Peak Oil: Implications of a Global Dependency

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> "…when 300 million people do unconscious behaviors, then it can add up to a catastrophic consequence that nobody wants, and no one intended." - Chris Jordan

Introduction/Thesis

As just one nation in the world, the United States consumes nearly 30,000 barrels of oil every two minutes. Every two minutes. By the time you have read the first few paragraphs of this paper, that incredible amount of oil has just been consumed to form gasoline, petrochemicals, heating oil, and a vast number of other petroleum-based products. These figures are certainly well beyond the human capacity to comprehend, forcing the implications of this consumption to the background of our minds. Our worldwide mass-consumption of crude oil has inherent detrimental implications that have the potential to dismantle the lifestyle we have grown accustomed to, and according to peak oil theory, these unintended consequences are likely to occur sooner than we anticipated.

The theory of peak oil is that the productive capacity of an oil well follows a bell-shaped curve, accounting for intense investment after discovery, eventually peaking, after which the productive capability of the well diminishes exponentially. This theory can be applied not only to a single well, but to any agglomeration of oil-rich regions as well, even the global oil supply. The potentiality of a global peak in oil is, in time, a certainty, given any rate of continual consumption. Across the world we already meet the requirement of continual consumption, yet what of time? Are the economic, geological, and geopolitical trends of the past decade any indicator of the occurrence of a global peak in oil production? And what recent events might support this theory? A global peak in oil consumption succeeding a productive peak may be within sight for our younger generations. The crude oil market trends of the past decade, in tandem with recent international geopolitical developments, are a direct indicator of a pending peak in petroleum consumption, and a subsequent energy crisis.

Theoretical Frame

A topic concerning fossil fuel resources, and more specifically, oil, encompasses a vast amount of information for a product that has only been commoditized during the past century. Due to the vast array of implications crude oil imposes on global society, a focus on economic, cultural, and geopolitical factors surrounding the production and

consumption of oil are key to understanding peak oil theory. Each of these factors compose the foundation for support or dismissal of Hubbert's peak as applied to world reserves. Those who support this theory present economic data involving crude price fluctuations and figures showing diminishing extraction rates in our major oil producing regions. These figures promote the belief that peak oil theory is accurate, geographically malleable, and can be applied to world oil reserves. Furthermore, these claims assert that a peak in oil consumption may happen within the next century, and possibly within the half-century. The views are held by such scholars and figureheads as Dr. David Goodstein of the California Institute of Technology and former case officer with the Central Intelligence Agency, Robert Baer, each with differing experiences that have shaped a similar view. This view is that the global oil market is ecologically, economically, and politically unsustainable.

Yet this is certainly not the only viewpoint held for this theoretical debate surrounding peak oil theory. Certain counter arguments do exist to denounce peak oil theory, including the claim that supporters of the theory do not adequately account for market effect on resource consumption. This is commonly argued by the idea that any market failure surrounding oil scarcity will find remedy in replacement fuel sources and infrastructural technologies. Further comment made on peak oil theory revolves around the idea that production will simply be increased worldwide to accommodate for scarcity in our current reserves. This increase in production could be accounted for by unconventional extraction methods, including oil shale and offshore drilling, as well as opening up currently unavailable drilling sites, such as the Arctic National Wildlife Refuge. Many supporters of these efforts to criticize peak oil theory and extend the age of oil include national and multinational corporations involved directly in the oil market or indirectly as energy or defense firms, among other examples. Each of the previously mentioned authors discuss these complications with their respective analyses, and more sources include that of reports released by Exxon Mobil Corporation and scholars supported by the United States Department of Energy. These viewpoints raise valid and well-developed complications to peak oil theory and the potentiality for a global peak in oil production in the near future.

Approach/Methodology

The focus of this study is the application of peak oil theory to world oil reserves based on the physical, economic, and geopolitical trends of oil consumption and production in the past decade. While oil has existed for centuries in various understandings and uses by mankind, for the purposes of this study of peak oil, only publications and data from 1950 to present will be applicable, as it is a study of commodity oil, not the basic resource itself. Geographically, the implications of peak oil theory are on a global scale, yet it is still necessary to focus on certain key regions. Primarily, these regions will include the United States, China, and the Middle East, each of which have an essential role of influence in the global oil market due to their political, cultural, and demographical characteristics. Sources for this study include literature, statistical data, corporate and scientific reports, and periodical publications.

A combined analysis of the literature used in this study of peak oil theory provides a broad scope to the intricacies of oil consumption. A trend analysis will attempt to determine whether one can apply these findings to a peak in oil consumption, and a pending international catastrophe. Aiding the literary accounts is a wealth of statistical data and reports offering recent oil production and consumption information, as well as projections for these figures. Researching this question will require the application of production and consumption trends to international conflictual developments, and a subsequent analysis of that relationship to peak oil theory. For example, is might be possible that Thomas Friedman's first law of petropolitics can coincide with an alteration in worldwide consumption. This process will allow for a specific, in depth study of peak oil theory as applied to the global oil supply.

Findings

Based on recent production trends, crude oil resources are likely to reach a productive peak within the next decade. Production figures are potentially the most important data in relation to peak oil theory. This data offers information on how much oil a given well, nation, entity of fields, or company, is producing and how much is actually estimated to remain underground at the sites in question. Data involving the prediction of remaining reserves is unsurprisingly variable between sources. Among oil companies, oil producing nations, and independent audits, both specific and global reserves can vary greatly in prediction. Robert Baer expresses this variation in his recent

publication, The Devil We Know. “Based on inflated industry and company estimates, the remaining proven reserves worldwide amount to 1.255 trillion barrels. But if we go by actual production, according to the respected, independent Energy Watch Group, oil reserves are in fact closer to 854 billion barrels” (Baer p.141). He goes on to discuss Middle Eastern reserves. “Officially they’re put at 677 billion barrels. But calculated on the basis of production, they’re more like 362 barrels…” (Baer p.141). Not only does this account explain the variation of reserve estimates, it also brings into question the reliability of production data. In 2004, Royal Dutch Shell announced that it had been systematically overestimating its proven reserves by 20%, or nearly 4.35 billion barrels, and its stock was immediately dropped. According to an Associated Press article published on March 9, 2004, the corporation had been warned of its reserve estimates being “inconsistent with U.S. Securities and Exchange Commission guidelines” (AP 2004). This type of unreliability, stemming from a major oil company, questions our ability to project the longevity of our current oil supply. Furthermore, within regulations for the Organization of the Petroleum Exporting Countries (OPEC), the higher the claimed reserves of an OPEC nation, the more that nation is permitted to extract (Baer, 140). It is therefore possible that if fears of scarcity were to occur for any OPEC nation, a subsequent overestimate would provide more immediate income for that country at an unsustainable rate of production.

In terms of productive capacity in relation to peak oil theory, the United States offers itself as an excellent case study. Peak oil theory states that a peak in production levels will occur after a period of intensive, exponential development and extraction. After this peak, production will then, theoretically, taper off at a rate of exponential decline. Shell Oil Company Geoscientist M. King Hubbert, who developed the theory of peak oil, accurately applied his theory to the United States, which experienced peak oil in 1970. The following graph is Hubbert’s prediction

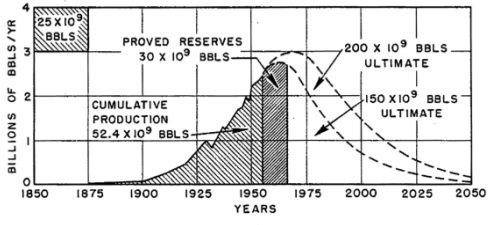
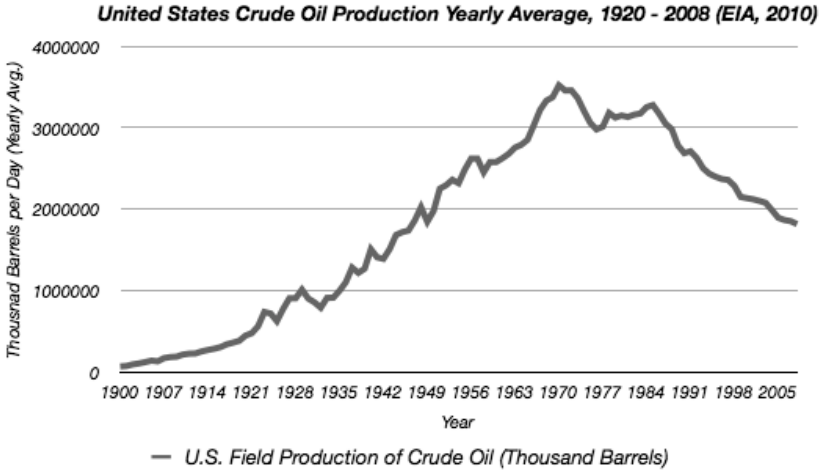


Figure 21 – Ultimate United States crude-oil production based on assumed initial reserves of 150 and 200 billion barrels.

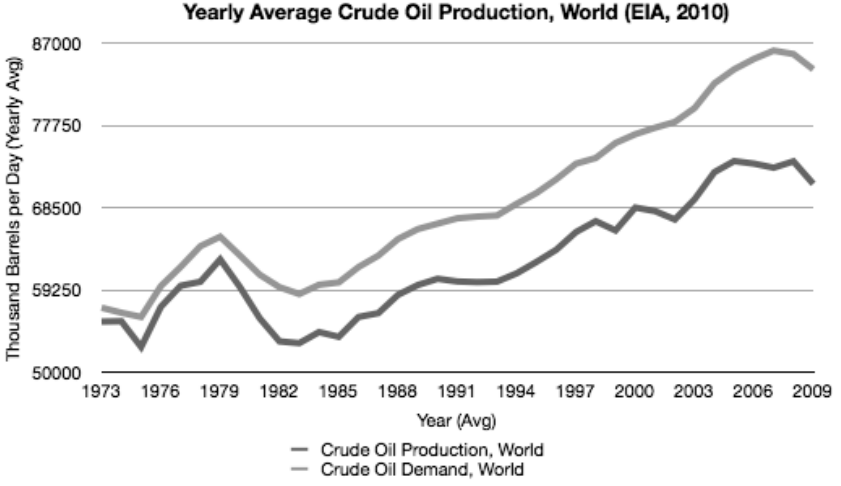
for the United States, published in June of 1956 by the American Petroleum Institute. This graph shows his production projection through 2050, and as you can see, he predicts that the United States will reach a peak in oil production at or around the year 1970. Using a data sheet offered by the Energy Information Administration (EIA) of the United States Department of Energy (USDOE), the next graph displays actual United States crude oil production through 2008. This second graph clearly displays a peak in production at the year 1970, and continues a declining pattern only slightly higher than Hubbert's upper level estimate. A recent EIA report, titled U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Proved Reserves, 2008, confirms continually declining crude oil reserves in the United States. "…even though discoveries of crude oil rose



for the third year in a row, proved reserves of crude oil fell by more than 10 percent" (EIA, 2009). This report is based on data collected throughout 2008 on crude oil discoveries, reserves, and production, and provides evidence of a continuation of the pattern seen in the graph above.

The data and trends above provide a case study of Hubbert's theory of peak oil. With this understanding of the theory, it is possible to graphically analyze global production and potential productive indicators of a pending global peak in productive capacity, based on world production data. Once again, the EIA provides a wealth of data regarding oil production, consumption, demand, and many other compiled statistics. Below, a graph illustrates worldwide oil production and demand from 1973 to 2009.

World production and demand have recently peaked, with global demand showing a more prominent peak in 2007 at an average of 86,138 thousand barrels per day. Global demand decreased by roughly two thousand barrels per day, annually, in 2009, and continues to decline today. Yet more importantly than recent demand trends, global production has been faltering since the late-1990's, and has never adequately met demand since 1980. While global production has marginally increased over time, it has failed to meet global demand during the past decade, when demand was growing exponentially. One might expect that the wealthiest oil-nations and oil companies would certainly have taken advantage of this increase in demand. If they had, there would be a surge in production and reserves at a slight delay to the demand curve. The world either cannot, or will not, produce at an adequate capacity related to demand. Where these production figures begin to factor in with peak oil theory is at a key aspect of the theory, well explained by David Goodstein in Out of Gas. "Given

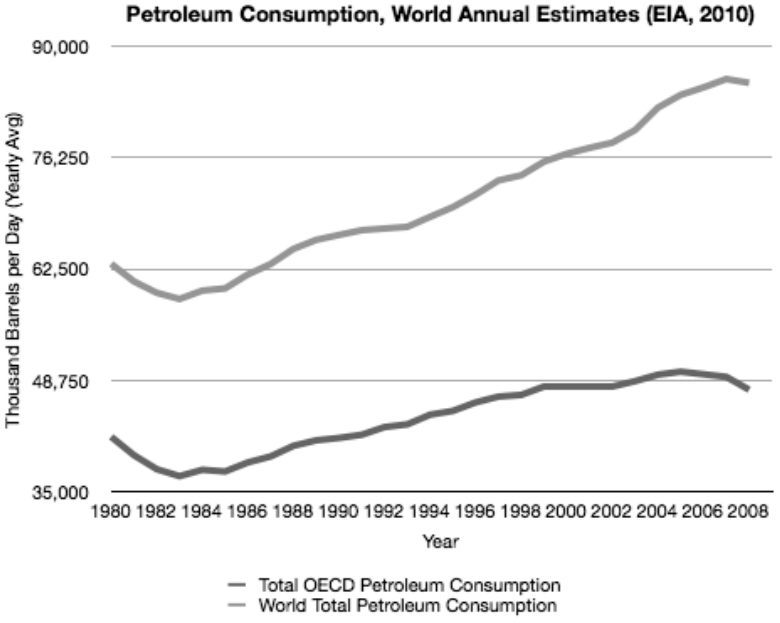


that worldwide demand will continue to increase, as it has for well over a century, Hubbert's followers expect the crisis to occur when the peak is reached, rather than when the last drop is pumped" (Goodstein, p.30). If the recent fault in global productive capacity is any indicator of a peak, or near peak, in the production of conventional oil, there may very well be a global crisis in oil supplies in the near future. The reasoning behind a peak crisis, opposed to a depletion crisis, is that after an oil peak, production declines exponentially while demand continues at a steady or increasing rate. As seen

above, production already fails to meet demand, so it can be understood that there would be serious trouble should the gap between production and demand continue to grow.

Worldwide consumption of crude oil has continually increased throughout the past decade, presenting a seemingly endless international trend. Even as oil consumption dropped recently in the United States and other most developed countries, total consumption worldwide has continued to increase, and an intermediate demand projection offered in the EIA Long-term Global Oil Scenario expects demand to rise continuously throughout the century. As just one nation, the United States accounts for ~20% of the world's total energy consumption, based on 2006 EIA figures. Equally important to this mass-consumption is the increasing demand for oil in developing nations. China has been importing oil at an increasing rate of 6% each year during the past decade. Specifically, Chinese imports of Saudi crude have also increased, notably during the 2009 recession, when China's Saudi imports doubled to over one million barrels per day, accounting for nearly a quarter of the nation's oil imports (Mouawad, 2010). This underscores an ongoing expectation that China, among other developing nations, will continue to increase its demand for crude oil, stretching markets from major exporters like Saudi Arabia. According to a March 2010 article by New York Times journalist Jad Mouawad, "Only two years ago, consumers were clamoring for more supplies, OPEC producers were straining to increase their output, and prices were rising to record levels". This article references the fact that OPEC producers could not adequately meet the intense demand resulting from the economic prosperity seen during the mid-part of the previous decade, and its subsequent effect on crude prices. If our global consumption increases, as it likely will, we are likely to run out of oil significantly earlier than predicted.

The global pattern of petroleum consumption during the past decade is unsurprising, and expresses the previously stated claims that the world is consuming oil at a continually increasing rate. Below, a graph of worldwide petroleum consumption is displayed, where the green line



expresses total world consumption, and the blue line expresses the total consumption of countries in the Organization for Economic Co-operation and Development (OECD). This organization includes thirty most-developed countries and developing countries, including the United States, the United Kingdom, Germany, and Australia. Notably, it does not include China, a developing nation that is vastly expanding its economic influence and consumption of natural resources. After a period of decline ending in 1983, our global consumption of petroleum has increased exponentially, and has only seen a slight drop during 2008, likely due to the onset of a global economic recession. The importance of the developing world is extremely notable during the past decade. Starting around the year 1999, consumption from OECD countries began to level out, yet at the same time global consumption experienced an exponential increase in the rate of consumption that continued through 2007. This is a direct indicator of the influence that developing nations, especially China, have on the global consumption of petroleum. This graph is attributable as well to the theory of peak oil as related to a consumption peak. It seems that for a number of years, OECD nations have been consuming less and less oil, and during the past decade there has been no marginal increase in consumption by these

nations. Consumption as a world total also appears to be decreasing since 2007, and regardless of Chinese consumption trends, if all thirty OECD nations continue to consume less petroleum, the net affect will likely be a reduction in global consumption.

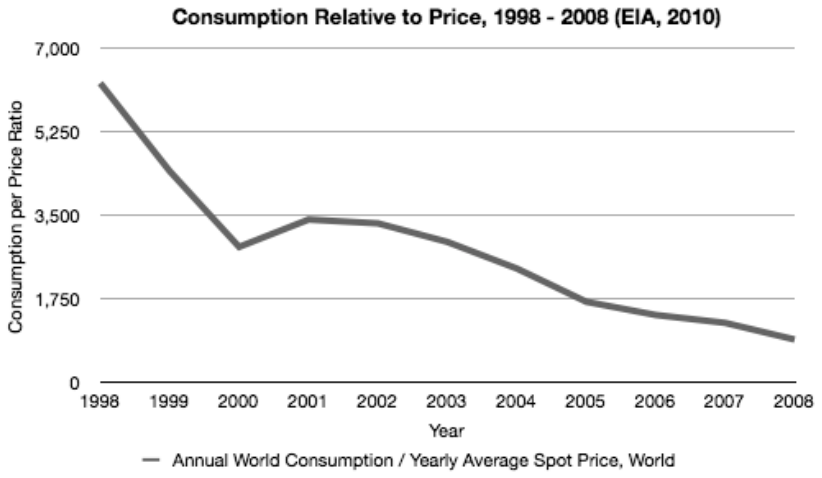
In analyzing the above data, the trends of oil consumption and production appear to be potential indicators of a pending oil peak. Production levels have been roughly evening out during the past decade, with consumption levels for major oil-importing nations mirroring this trend at a slight delay. This is a pattern to be expected at a period of peak oil. As productive capacity levels out, consumption would follow at a slight delay, as stockpiles are depleted. Peak oil is, in other words, an indication that we have consumed half or nearly half of our easily recoverable oil supplies. According to data sited separately by Baer and Goodstein, this may in fact be the situation we face. Goodstein offers statistics on the total amount of oil available since its discovery. "Over the period 1995-2000 the United States Geological Survey (USGS) made an exhaustive study of worldwide oil supplies. The resulting report concludes that, with 95 percent certainty, there was the equivalent of at least two trillion barrels when we started pumping" (Goodstein p. 29). Baer discusses the similar statistic for remaining reserves as of 2008. "Based on inflated industry and company estimates, the remaining proven reserves worldwide amount to 1.255 trillion barrels. But if we go by actual production, according to the respected, independent Energy Watch Group, oil reserves in fact are closer to 854 billion barrels" (Baer, p. 141). The average of the two figures cited by Baer for remaining proven reserves is 1.055 trillion barrels, which is essentially half of the USGS estimated two billion barrels (95% certainty). So based on our production and consumption trends since the first well drilled for commodity oil, we have consumed close to half of all available reserves. According to the theory of peak oil, a crisis in oil resource use will occur not at the point of depletion, but rather at the point where half of the resource reserves have been consumed. Once again, the raw data regarding our global crude oil market points to a pending oil peak, which, if peak oil theory is entirely accurate, transcends to a pending crisis in the supply of this vital resource.

Crude oil prices are not an indicator of oil scarcity, and more likely fuel our mass-consumption of the resource, rather than indicate its limits. Applying price trends to the theory of peak oil, while helpful in accessing a peak in resource consumption, is a more ambiguous process than that of analyzing production and consumption trends. Oil prices

are manipulated through multiple avenues in the international market. Prices vary from nation to nation and, often times, the price of a barrel of oil may reflect nothing beyond its commoditization. Prices are not a direct reflector of scarcity, or any other market or non-market trend, in the crude oil market (Adelman, 1986). Gasoline prices offer a good illustration of this reality. For the average consumer, barrel prices might seem to affect gasoline prices linearly. Yet as Goodstein clearly states, the prices paid by Americans to fill up are significantly lower than international gasoline costs. "…visitors from Europe are usually astonished to discover that gasoline is just about the cheapest liquid you can buy in the United States. Two dollars a gallon amounts to fifty cents a liter" (Goodstein, p. 46). The United States pays a subsidized price on the crude oil commodity, as a result of deals made between major oil-producing nations and members of every level of government. Nowhere is this more prominent than the relationship between Washington and Saudi Arabia. Money and political power has been shifted between the two nations for decades to provide the United States with cheap, endlessly supplied crude oil (Baer, 2003). So it is essentially impossible to impose any specific trend on oil prices, as there are too many factors that alter them. Whether it be back-room dealings, the addition of individually owned crude stockpiles into the market, or simply the cost of different transportation options for the commodity, prices never come from one single source, and therefore are not a direct indication of scarcity or a global peak.

While crude oil prices do not directly reference immediate or pending scarcity or peak production, there are some who believe that cheap oil is attributable in a separate way to peak oil theory. The idea is not dissimilar to the tragedy of the commons. Where there is a publicly available commodity, a common resource, that is essential to the livelihood of all peoples, the use of that resource will expand exponentially, regardless of cost. Now add to this situation an increasing yet never unattainable price, and you have even more intense production and consumption of that resource. Again, Goodstein discusses this phenomenon in relation to the cheap price paid by Americans for crude oil and gasoline. "One consequence is that we Americans, with 5 percent of the world's population, consume 25 percent of the world's oil. Cheap gasoline is not the solution; it's a big part of the problem" (Goodstein, p. 46). Goodstein clearly displays the relatedness of over consumption to price. The graph below represents global crude oil consumption per yearly average price from 1998 to 2008. The yearly average price during this time

period expanded exponentially from ~$11 dollars per barrel in 1998 to ~$95 dollars per barrel in 2008. When the price was low, averaging $11.82 dollars per barrel in 1998,



the consumption to price ratio was very high. While both price and consumption of crude oil increased during the past decade, the ratio shows a downward trend in the amount of oil consumed at increasing prices. This is in direct support of Goodstein's theory that cheap oil is, in fact, a contributor to over consumption of a resource. Regardless of how crude oil prices are derived, it can be surmised that the lower the cost, the more we will consume. So even if at the onset of a oil crisis we were to implement more efficient, cost-saving technologies for our oil-driven products, it is likely we will not conserve this vital resource, but rather deplete it at an increasing rate.

Significance of Findings

Crude oil is everywhere, whether as a raw resource or as a refined and developed product that might not resemble its origin at all. It is a commodity that has been used to its complete and full potential by humankind, and is vital to all people of any socio-economic status in any nation. The findings of this study on the application of peak oil theory to global reserves have shown that there is, at minimum, a pending peak in crude oil within the next half century, yet depending on the production and development patterns during the next few years, this peak could be experienced as soon as ten to fifteen years from present. Production is faltering while consumption and demand rise exponentially. Even if there were one hundred years of comfortable consumption of crude oil remaining, it is still a finite resource, one that will, given time and continuous

consumption, be depleted. According to peak oil theory, a crisis will occur when we reach a peak in oil production, or rather, when we have consumed half of all the oil available for extraction; and we are very close to doing just that. So while our remaining 1 trillion barrels of oil seems like an incredible amount of oil, an amount that could not possibly translate to a crisis, at the present rate of consumption that amount would be depleted by the year 2050, and our world economy, wholly reliant on crude oil, would crash well before that time. If you are twenty years of age in 2010, you, your children, and your grandchildren will face the consequences of a global peak in oil resources, even based on the highest of total remaining reserve estimates.

There are certainly alternative oil reserves that can be researched and tapped throughout the world, yet these unconventional methods, including oil shale and deep sea (off-shore) drilling, come at higher production costs, and will contribute significant economic strain. Furthermore, common sense deters the notion that the discovery of a large-scale oil field, one to rival the Saudi Ghawar Field (the world's largest oil reserve), will eliminate all worry of an oil crisis. The discovery of such a field would take years of investment and development to reach commodity production capability. All the while the world is consuming existing reserves, and by the time the field is in full production, it may only add enough oil to offset consumption trends during the years it took to develop that field. Another noteworthy complication in the multiple techniques of averting a global oil crisis is the increase in the efficiency of our crude usage, especially that of gasoline. Hybrid cars, for example, appear to use less gasoline due to their increased efficiency and partial deference of energy to battery power. This leads to an example of Jevons Paradox. When a consumer experiences a decrease in the cost of a convenient and vital task of everyday life, one can surmise that the occurrence and intensity of that behavior will increase for a multitude of reasons. If the use of one's car is less expensive than that of using public transportation, or simply not going somewhere, then the car will be used. This is a basic economic situation; as price goes down, due to a number of factors, quantity demanded (consumption), goes up, and when the product is gasoline the rate of depletion of worldwide crude oil supplies also goes up. These few examples are certainly not exhaustive of all situations and complications involving the production and consumption of crude oil, but serve to display the vast complexity surrounding any solution to an oil crisis.

What is most striking in the discussion of an oil crisis as a result of a global peak in oil reserves is that such a crisis would affect all aspects of our entire global social, economic, cultural, and political network. Everything consumed, whether by necessity or conspicuously, has a footprint in oil. All the petrochemicals used on a day to day basis in all trades are a direct product of crude oil, and no matter how local a product may be, it still contains an oil footprint stemming from the transportation sector. Even the infrastructure of renewable energy systems has likely been created and implemented using crude oil products and fuels. Moreover, the geopolitical effects of a global oil crisis would be vast. There is a direct correlation between the oil reserves a nation contains and its freedom rating as applied by the international organization Freedom House. Saudi Arabia, Iraq, Iran, United Arab Emirates, Qatar, Russia, Libya, and other major oil producing countries are all labeled not free. Other major exporters, including Ecuador and Venezuela, are labeled "partially free". New York Times columnist Thomas L. Friedman dubs this trend the "first law of petropolitics"; freedom has an inverse relationship to the price of oil. This trend not only has the potential to cause irreconcilable rifts in our geopolitical environment, it may already have done so to a certain degree.

It is both unsurprising and astonishing that the entire world balances upon the most unstable regions which control our oil reserves. The Middle East, arguably the most corrupt, war torn, and tactically imperative region in the world, contains ~54% of the remaining claimed proven reserves worldwide. An example of the instability of our crude oil market is found in the Strait of Hormuz, a narrow waterway between the Persian Gulf and the Gulf of Oman through which all major international crude oil supplies flow. Iran, an increasingly powerful, self-interested, and potentially hostile nation, borders this waterway, and given reason has the ability to shut down the Strait, and the global economy, at will (Baer, 2008). Perhaps it is of no surprise that the developed nations of the world have political and military assets in nearly every country surrounding the Strait of Hormuz and Iran. For decades, the developed world has had this foothold in the Middle East, protecting the continued flow of crude oil across the Atlantic and north to Europe, offering direct evidence of the regions strategic importance. Additionally, as the price of oil has risen in the past decade, so has the number and intensity of conflicts occurring in and related to the Middle East, including 9/11, the Second Gulf War, the war

in Afghanistan, the 2006 Lebanon War, an emerging Iranian superpower, and increasing cultural and political instability in Saudi Arabia. These are all examples of major geopolitical conflicts and developments during the past decade. During this same time, the Middle East, notably Saudi Arabia, has failed to meet market demand for oil, while crude prices rose from ~$11 dollars per barrel to ~$95 dollars per barrel. These three trends: Increasing conflict, declining crude oil production rates, and increasing crude oil market prices, are a perfect storm for the occurrence of a peak in conventional petroleum resources, and as supplies become increasingly scarce, these trends are likely to become more prevalent as well.

A crisis in oil reserves, based on current consumption rates and the absence of viable commoditized alternatives, is inevitable. Based on the geopolitical and market trends of the past decade, a global peak in oil reserves is probable well within the next few decades, possibly sooner. Worldwide reliance on a finite resource can have no different outcome. A comfortable lifestyle of conspicuous consumption surrounded by oil is enjoyed by millions throughout the developed world and continues to spread into certain developing countries as well. It is the resource that provides each of us with the necessities in life, and it is impossible to completely avoid its footprint. A crisis in oil reserves as a result of an oil peak will be globally catastrophic, and the consequences of our mass-consumption of a finite resource will not differentiate between peoples or nations, race or religion, rich or poor. This non-differentiation, due to the unavoidable use of crude oil, will distribute the consequences of an oil crisis across all peoples worldwide, with implications across the economic, political, and social structures throughout our world.

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