diminish the wilderness character that the area currently has from the point of view of American society. How much that character is valued by society is the question at hand.

Based on the methods presented by Gordon and Meade (1994), we decided to calculate the wilderness factor of ANWR by assuming that joining an environmental organization constitutes a will to preserve the environment and keep regions like 1002 pristine. We are then conjecturing that the amount of money that these organizations get annually from their members is what our society would be willing to pay to preserve ANWR. This is the value we concluded represented the wilderness factor.

The whole idea of looking at environmental groups is not to assess people's value of ANWR, but rather to see how much money they are willing to spend to protect "wilderness" in general. Since ANWR represents what we feel to be the epitome of the wilderness case, money devoted to such a cause would likely defend ANWR as a first priority. The way in which several environmental groups have been liquidating other conservation assets in order to fund their ANWR campaigns is evidence of this.

This is clearly an indirect method which both undervalues the region by not considering other sources and means of wilderness protection - most especially the value of the human capital donated by those who dedicate their lives to protecting the environment - and overvalues the undeformed region of ANWR by assuming that all conservation funding is targeted that that one region. What this number approximates is the American people's individual annual monetary contributions towards conservation and given the fractional size of the undeformed region compared to all of America's sensitive environmental lands, we believe that this value, despite its severe limitations, will if anything overestimate the wilderness value of the undeformed region.

We took the Natural Resources Council of America, formed by 28 million members to be representative of the majority of the population that is a member of an environmental group. If all members of the NRCA are members of only one of their organizations, then 10% of the American population is part of an environmental group. If all members of the NRCA are members of two organizations at the time, since they would be counted twice by the Council, are the 5% of the American population.

The population of the United States is of 290,342,554 (2002). 10% of the population is then 29,034,255 people and 5% is 14,517,128 people.

To calculate the average membership fee of an environmental organization, the cost of the memberships of five widely recognized groups (Audubon Society, Sierra Club, National Wildlife Federation, The Wilderness Society, WWF) were averaged. The resulting value is of $26.8 for an annual membership to an environmental organization.

To obtain the wilderness factor of ANWR, we multiplied the number of people calculated to be part of an environmental organization by the fee they would pay annually. The resulting values are $778,118,034 when 10% of the population is member of an environmental organization and $389,059,017 when 5% of the population is. We will therefore select the larger figure, $780 million as the amount per year that the ANWR as wilderness is worth to American society.

Restoration Costs:

The restoration cost is the cost that will be encountered to dismantle the exploration, production, and transportation equipment and to erase as much of the footprint due to the drilling as possible. The restoration includes taking down roads, removing pipelines, deconstructing processing plants and all other Drilling Infrastructure, and the restoration of Tundra. For the North Slope, the restoration cost ranges between $2.7 Billon to $6 Billion. Assuming that the damage on the North Slope is no less per unit are than the damage proposed for the undeformed region, we can take ratios of the footprint areas and therefore calculate the likely restoration cost of the undeformed region.

The area of the footprint on the North Slope ranges between 10,000 acres and 15,000 acres. To account for the unanticipated, we want to maximize the cost of restoring the environment, and so we want to take the minimum area of the North Slope footprint, as that will give us a greater cost per square kilometer. Therefore, we assume that the footprint for the North Slope is 10,000 acres. To convert acres into square kilometers, we must divide the acres by 247. Hence, the footprint for the North Slope is 40.49 square kilometers. To get the maximum cost per square kilometer, we take the cost as $6 billion. Thus, the restoration cost per square kilometer is $148.2 million. This cost will occur over at least a 10 year period. Hence, the restoration cost per square kilometer per year is about $15 million.

We now consider the footprint on the undeformed region. We assume that we build 500 kilometers of pipes (the theoretical maximum given the size of the region and number of sites) which will leave a footprint 10 meters wide along the width of the pipe. This width accounts for local proximity impacts as well as construction damage as the physical pipeline is roughly half that width. This gives a footprint of 5 square kilometers. We also assume that we will build 20 platforms, which have an area of about 2000 square meters each. This implies that the area of the platform is 0.002 square kilometers. Another assumption we make is that the footprint of the platform is going to be at most 2.5 times the area of the platform to again account for proximity effects and construction damage. Hence the footprint of the platforms is 0.005 square kilometers. Therefore, the total footprint on the undeformed region is 5.005 square kilometers. Hence, the restoration cost for the undeformed region per year is about $75 million.

At first glance, this might not make sense, because this implies that the longer the corporation takes to restore the environment, the greater are their costs. But let us assume that the 'value' of ANWR decreases by about $75 million a year for every year that the corporation is in ANWR. Therefore, for every year that the oil corporation is in ANWR, society 'loses' $75 million. Hence, it would be in the best interests of society to finish drilling, and restoration as soon as possible.

Theoretically, there should be an Enforcement Cost because the Restoration will have to take place within a certain time limit. However, due to limited time, and a lack of other resources, we could not find the regulations imposed by the Government on Oil Corporations. This is a matter for further study, as it would affect the total Restoration Cost.

Accidental Oil Spill Cost

In addition to the anticipated damage oil extraction will inflict on the environment, there are potential unexpected costs from accidental oil spills. As outlined in the proposed drilling method, sensors to detect changes in volume and pressure, catches to contain smaller leaks, and valves to minimize the amount of larger spills will be used throughout the pipeline network. Despite these precautions, spills will most assuredly occur and the cost of clean-up and remaining damage will be a burden borne by society.

There is a solid body of data on the severity and frequency of oil spills from the Trans Alaskan Pipeline (TAPS) which can be used to extrapolate the potential oil spills from the infrastructure created for ANWR drilling. TAPS is a considerably longer network, uses older technology, and travels through more seismically active land. The values from TAPS thus can be used as a maximum for the damage that oil spills could inflict on ANWR.

To quantify the most probable maximum annual spill volume in ANWR, the frequency of each possible spill event is multiplied by the maximum spill volume of each event and the individual spill events summed. From this methodology, the maximum probable annual spill volume is 12.3 million liters (see chart). For a sense of scale, if this spilled oil was concentrated in one place to a depth of 10mm, it would cover 1.23 square kilometers, or 1/10 of 1% of the undeformed region.

The cost of cleaning up these potential spills using current methods (admittedly not the same degree of oil removal as with all the above mentioned methods), can be calculated using information from a study presented at the Artic and Marine Oil Spill Program Technical Seminar, which averages the cost of cleaning-up all spills in the U.S. per tonne of oil. For crude oil spills, the average cost according to this study is $13.05/liter.

Litigation Costs: If drilling is approved, it has been argued that there could be several potential court cases brought up by environmentalists and other social groups. Since 1995, most environment litigation cases brought up have not been about dams, nuclear power or pesticides, but about rare and endangered species. We estimate that there will be anywhere from 1 to 10 litigation cases (about half the number of environmental groups because we suspect that most of the cases will be class action lawsuits). The time and effort spent on these cases by the judicial system could have been spent on other matters, and hence this is a cost to society. While it is possible to assign a value to this damage, such is beyond the scope of this project and is a matter for future investigation. Most likely the total damage would be comparatively insignificant, but a more complete analysis should examine this figure.