



Verifying the Export Land Model - A Different Approach

Posted by [Gail the Actuary](#) on October 1, 2010 - 9:27am

Topic: [Demand/Consumption](#)

Tags: [export land model](#), [george lordos](#), [jeffrey brown](#) [[list all tags](#)]

This is a guest post by George C. Lordos, of Nicosia, Cyprus, known as [Lumina](#) at The Oil Drum. He has degrees in Philosophy, Politics and Economics from Christ Church College at Oxford University and in Business Administration from the MIT Sloan School of Management, where he specialized on strategy, finance and system dynamics. George has business interests as a Principal/Chairman in food trading, energy efficiency, renewable energy and information technology. He also makes a hobby of blogging about sustainability, energy and finance. George's blog is at baobab2050.org.

The [Export Land Model](#) of forecasting future oil supplies available for sale to oil importing economies, which as far as I know was first presented at the 2007 ASPO-USA conference by its authors Sam Foucher and Jeffrey J. Brown, takes my "[Cassandra Prize](#)" for its importance and for the deafening silence with which stakeholders have been reacting to it, despite the [mainstream media giving it some coverage](#).

In this post, I use a different way of grouping countries to confirm key insights of the Export Land Model.

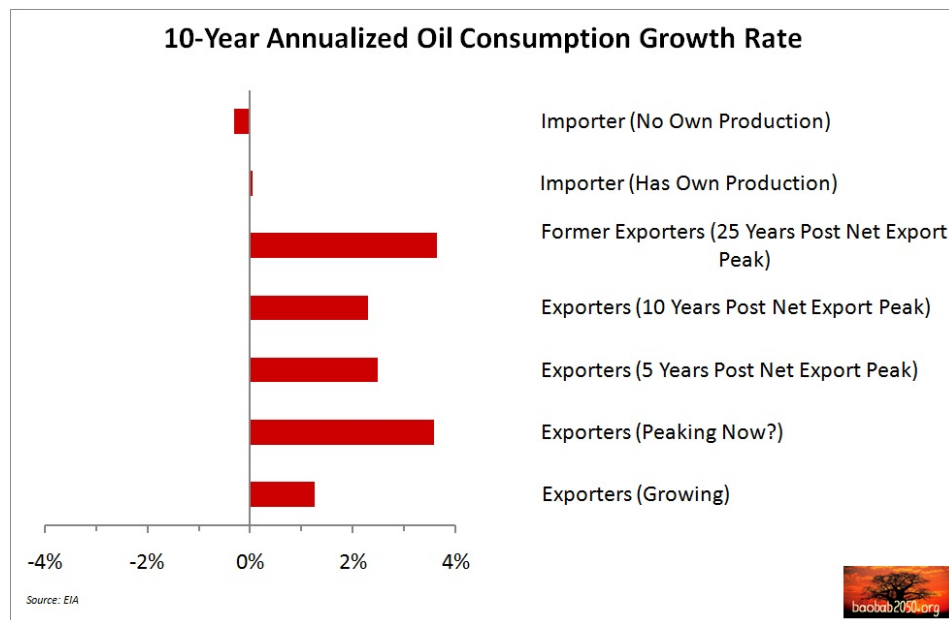


Figure 11: An ELM Key Insight is that the domestic consumption of oil exporting nations will, over long time periods, tend to grow faster than the domestic oil consumption of oil importers because of the windfall effect of oil revenues, and will tend to continue to grow even past the production peak, especially whilst net exports are positive.

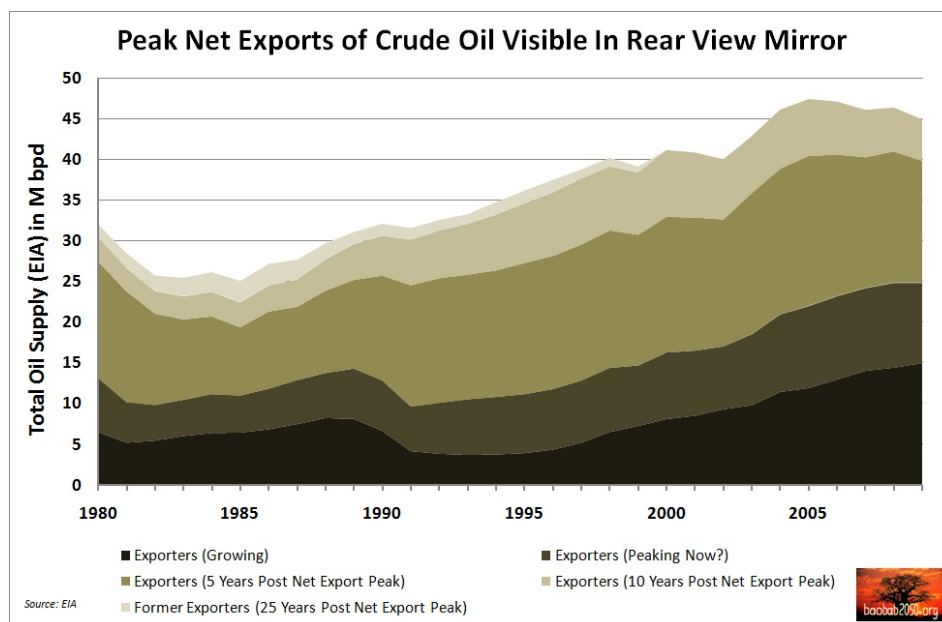


Figure 1: Net oil exports per day, with exporters grouped by the rate of change of their net exports.

Note: For all images, click on figure to view full size version.

In this analysis, a 30-year data set on oil production and consumption [which is made publicly available by the U.S. Energy Information Administration](#) is analysed in an effort to confirm the two key insights of the [Export Land Model \(ELM\)](#). These insights, as I understood them, were the following:


- 1. For oil exporting nations, the higher the level of their domestic oil consumption as a fraction of their production, the more the changes in production volume will amplify the resulting change in net exports.**
- 2. The domestic oil consumption of oil exporting nations will, over long periods, tend to grow faster than the domestic oil consumption of oil importers because of the windfall effect of oil revenues, and will tend to continue to grow even past the production peak, especially whilst net exports remain positive.**

In a country that is past its peak of oil production, the above dynamics operate together to cause the net export decline rate to be much higher than the production decline rate. If this effect appears simultaneously in many exporters, for instance due to global peak oil, the accelerated decline in net exports will disproportionately strike nations which are heavily dependent on imported oil.

The analysis, which follows below, confirms that both key insights of ELM are consistent with real-world global production, consumption and net export data from 1980 to date.

PART I: THE SUMMARIZED DATA

All of the figures in this post are drawn from a summarized data set, an extract of which is shown below:

		Crude Oil, Condensates, NGPL, Other Liquids and Implied Refinery Gains in 000's bpd			Rates of Change			
		2000	2005	2009	10-year total change	5-year total change	10-year annualized	5-year annualized
Crude Oil Net Exporters (Growing)	Production	15811	20333	23711	50%	17%	4.1%	1.5%
	Consumption	7689	8397	8717	13%	4%	1.3%	0.4%
	Net Exports / (Imports)	8122	11936	14995	85%	26%	6.3%	2.3%
Crude Oil Net Exporters (Peaked?)	Production	9265	11398	11409	23%	0%	2.1%	0.0%
	Consumption	1065	1321	1516	42%	15%	3.6%	1.4%
	Net Exports / (Imports)	8199	10078	9894	21%	-2%	1.9%	-0.2%
Crude Oil Net Exporters (About 5 Years Post Peak)	Production	23204	25918	23337	1%	-10%	0.1%	-1.0%
	Consumption	6595	7551	8434	28%	12%	2.5%	1.1%
	Net Exports / (Imports)	16609	18367	14903	-10%	-19%	-1.1%	-2.1%
Crude Oil Net Exporters (About 10 Years Post Peak)	Production	10415	9460	7859	-25%	-17%	-2.8%	-1.8%
	Consumption	2197	2459	2755	25%	12%	2.3%	1.1%
	Net Exports / (Imports)	8218	7001	5104	-38%	-27%	-4.7%	-3.1%
Crude Oil Former Net Exporters (About 25 Years Post Peak)	Production	7840	7089	6746	-14%	-5%	-1.5%	-0.5%
	Consumption	8033	10268	11480	43%	12%	3.6%	1.1%
	Net Exports / (Imports)	-193	-3179	-4734	2349%	49%	37.7%	4.1%
Crude Oil Net Importers (Producers)	Production	11132	10306	11231	1%	9%	0.1%	0.9%
	Consumption	33288	35408	33461	1%	-5%	0.1%	-0.6%
	Net Exports / (Imports)	-22156	-25102	-22230	0%	-11%	0.0%	-1.2%
Crude Oil Net Importers (Non - Producers)	Production	102	85	81	-21%	-5%	-2.3%	-0.5%
	Consumption	17905	18701	17352	-3%	-7%	-0.3%	-0.7%
	Net Exports / (Imports)	-17803	-18616	-17272	-3%	-7%	-0.3%	-0.7%
All Current Exporters	Production	58694	67109	66316	13%	-1%	1.2%	-0.1%
	Consumption	17546	19728	21421	22%	9%	2.0%	0.8%
	Net Exports / (Imports)	41148	47381	44895	9%	-5%	0.9%	-0.5%
All Current Importers	Production	19074	17480	18057	-5%	3%	-0.5%	0.3%
	Consumption	59226	64377	62293	5%	-3%	0.5%	-0.3%
	Net Exports / (Imports)	-40152	-46897	-44236	10%	-6%	1.0%	-0.6%
Whole World	Production	77768	84589	84374	8%	0%	0.8%	0.0%
	Consumption	76772	84105	83714	9%	0%	0.9%	0.0%
	Errors or stock differences	996	484	659				

Source: EIA

Table 1: Production, Consumption and Net Export volume and growth rates by group of countries arranged in increasing order of import dependence, for 2000, 2005 and 2009

[Click here](#) for a listing of the countries assigned to each grouping.

There are currently 44 countries / territories that are net exporters of crude oil, who therefore supply the requirement of 173 countries who are net importers – and only about a quarter of the

latter have some production of their own. At least from the perspective of countries who are heavily dependent on net oil imports, the continued availability of oil on world markets at a reasonable price that their economy can bear is a key factor affecting long term economic and social stability. In Table 1 above, we note that net oil exports of all current exporters are down 5% from their 2005 peak volume.

PART II: CRUDE OIL NET EXPORT ANALYSIS, GROUPING EXPORTERS BY THEIR GROWTH RATE IN NET EXPORTS

From studying the EIA data, I identified 10 countries which are still posting strong growth in their net exports, which is the green line in Figure 2 below. Together, these countries account for approximately one third of today's global net exports. Note that this group includes Russia, which suffered a massive production and consumption collapse in the wake of the 1991 implosion of the former Soviet Union. Over the last 10 years (see Table 1 above) this group of countries posted a 50% increase in their crude oil production, a 13% increase in their domestic consumption, and an 85% increase in their net oil exports. This is consistent with both key insights of the ELM.

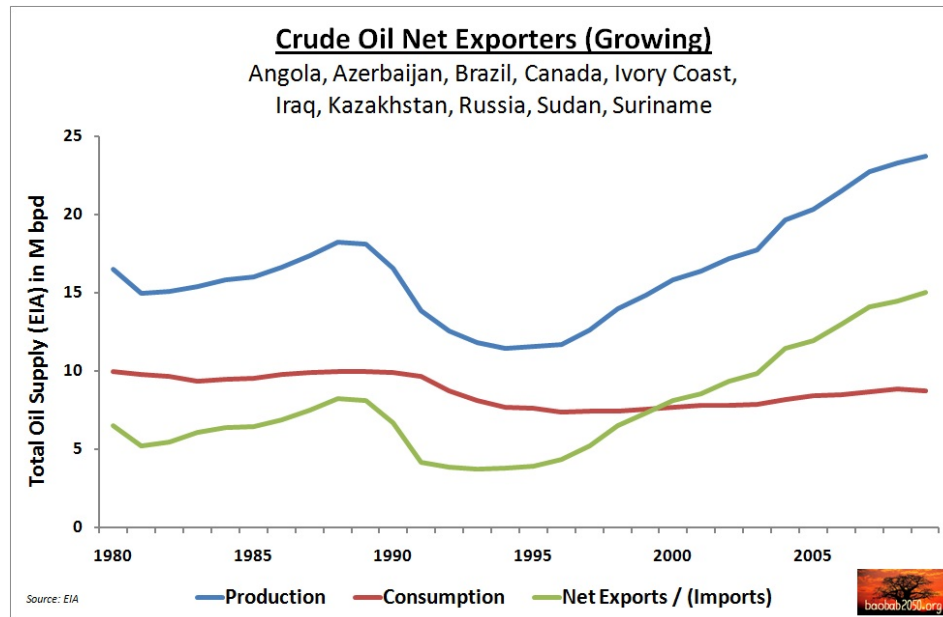


Figure 2: Production, domestic consumption and net export figures in millions of bpd, for the group of countries showing the strongest growth in net exports as of 2009.

The next group consists of countries which up until recently had exhibited strong net export growth, but have since stalled. Their growth rate in consumption (42% over 10 years) in parallel with their past strong net export performance is consistent with the second ELM insight. The fact that their net export growth rate is neither amplified nor attenuated by the 10-year change in their production rate (they are roughly equal) might also be weakly consistent with the first ELM insight because right at the peak of net exports, the effect should logically change over from amplification to attenuation. I therefore tentatively labelled these exporters as “Peaking?” in Figure 3 below:

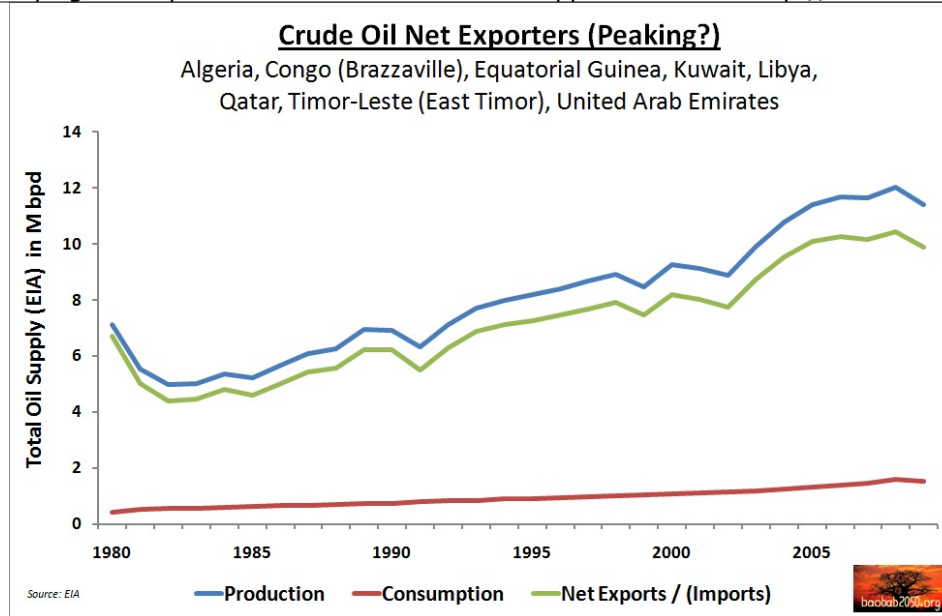


Figure 3: Production, domestic consumption and net exports for a group of countries whose net exports may have recently peaked.

Then, going down the pecking order of net export growth rate, I grouped together the net exporters where I felt more certain about the peak in their net exports. This group experienced a fall in production of 10% over the last 5 years, and together with a 12% domestic consumption increase, they ended up posting a 19% decline in their net exports. This is consistent with both the key insights of ELM. Collectively, their net exports display a clearly visible peak about 5 years ago, as shown in Figure 4 below:

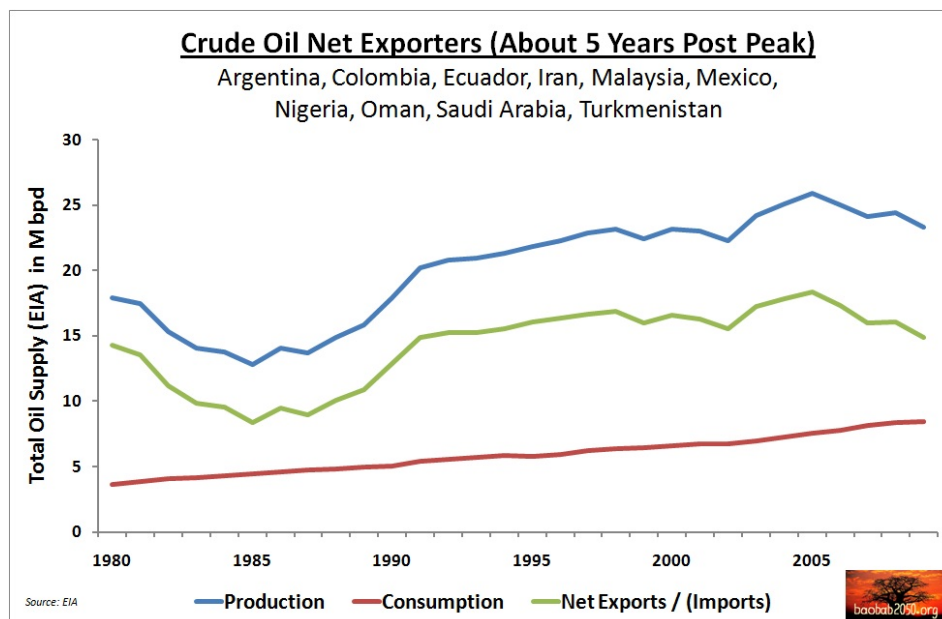


Figure 4: Production, domestic consumption and net oil exports in millions of bpd for a group of exporters whose net export decline has become more clearly established (about 5 years post peak).

The next group in Figure 5, where net export declines collectively set in an average of 10 years ago, appears to be in terminal net export decline. These countries are in the twilight of their net

oil exports. Over the last 10 years, their production has fallen by 25%, domestic consumption rose by 25%, and net exports are still positive but they are down by 38%. This is also consistent with both key insights of ELM.

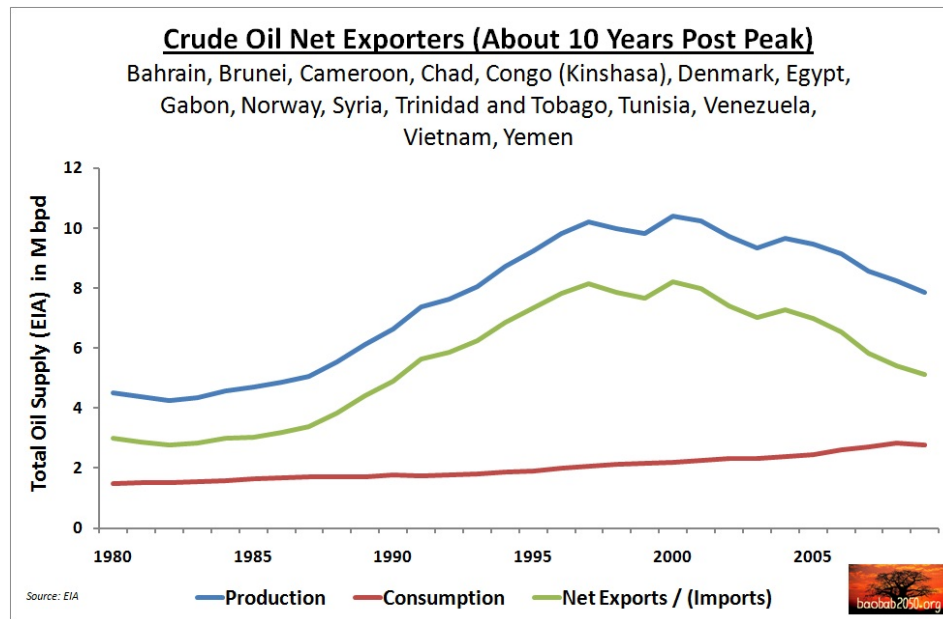


Figure 5: Production, domestic consumption and net exports for a twilight group of oil exporters. These countries are not far from collectively becoming net importers (about 10 years post peak).

And finally, the destiny of every oil exporter – a destiny that ELM predicts will strike sooner than most people realize. In Figure 6 I show all the countries which were formerly net exporters, but have since collectively become net importers – with their collective net export peak occurring over 25 years ago. The zero net exports threshold was crossed in 2000, and since then, production has fallen by only 14%, but consumption has risen by 43% – largely thanks to China.

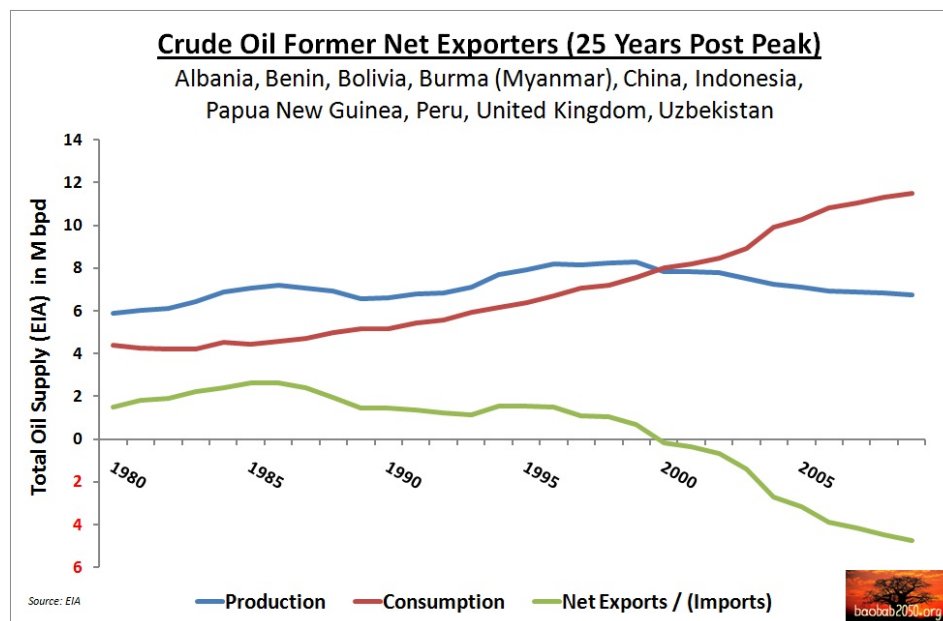


Figure 6: Production, domestic consumption, net oil exports and net imports in countries that were formerly net exporters, before domestic consumption overran a relatively stable total

production. Note that China's impact in this chart is quite large and disproportionate relative to the other countries.

This last group of “former exporters” also confirms the key insights of ELM, but more importantly it amply demonstrates the main reason why ELM should be taken a lot more seriously: although it will take many decades for production from this group to approach zero, **their net exports have already been less than zero for one decade.** The rapid onset of net export decline is thus “baked into the structure of the global oil system” and all net importers, especially those who have no oil production of their own or few geopolitical chips to bargain with, can only ignore this at their peril.

The implications of ELM for the “health” of a world economy addicted to its daily dose of 85 million barrels of crude oil are serious, and they are mostly being ignored. To some, the two key insights of ELM might seem mathematically trivial and obvious, but out there in the real political economy it is important to confirm the trivial and obvious with real data. It is doubly important in the case of crude oil, because the focus of mainstream media is entirely misplaced: they don't often go past discoveries, additions to reserves, or maybe production figures if we are lucky.

To sum up this section, and referring back to Figure 1 and Table 1 at the top of the post, apart from the 5% decline in total net exports relative to the 2005 peak we also note that the volume of net exports from the two groups of declining exporters is 20m bpd, which is currently more than the 15m bpd volume of net exports from the group of growing exporters. We also note that the 5-year annualized net export growth rate of the 15 million barrels of the growing group is 2.3%, but the weighted 5-year annualized net export decline rate of the two declining groups is 2.4%. The “peaked?” group, sitting in between the growing and declining groups, exports 10m bpd and their 5 year annualized net export decline rate is almost zero (-0.2%).

Of course these are snapshot comparisons and not fitted trend lines, but this volume and growth rate comparison between growing and declining exporters is nevertheless significant, as it implies that in our immediate future we will see a probably downhill-inclined plateau of net exports. Indeed, fitting a least squares trendline to the 2005 – 2009 production plateau which most people expect to continue, and a long term consumption growth trendline going back to 1996 when the FSU appears to have stopped collapsing, I got these results for a 2010 – 2015 projection of production, consumption and net exports (Figure 7):

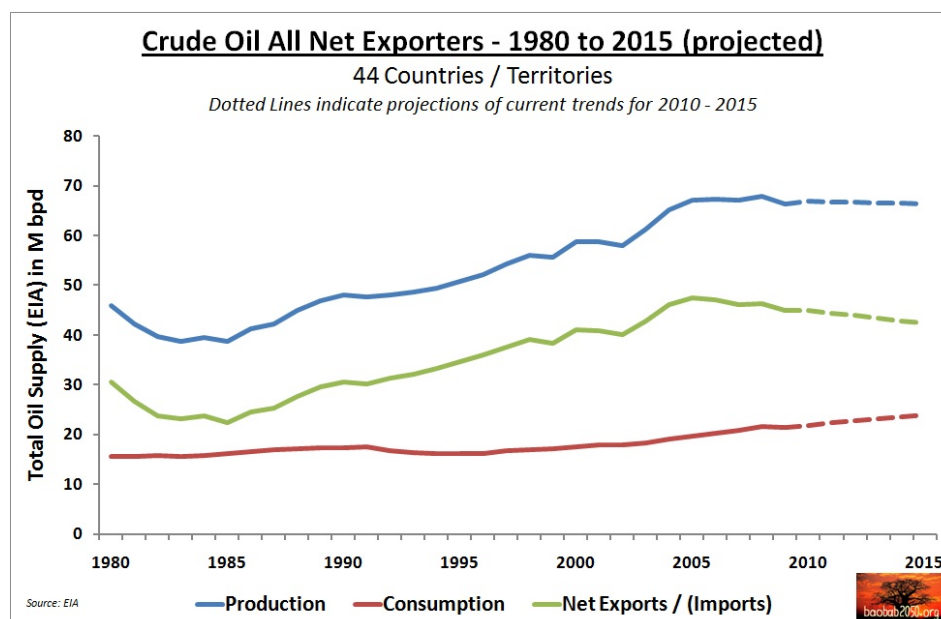


Figure 7: Production, Consumption and Net Exports for all current net exporters 1980 - 2009, with projection for 2010 - 2015

Put in different words, any “plan” to grow total net exports will face the headwinds of (a) having to replace large volumes of declines from the 20m bpd declining group, (b) having to also replace increasing declines from the 10m bpd “peaking?” group, and (c) the growing group possibly speeding up their consumption growth rate to levels similar to those of all other current and former net exporters (see Figure 11 below). Considering that net exports are already 5% below their 2005 peak and that near-term trends are biased towards a downhill rather than an uphill plateau, it is more likely than not that global net exports have already peaked. Therefore, I am going out on a limb and calling 2005 as the peak year for net oil exports – barring any big surprises such as many net exporters suddenly deciding to start investing in cleantech in a big way!

PART III: THE OTHER SIDE OF THE COIN – NET IMPORTERS

If the peak in net exports is behind us, what happens to net importers? Clearly, the groups of importers who have some production of their own, including all the countries in Figure 6 and some of the countries in Figure 8 below, will have more options available to them as the unavoidable efforts to reduce their economy’s dependence on oil only have to go as far as needed to support the demand with their own production.

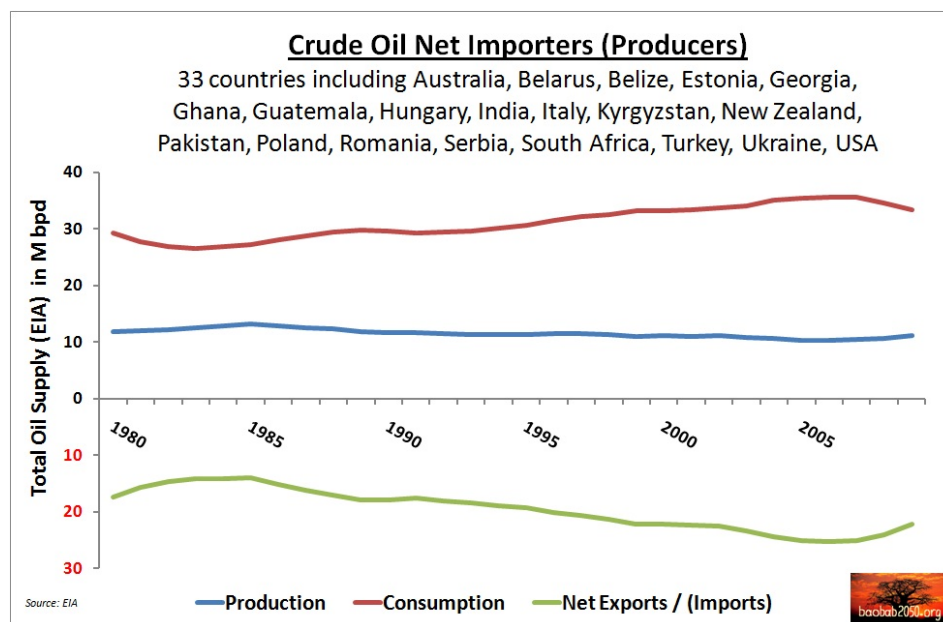


Figure 8: Oil production, consumption and net imports for countries that produce a non-negligible fraction of their consumption

The situation of this group is at least a little more bearable than that of the much larger number of countries – including Japan, South Korea and many E.U. member states – who have no production of their own (Figure 9 below), some of whom will have to wean themselves off oil entirely if they lose access to the world oil markets as shortages of net exports develop.

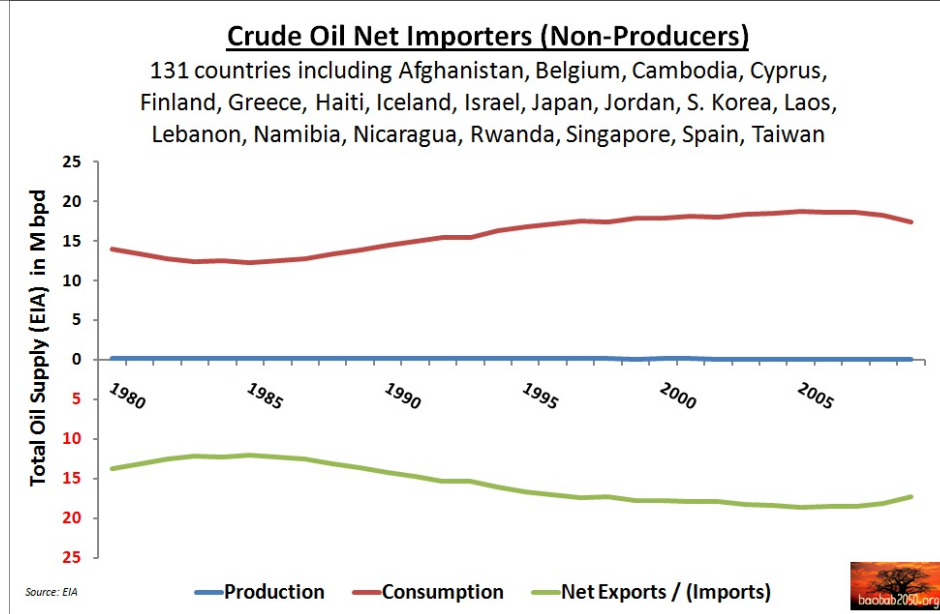


Figure 9: Oil production, consumption and net imports for a group of countries whose production is less than 1% of their consumption

The situation of most importer countries is made more complicated because it is very unlikely that large, powerful nations will “play nice” and scale back their own import requirement to allow a smoother adjustment for every importer. China has been busy sealing long-term resource purchase agreements in Eurasia and Africa using clever devices to lock in supplies such as [pipelines from Siberia](#) and joint venture refineries in the [Middle East](#) and [Africa](#), and U.S. troops are all over the Middle East, particularly Iraq which is one of the few potential future growth stories left. It is hard (though not impossible) to model this, but the likely picture past the second decade of this century is that small or geopolitically weak importing countries will pay exorbitant spot prices for crude oil and be confronted with increasingly unstable oil supplies and wrenching emergency adjustment pressures.

PART IV: CONFIRMATION OF THE EXPORT LAND MODEL

The purpose of this post was to find empirical validation of the two key insights of the Export Land Model in real-world data. We analysed production, consumption and net export data for every country in the world from 1980 – 2009 and have found proof that both key insights of ELM are consistent with real-world data. Figures 10 and 11 speak for themselves.

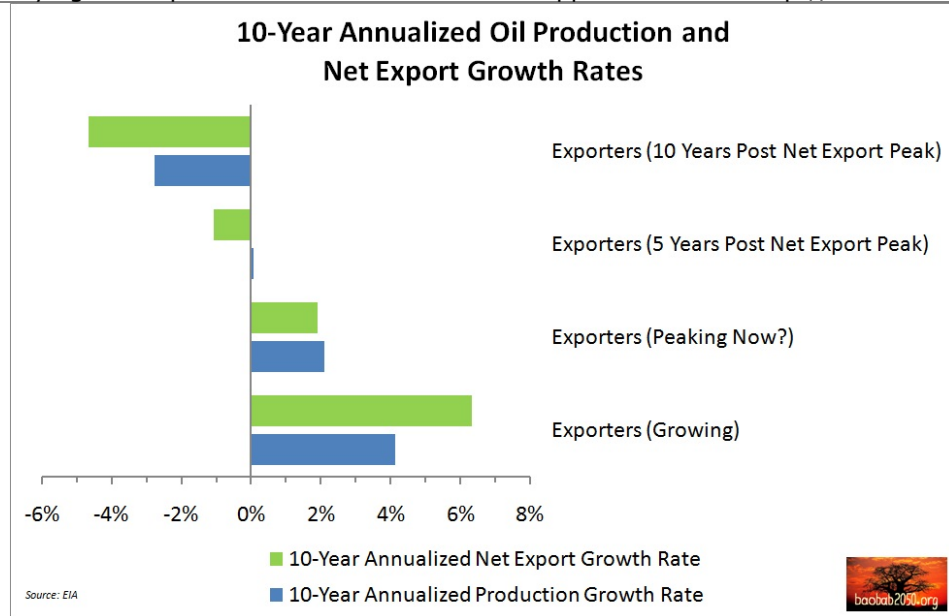


Figure 10: Key Insight One stated that for oil exporting nations, the higher the level of their domestic oil consumption as a fraction of their production, the more the changes in production volume will amplify the resulting change in net exports.

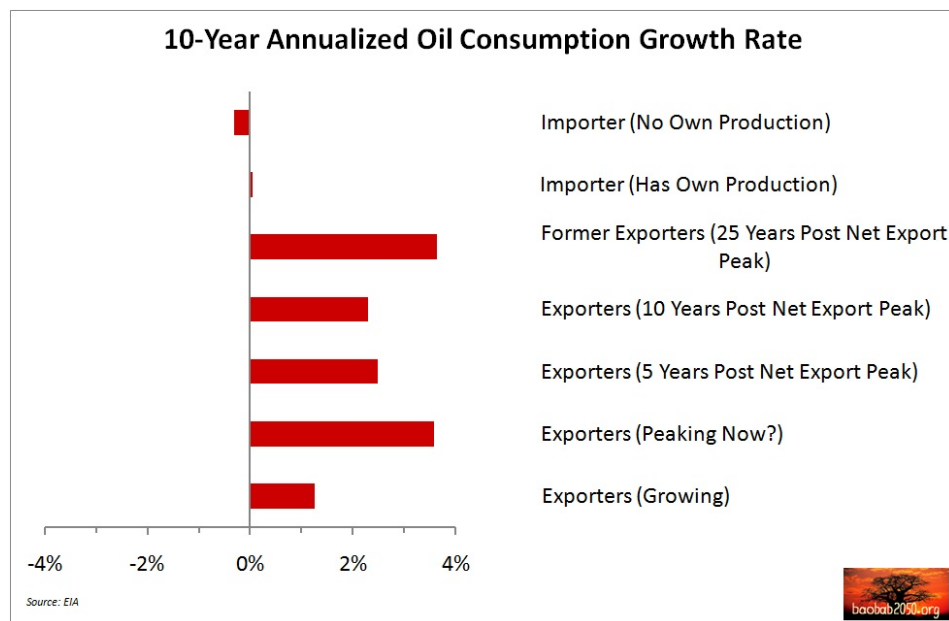


Figure 11: Key Insight Two stated that the domestic oil consumption of oil exporting nations will, over long periods, tend to grow faster than the domestic oil consumption of oil importers because of the windfall effect of oil revenues, and will tend to continue to grow even past the production peak, especially whilst net exports remain positive.

PART V: METHODOLOGY AND REFERENCES

I obtained production and consumption data of “Crude Oil, NGPL, and Other Liquids” from the [1980 – 2009 International Energy Statistics supplied online by the EIA](#). I then adjusted the production data by a factor of 101.5% to 102.5% to incorporate the appropriate refinery processing gains for each calendar year, thus attributing the RPG’s back to the source of the crude oil. This adjustment is essential to remove noise and obtain a fair picture out of net export

data, given that my definition of Net Exports is “Production – Consumption”. Then, using the first year of their independence as my benchmark, I back-casted and pro-rated the production and consumption of “former” countries (USSR, Yugoslavia, Czechoslovakia and Serbia & Montenegro) into the component countries, so as to have a 30 year data set for all of today’s countries. I also merged East and West Germany into “Germany”, and I merged UK and Dutch offshore production figures into the mother countries. I then calculated net exports for each country by simply subtracting consumption from production.

The grouping was accomplished by first calculating “cumulative production to cumulative consumption” ratios, one over the full 30 year period, and another over the last 3 years, and then by grouping countries in descending order of net export growth rate based on these ratios and on the actual 30 year net export history. Other people may group certain countries differently, because for some countries the data may show stagnation or even decline, but the potential to be in a faster-growing group might still be there (Venezuela and Libya come to mind). However, as there are so many unknown unknowns, I decided to stick with what the data has been saying, for better or for worse.

The Export Land Model (ELM) is explained in the following two posts by its original authors:

[Declining net oil exports—a temporary decline or a long term trend?](#) – by Jeffrey J. Brown and Samuel Foucher

[A quantitative assessment of future net oil exports by the top five net oil exporters](#) – by Jeffrey J. Brown and Samuel Foucher



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