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Trade and Uneven Development: Opportunities and Challenges



Risks to Global Trade and Implications for South Africa's Economy and Policy

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Abstract

The past two decades have witnessed an unprecedented globalisation of trade in goods and services. This process has been driven, *inter alia*, by technology, ideology and the availability of relatively cheap energy. By extrapolating this trend, one may expect further integration of world markets and increasingly unhindered international trade. However, there is mounting evidence of significant risks to the globalisation of free trade, at least in goods and possibly in certain services as well. Three main risk areas are identified: (1) fossil fuel depletion, in particular a possible peak in world oil production within the next five to ten years; (2) climate change, and especially its effect on agricultural production; (3) and instability in the world financial system caused primarily by the US's unsustainable twin deficits. The paper explores some possible implications of these risks for the South African economy and its foreign trade in particular. It argues that South Africa's trade policy should take due cognizance of these threats to global trade, and advocates adaptation and mitigation strategies designed to improve self-sufficiency and to protect the poor in sensitive areas, especially food and energy security.

Contents

1	Introduction.....	1
2	The End of Cheap Oil	2
2.1	‘Proven’ oil reserves	3
2.2	The ‘Hubbert Peak’	4
2.3	Reserve growth	6
2.4	When might the peak occur?.....	7
2.5	Conservation and alternative energy sources.....	9
2.6	Likely consequences of ‘peak oil’ for international trade	11
2.6.1	Global economic prospects	11
2.6.2	Transport	12
2.6.3	Agriculture	12
2.6.4	Manufacturing.....	14
2.6.5	Restructuring international trade.....	15
2.6.6	Geopolitical risks	15
3	Climate Change.....	17
4	Global Monetary Imbalances and the US Economy’s Unsustainable Trajectory	19
5	Economic and Social Implications for South Africa	21
5.1	Trade	21
5.2	Other macroeconomic effects	22
5.3	Energy security	24
5.4	Food security.....	25
5.5	Social stability.....	25
6	Policy Response Options for South Africa	26
6.1	Adaptation and mitigation.....	26
6.2	Precautionary policy measures	28
7	Concluding Remarks.....	30
	References.....	33

1 Introduction

The past couple of decades have witnessed an unprecedented globalisation of trade in goods and services. This process has been driven, *inter alia*, by technology, ideology and the availability of relatively cheap energy. By extrapolating this trend, one may expect further integration of world markets and increasingly unhindered international trade. However, there is mounting evidence of significant risks to the globalisation of free trade, at least in goods and possibly in certain services as well.

Three main risk areas are identified: (1) fossil fuel depletion, in particular a possible peak in world oil production within the next five to ten years; (2) climate change, and especially its effect on agricultural production; and (3) instability in the world financial system caused primarily by the US's unsustainable twin deficits. The paper attempts a preliminary assessment of the likely economic implications of these risks for South Africa, and considers how the South African government could manage these risks through adaptive and mitigating policy adjustments. Importantly, these recommendations are tentative, as the main aim of the paper is to introduce these issues for wider discussion and debate, and to motivate for more detailed research on their implications.

The scope of the paper is broad, and therefore a certain amount of detail is sacrificed. This is not to suggest that details are inherently less valuable, but rather that a broad overview seems to be a good starting place for debate and discussion. In terms of international trade, this paper focuses mainly, but not exclusively, on trade in goods. The arguments may or may not apply to other aspects of trade, such as services and intellectual property. This selectivity is motivated by both tractability and relevance, inasmuch as physical resource limitations are a central pillar of the argument. The paper gives most attention to the issue of oil depletion, partly because this information is not widely appreciated, and also because it presents arguably the biggest medium- to long-term threat to international trade. Furthermore, as will be seen, the other risk factors – while important in their own right – are closely intertwined with energy issues.

The remainder of the paper is organised as follows. Section 2 outlines the debate on the future of oil supply and prices, and considers their likely impact on global trade. Section 3 considers some of the implications of global warming and climate change for international trade. Section 4 briefly examines the precarious global macro-economy and financial system, highlighting the unsustainability of the United States' twin deficits. In section 5 the possible implications of these risks for the South African economy are elaborated. Section 6 considers policy response options for the South African government, and advocates mitigation strategies and policies designed to improve self-sufficiency and protect the poor in sensitive areas, especially food and energy security. The final section concludes by highlighting the interactive nature of the main risks, which is likely to compound the probability and magnitude of their effects.

2 The End of Cheap Oil

It is rare to encounter explicit admission that the current integrated global trading system is highly dependent on the relatively cheap availability of crude oil to fuel transportation networks (ships, automobiles and airplanes in particular). In fact, fossil fuel energy is arguably the key resource for the global industrial economy. Oil takes precedence as the most significant energy source, although natural gas is assuming increasing importance, particularly as a source of electricity. As such, this section focuses on the issue of oil depletion, although the arguments do extend to natural gas and coal as well.

Global demand for oil has been growing steadily for a century and a half, albeit with two hiccups in the 1970s. At the same time, the supply of oil has been depleting since the day the first wells began pumping the black liquid in Pennsylvania in 1859.¹ This simply follows from the fact that existing oil reserves were formed over many millions of years; consequently, from a human perspective oil has a finite supply. Ever since 1859, however, global oil production volume has trended upwards, and we have become accustomed to year after year of economic growth underpinned by the relatively cheap availability of oil. Extrapolating past trends, the International Energy Agency (IEA, 2004) forecasts average annual growth in oil demand of 1.6% over the next 25 years, notably in the absence of major price movements or supply constraints.

But with oil prices recently breaching the \$70 per barrel mark in the wake of Hurricane Katrina, some economists are starting to warn of an oil price shock similar to those experienced in the 1970s. It is therefore pertinent to ask why the oil price is so high at present, and whether the prospects are that the price will fall, remain relatively constant, or rise further in the foreseeable future. As will be seen, this issue has massive implications for the world economy in general, and for international trade flows in particular.

Two main reasons are commonly given for the current high oil price, the first being rapidly growing demand, especially from developing economies. Last year, China's demand for oil grew substantially despite the surge in price, and that country now ranks second behind the US amongst oil importers. Thirty per cent of last year's growth in oil demand is attributable to China. According to a recent article in the Business Report (2005b), "[g]rowing demand from India and China is often cited as the main reason for rising oil prices and reflects increasing geopolitical concerns over energy security the world over." The US itself this year has expanded its consumption of oil in defiance of significantly higher costs.² This testifies to the highly inelastic and growing thirst for oil in industrial and industrialising economies, which has narrowed the gap between supply and demand. As of mid-2004 Saudi Arabia was the only nation with significant spare (conventional) oil production capacity (IEA, 2004: 111), and even this is close to exhaustion.

¹ Technically, depletion began in ancient times when oil was first used, but before 1859 the quantities involved were insignificant.

² US gasoline demand finally dropped markedly as the price rose to \$3 per gallon following the devastation wrought by Hurricane Katrina. However, this fall-off in demand may have resulted in part from less driving in the affected areas as well as reduced supply.

Secondly, many commentators currently argue that the real reason for high oil prices at present is a lack of refining capacity rather than inadequate crude oil supplies. If this capacity were expanded, they say, there would be plenty of extra oil available. But if present and future crude oil supplies are plentiful, then why has refining capacity not been expanding in the past few years, or even decades? The common answer is that oil prices were too low to make such investments financially attractive. But could it also be because the major oil companies suspect that the days of plentiful oil are numbered, and therefore it would be financially unwise to invest massive sums in infrastructure which will soon fall idle? In any event, it is not clear why the lack of refining capacity would affect the price of unrefined crude oil to the extent claimed, as opposed to prices of refined oil products.

This brings us to three pertinent questions. (1) How much oil remains to be produced? (2) How long is it likely to last? (3) What will happen to the price of oil over the coming years and decades? These questions are the subject of an intensifying debate between two main camps, which may be called the pessimists and the optimists. The former group is comprised mainly of petroleum geologists and ecologists who warn that we are approaching an imminent peak in global oil production, which jeopardizes the future of industrial society as we know it. The optimistic side of the debate is populated mainly by economists, oil-industry lobbyists and official government sources, such as the United States Department of Energy (DoE) and the International Energy Agency (IEA). They argue that production will increase for another two or more decades and consequently there is no cause for immediate concern. The following sections present an overview of this debate.

2.1 'Proven' oil reserves

According to ASPO (2005), some 945 billion barrels of oil (Gbo) have been extracted from the Earth to date. This amount refers to 'conventional' or 'light' oil, which excludes 'unconventional oils' such as heavy oil, oil from tar sands, oil shale, and polar and deep water oil. More contentious is how much oil remains. Geologists distinguish between 'resources', hypothetical estimates of all the oil existing in an area, and 'reserves', "the known quantity of oil that lies in fields and that can be produced with existing technologies, within a foreseeable time frame, at a commercially reasonable cost." (Rifkin, 2002: 15). The key concept from an economic perspective is therefore reserves, which is a flexible amount that varies with technological progress and economic conditions, especially the price of oil.

Despite long-term rising production, so-called 'proven' oil reserves – official estimates of ultimately recoverable supply – have been rising steadily for decades and currently stand at approximately 1,200 Gbo, according to various official estimates (IEA, 2004). The upward trend is explained both by new discoveries and by the fact that historical reserves are frequently revised upward as new technologies allow more oil to be extracted from old wells. However, these reserve figures are aggregates of official estimates from individual oil-producing countries, are not subject to independent audit, and are thus vulnerable to manipulation for political-economic reasons. At the heart of the debate on how much oil is left is a dispute over the reliability of official proven reserves. Campbell & Laherrère (1998), for example, point out that most OPEC nations revised their proven reserves upward by anything between 30% and 300% in the mid to late 1980s. This occurred shortly after the collapse in oil prices to around \$10 per barrel in 1985, and OPEC's decision that

production quotas would henceforth be based on proven reserves. Cash-strapped countries that were highly dependent on oil revenues therefore had every incentive to inflate their reserve estimates. Moreover, the figures published in periodicals such as *World Oil* and *Oil & Gas Journal* reflect no change in reserve estimates from year to year for many countries, despite the fact that they were pumping oil and may or may not have been making any new discoveries (see IEA, 2004: 92-3).

Furthermore, Matthew Simmons (2005), an independent energy consultant and former advisor to the Bush Administration, argues that Saudi Arabia's oil reserves – amounting to about a quarter of the world total – are substantially over-estimated. He claims that the Saudis have been over-pumping their oil wells, which means that the final gross quantity of oil that can be extracted will be significantly less than previously estimated (for geological reasons).

As a result of all these indeterminacies, geologists' estimates of ultimately recoverable reserves vary from around 1,850 Gbo (ASPO, 2005) to some 3,003 Gbo (United States Geological Survey, USGS, 'mean' scenario).

The second key question posed above, namely how long will oil last, obviously depends on the extent of ultimately recoverable reserves, as well as rates of production and consumption. The conventional view (held by the optimists) rests on a formula called the reserve to production (R/P) ratio, which – based on the official reserve estimate of 1,200 Gbo – is currently in the region of 40 years. The fact that this implies we have enough oil to last a little more than one generation at the current annual rate of production does not seem to perturb the optimists. However, this simplistic and unrealistic viewpoint suggests that oil production will remain flat (at around 80 million barrels per day) for 40 years and then suddenly collapse to zero. Both geologically and economically, such a pattern of production would be impossible, for it says nothing about the way production from oil wells gradually declines, nor about how prices and demand will respond to diminishing supply. We turn now to a more realistic assessment of the evolution of oil production.

2.2 The 'Hubbert Peak'

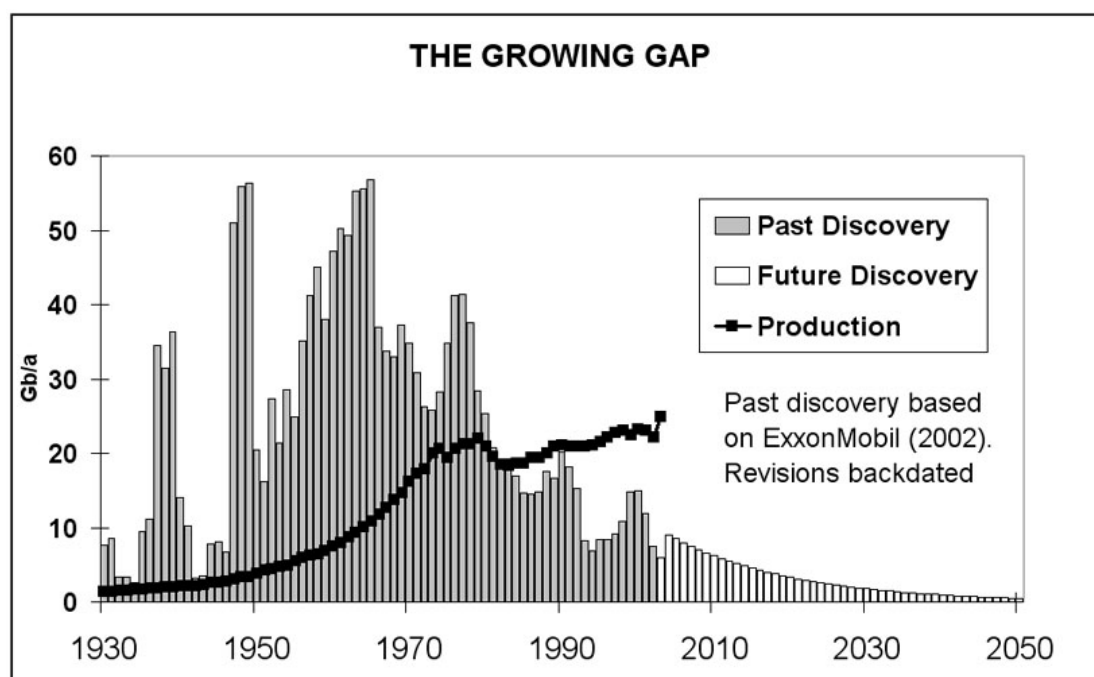
In the 1950s, a petroleum geologist named M. King Hubbert theorised that oil production in a given region would follow a bell curve, rising to a peak when approximately half of the total oil had been extracted, and thereafter gradually falling to zero. His theory was based on the observation that production from individual oil wells tends to rise to a plateau, remain relatively constant at a maximum rate for some time, and then decline fairly rapidly. Aggregating numerous such production profiles generates a rough bell curve, to which he applied a logistic probability distribution function for forecasting purposes.

In 1956, Hubbert used his model to make the highly contentious prediction that oil production in the lower 48 United States (US/48) would peak some time between 1966 and 1972 (Heinberg, 2003: 88). He turned out to be correct, the actual peak occurring in 1970, after which date production has followed a declining trend. Hubbert hypothesized that world oil supply would follow a similar bell-shaped curve, mirroring the pattern of (earlier) oil discoveries. His theory has been the subject of intense debate, particularly in recent years. Increasingly, the debate centres more on *when* the peak in world oil production will occur, and less on *whether* it will occur.

Since the late 1990s, a slew of books has been published on what is commonly called the ‘peak oil’ phenomenon, including those by Campbell (1997), Youngquist (1997), Deffeyes (2001, 2005), Heinberg (2003, 2004), Goodstein (2005) and Roberts (2005). Journal articles on peak oil include those by Campbell and Laherrère (1998), Duncan and Youngquist (1999) and Duncan (2001, 2003). All of these authors assert that oil production will follow some sort of Hubbert curve, and that the consequences of peaking for industrial civilisation will be very serious, if not calamitous.

What is the evidence underpinning the Hubbert curve? First, in the US/48, which is the most intensively explored and drilled region on the planet, oil discoveries peaked in the 1930s, while production peaked in 1970. Global new oil discoveries peaked in the 1960s and have been on a declining trend ever since. If the world curve follows the US pattern, this suggests a peak in world oil production this decade, about forty years after the discovery peak (Heinberg, 2004). According to Duncan (2003), more than half of the 44 significant oil-producing nations have already passed their individual production peaks. Moreover, Heinberg (2004: 43) reports that “[s]ince 1981, the amount of new oil discovered each year has been less than the amount extracted and used.” At present, at least two barrels of oil are consumed for every one that is discovered. Simmons (2005) argues that Saudi Arabia – the country relied upon by the rest of the world for spare capacity – may soon peak itself, signalling a world peak. Figure 1 below shows the historical patterns of conventional oil discoveries and actual production. Clearly, unless major new oil discoveries are made in the near future, production will begin to decline fairly soon.

Figure 1: Historical oil discovery and production



Source: ASPO (2005)

It is important to clarify what is meant by ‘peak oil’. It does not mean the end of oil, since the peak (according to Hubbert’s theory) occurs when approximately half of the

total oil supply has been extracted. What it means, rather, is the end of cheaply available oil, since the costs of extraction on the ‘far side of the hill’ will increase secularly while the supply declines. Moreover, demand (or desired oil) – which has been on a steadily rising trend along with population growth and economic expansion – will increasingly outstrip supply. As a consequence, the immediate implication of ‘peak oil’ is steadily rising prices of oil and its derivative products and services, along with increased volatility. Thus the third question posed above, i.e. what will happen to the oil price in the future, turns out to be the most important one in economic terms.

It is already clear that world oil production is not following a smooth, bell-shaped Hubbert curve, but has rather exhibited a somewhat ‘bumpy plateau’ since the 1970s. This is due mainly to intentional supply limitations on the part of OPEC producers, and to complex supply-demand adjustments following the oil price shocks. This is what Hubbert himself failed to predict, and partially explains why his peak forecast for world oil production (somewhere in the 1990s) was premature (the other reason being the rate at which exploration and extraction technology has improved). With oil prices rising markedly and both demand and supply adjusting, we are most likely in for a bumpy ride in the short to medium term. Eventually, however, we will reach the other side of the plateau and – according to the peak oil fraternity – begin an inexorable decline.

2.3 Reserve growth

Ultimately recoverable reserves are an economic concept, and so “as oil starts to become scarce and the price per barrel goes up, the amount recoverable at that price will necessarily also increase” (Goodstein, 2004: 29). This also applies to non-conventional sources of oil such as tar sands and shale oil. There are two main sources of reserve growth: new discoveries and better extraction methods.

Economists correctly point out that higher oil prices will stimulate increased exploration activity. However, more *exploration* does not automatically convert into significant new *discoveries*: it depends on the extent to which undiscovered oil fields still exist. Again, opinions on this matter vary greatly, even among geologists. Colin Campbell thinks that most oil has already been found (Rifkin, 2002: 29), while the USGS is (again) optimistic about future finds. Similarly, the IEA (2004: 81) forecasts rising global production to meet growing demand at least until 2030, “so long as necessary investments in supply infrastructure are made,” which they estimate will require a staggering \$3 trillion. Notably, however, the IEA’s (2004: 81) *Energy Outlook* “contains a High Oil Price Case, in which the average IEA crude oil import price is assumed to average \$35 per barrel over the projection period.” With current prices fluctuating around \$60 per barrel, one cannot have much confidence in the IEA’s projections.

As mentioned previously and depicted in Figure 1, oil discoveries peaked in the 1960s, and have been especially low since 1990. Some argue that discoveries in the 1990s were low because oil was relatively cheap and hence exploration activity was unprofitable. But the price was also low (in both real and absolute terms) in the 1950s and 1960s when most of today’s known oil reserves were found. Furthermore, the oil price has been rising since 1999, and as yet there have only been a couple of substantial finds, in Kazakhstan and off Nigeria’s coast. Historically, while some 50,000 oil fields have been discovered, nearly half of all the oil found was contained

in the forty largest oil fields (Goodstein, 2004: 16). The chances of more mega-fields being discovered seem remote, since these are the ones which are generally found early on. The one major exception, on which the optimists' hopes are apparently pinned, is that further mega-fields will be discovered in deep water, for example off the West coast of Africa. Encouragingly, ASPO's (2005) latest projection contains a significant upward revision of its previous estimate of deep water oil reserves, which pushes the peak for all liquids from 2007 to 2010. As ASPO (2005: 12) notes, "[a]nyone familiar with this forecasting will know of the many uncertainties and difficulties, but it seems best to advance step by step by reporting progress as it occurs, remembering always that it is subject to change."

Ultimately recoverable reserves may also grow as a result of improvements in drilling and extraction technologies. "The way the oil industry uses the term, the increase in recoverable oil counts as "discovery," and it accounts for much of the new discovery the USGS expects in the next thirty years" (Goodstein, 2004: 29). However, it should be noted that sophisticated technologies have been used since the 1970s, and yet the rate of 'discoveries' including backward revisions, as shown in Figure 1, has continued to decline. Nonetheless, Cambridge Energy Research Associates (CERA, 2005) recently produced a report on global oil supplies which claims that

"global oil production capacity is actually set to increase dramatically over the rest of this decade... As a result, supply could exceed demand by as much as 6 to 7.5 million barrels per day (mbd) later in the decade, a marked contrast to the razor-sharp balance between strong demand growth and tight supply that is currently reflected in high oil prices hovering around \$60 a barrel."³

One must not lose sight of the fact that the costs of extracting harder-to-access oil (e.g. deep water or heavy oils) are higher, and the higher price will have serious economic implications downstream. Moreover, the economic responses to higher prices – should they convert in practice into greater reserves – will act merely to delay the Hubbert peak, not to obviate it. Let us therefore consider the range of estimates regarding when the peak might occur.

2.4 When might the peak occur?

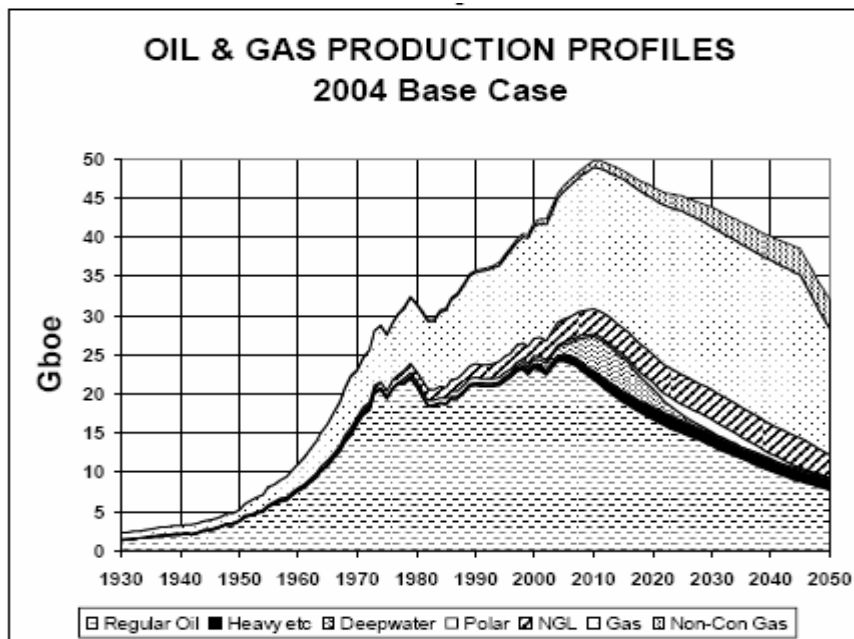
Due to disputes over the extent of ultimately recoverable reserves, estimates of the timing of the Hubbert peak vary considerably. At the pessimistic end of the scale, Campbell & Leherre's (1998) early study put the peak date at before 2008, while Duncan (2003) forecast 2006 and Deffeyes (2005) expects the peak to occur in late 2005. The Association for the Study of Peak Oil & Gas (ASPO), which is headed by Colin Campbell, publishes a revised estimate of the Hubbert curve every few months. According to its latest scenario (ASPO, 2005), regular oil (which excludes heavy oil, shale oil, tar sands, deep water and polar oil, and natural gas liquids) peaked in 2004, while all liquids plus gas are projected to peak in 2010 (see Figure 2). Most of those using the Hubbert methodology predict a peak some time between 2005 and 2016 (Heinberg, 2003).

On the other side of the spectrum, the US Department of Energy's 'mean' scenario says that oil will not peak until 2037. This assessment is based on the US Geological Survey's (USGS) estimate of ultimately recoverable reserves being 3,003 billion

³ See <http://www.cera.com/news/details/1,2318,7453,00.html>

barrels. However, the graph produced by their model (see Figure 3) shows the highly unlikely scenario of 2% annual growth until 2037 followed by 10% per annum depletion rate – an extremely steep cliff. Somewhat more realistically, although no less optimistic, CERA (2005) contends that the ‘inflexion point’, as they euphemistically call the peak, will not occur before 2020, and that there will be an undulating plateau for several decades hence, rather than a sharp peak.

Figure 2: ASPO’s Oil and Gas Liquid Fuels Depletion Scenario

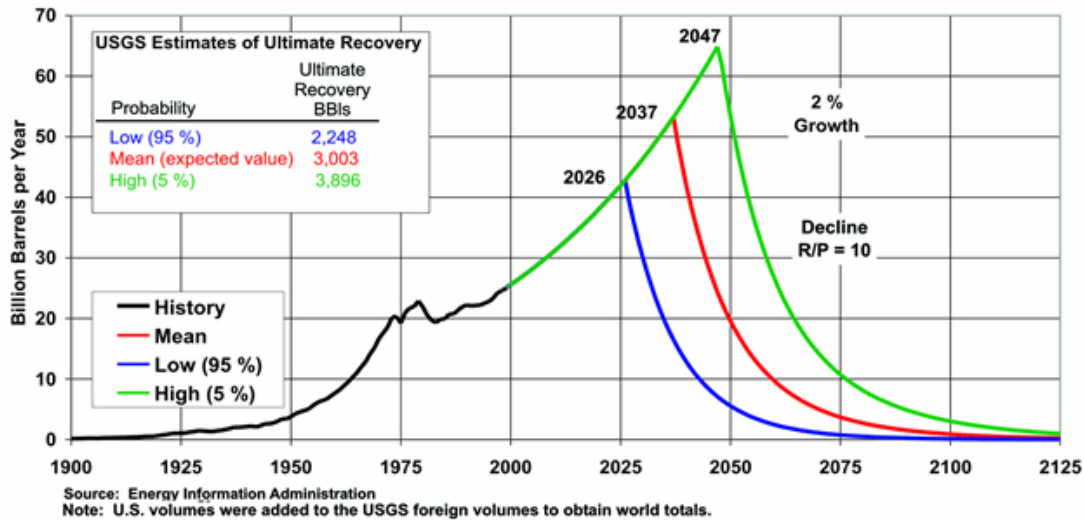


Source: ASPO (2005)

Which geologist or organisation, one might ask, is most credible? Certainly, some of the difference of opinion may be explained by individuals’ propensity for optimism or pessimism. But it is also worth considering – as economists are wont to do – who has the biggest vested interest? Individual geologists such as Campbell or Deffeyes might stand to gain from a pessimistic standpoint on peak oil through sales of their books and publicity. However, given that these individuals, as well as other peak oil pessimists, are in the vast minority, and considering that most people do not like bad news, their books are hardly best-sellers and they have put their reputations on the line in a generally hostile environment. On the other end of the spectrum, we have the US Government and the IEA, the latter being an agency of the Organisation for Economic Cooperation and Development (OECD) and thus subject to political pressure. Suppose the Bush Administration actually believed that oil would peak within the next few years. Would they have wanted to publicise this information while attempting to convince American voters and foreign governments to support the war in Iraq on the basis of weapons of mass destruction? Or would they have wanted to obscure the looming oil crisis while at the same time taking military steps to ensure their future oil supply from the region which boasts 60 percent of the world’s remaining oil reserves? It should be borne in mind that Vice President Dick Cheney was formerly the chief executive of Halliburton, the world’s largest oil service company, and hence had an inside track on oil prospects. As for consultancies, those with optimistic forecasts (such as CERA) could expect to obtain plenty of business

from oil and automotive companies (*inter alia*) whose profits would be hurt by consumers switching to non-oil based products.

Figure 3: US Energy Information Administration’s annual production scenarios with 2% growth rates and different resource levels (R/P = 10)



Source: Wood *et al* (2004)

In any event, after surveying many of the pessimistic and optimistic views on when oil production will peak, Heinberg (2004: 34) remarks that the “Age of Oil is indeed about to come to an end, by *everyone’s* estimates” (original italics). Ultimately, as Heinberg (2003) points out, the timing of the peak in world oil production will only be apparent several years after the fact, as there is likely to be considerable volatility in the years before and after the peak. The relevant questions are: what are the likely consequences and what can or should be done about it?

2.5 Conservation and alternative energy sources

Before turning to the likely consequences of the end of cheap oil, it is necessary to consider the potential of conservation measures and alternative energy sources to mitigate the impending shortfall in oil supply. There are two principal conservation strategies, namely increasing energy efficiency and reducing consumption (see Heinberg, 2003: 160-164). The scope for both of these conservation measures is large – technically if not politically. For instance, energy consumption per capita in North America is twice that in Europe, due in no small part to Americans’ notorious preference for large vehicles. Some conservation measures include reduced road speed limits, encouragement of car-pools (e.g. through dedicated highway lanes), greater use of bicycles (especially in city centres), and mundane actions such as switching off lights and heating in unoccupied rooms and buildings. Greater energy efficiency may be achieved through the use of more fuel-efficient vehicles, better building insulation (in hot and cold climates), more efficient lighting (e.g. Light Emitting Diodes and fluorescent bulbs rather than incandescent bulbs), and smarter electric power plants and industrial processes (for instance using cogeneration techniques), to name but a few.

Increasing energy efficiency over time in the US (and many other countries) is reflected in the declining ratio of energy consumption to GDP. A fairly dramatic shift took place after the 1979 OPEC oil price shock, indicating that substantial conservation gains are possible, although much of these improvements were subsequently lost when the price declined. In any case, the long-term trend is partly due to the increasing use of high-density energy sources, such as oil (relative, say, to coal). Heinberg (2003: 161) points out that “there are limits to the benefits from efficiency, since increasing investments in energy efficiency typically yield diminishing returns.” Furthermore, switching to new, more efficient technologies involves indirect energy costs, for example as new machinery or goods are produced.

Heinberg (2003) conducts a careful analysis of the potential of other energy sources (including natural gas, coal, nuclear, geothermal, hydroelectric, wind, solar power, biomass and tides) to compensate for declining oil. His prognosis is not comforting. Currently, no energy source is fully substitutable for oil, given this product’s amazing versatility as both a fuel (especially for transport) and an input in the petrochemical industry, as well as its high energy density. Certainly, electricity can be produced by substitutes such as natural gas, coal and renewable energy sources. However, a transportation network of automobiles, aeroplanes and ships on anything like the present scale is simply not feasible with existing energy technologies. Even heavy oil, tar sands and shale oil are not fully substitutable for conventional petroleum, as their costs of extraction are much higher and their energy return on energy invested (EROEI) is much lower.

Nonrenewable energy sources are by definition not a long-term proposition. In the medium term, however, they may assist a shift to renewable sources. Natural gas is also a highly versatile and efficient energy source, but its production may peak in about 20 years’ time, which has massive implications for heating, agriculture and electricity generation in its own right.⁴ Coal is highly polluting and not perfectly substitutable for oil; nevertheless, it will almost certainly be used more intensively in the future. Nuclear power is extremely costly up front, and as yet no solution to toxic waste has been found. Nevertheless, nuclear power plants may become more fashionable as oil prices rise, but it will take “at best a decade or more for the new power plants to come on line” (Goodstein, 2004: 19). Geothermal power, some of which is renewable, is in any event very limited geographically and in energy potential.

The renewable sources of wind, hydro and solar have much potential for electricity generation and are generally clean. However, they all come with some costs, and together they are unlikely to be able to support the current scale and kind of socio-economic structure enjoyed by industrial societies, especially in terms of transport. Biomass is highly polluting and contributes to deforestation if used on a large scale, while biodiesel and ethanol generally yield negative net energy. Finally, hydrogen is an energy carrier, not a primary source, and would require a very different infrastructure and thus be expensive to adopt (Heinberg, 2003).

Clearly, technological improvements are an unpredictable wildcard; it is conceivable that major strides will be made within a short time period when the incentives are

⁴ For a full discussion of natural gas, see Darley (2005).

adequately strong (i.e. when the price of fossil fuels is sufficiently high). But relying on possible short-term technological fixes on a massive scale seems imprudent at best and wishful thinking at worst. Heinberg (2003: 164-65) summarises the situation thus:

“[i]f there is any solution to industrial societies’ approaching energy crisis, renewables plus conservation will provide it. Yet in order to achieve a transition from nonrenewables to renewables, decades will be required – and we do not have decades before the peaks in the extraction rates of oil and natural gas occur... the transition will necessarily be comprehensive: it will entail an almost complete redesign of industrial societies.”

2.6 Likely consequences of ‘peak oil’ for international trade

While the economic impacts of peaking oil production are likely to be wide-ranging and deep, the focus of the present paper is on implications for international trade. The following subsections outline some possible consequences of the looming energy crisis first for global economic prospects, and then for three key sectors – transport, agriculture and manufacturing. The penultimate subsection summarises the possible effects on the structure of international trade. This is followed by a discussion of geopolitical risks related to oil depletion and how they may impact on trade. The analysis is necessarily tentative, and one of the main points this paper attempts to make is that much more attention needs to be invested in assessing the economic (and social) implications of oil depletion.

2.6.1 Global economic prospects

A steadily rising oil price will clearly create inflationary pressures across the globe and put a brake on economic growth. According to ABSA (2004: 1), “a \$10 per barrel increase in the price of oil will, over the course of a full year, raise the global inflation rate by about 0,5% and dampen economic growth by roughly 1%.” At least in the near term, whether or not higher oil prices cause an outright recession depends to a large degree on the monetary policy response by central banks. If central banks allow the higher energy prices to work through the system, then the increasing scarcity of fossil fuels will manifest appropriately in altered relative prices. A rise in energy prices would most likely be a stimulus to investment in both fossil fuel energy (e.g. greater exploration for new oil and gas fields) and renewable energy sources. This investment could serve to boost economic growth (or at least ease the decline).

Much depends on how sustained the oil price rises are, and how quickly they rise. If energy prices rise steeply, central banks may have no option but to counter inflationary pressures, as hyperinflation would possibly be a greater evil. If central banks around the world raise interest rates sharply, this may induce an international recession. Consumers will already be curbing spending as a result of higher energy prices (and second-round price increases for energy-intensive goods and services), and if this demand reduction is exacerbated by higher interest rates, which also depress investment, the economic situation could deteriorate rapidly. Indeed, some studies have shown that the economic recessions following the oil shocks in the 1970s were more the result of contractionary monetary policy than of the oil price increases themselves (Bernanke, Gertler & Watson, 2004).

In the longer term, mainstream economists would tend to argue that the price mechanism will ensure a relatively painless transition to fossil fuel substitutes if and

when oil becomes sufficiently scarce. Therefore, they would not advocate policies to wean countries off fossil fuels (e.g. by subsidising renewable energy sources), but rather rely on the market mechanism. “But as we learned in 1973,” writes Goodstein (2005: 18), “the effects of an oil shortage can be immediate and drastic, while it may take years, perhaps decades, to replace the vast infrastructure that supports the manufacture, distribution, and consumption [of oil]”.

We have some experience of the effects of supply-driven oil price shocks, especially those in 1973 and 1979, which resulted in worldwide economic recessions. What will be different after the peak in oil production is passed is that the price will never retreat to earlier levels, as it did previously. In other words, on the down-slope of the Hubbert curve the world faces an endless sequence of supply-side oil shocks. The US Department of Energy (DOE) commissioned a report on the peak oil situation by Hirsch *et al* (2005: 4), who conclude that:

“The peaking of world oil production presents the U.S. and the world with an unprecedented risk management problem. As peaking is approached, liquid fuel prices and price volatility will increase dramatically, and, without timely mitigation, the economic, social, and political costs will be unprecedented. Viable mitigation options exist on both the supply and demand sides, but to have substantial impact, they must be initiated more than a decade in advance of peaking.”

To begin to see why this is so, let us consider some sectoral impacts of falling oil supply and rising price.

2.6.2 Transport

The sector that will be most immediately and most obviously affected by oil shortages is the transport sector, which will experience rising costs and increased volatility. Clearly, this sector is critical to the international goods trade. As mentioned in the introduction, the rapid growth in goods trade over the past few decades has been fuelled (literally) by cheap oil. Rising oil prices will make long-distance trade relatively less competitive than local trade. Shipping, truck and diesel locomotive freight will be most directly affected by rising oil prices, but even electrically powered freight trains will suffer since all energy prices are likely to rise as less net energy is available. Uncertainty arising from oil price volatility is likely to put an additional brake on international trade flows as it will raise the risks faced by importers and exporters.

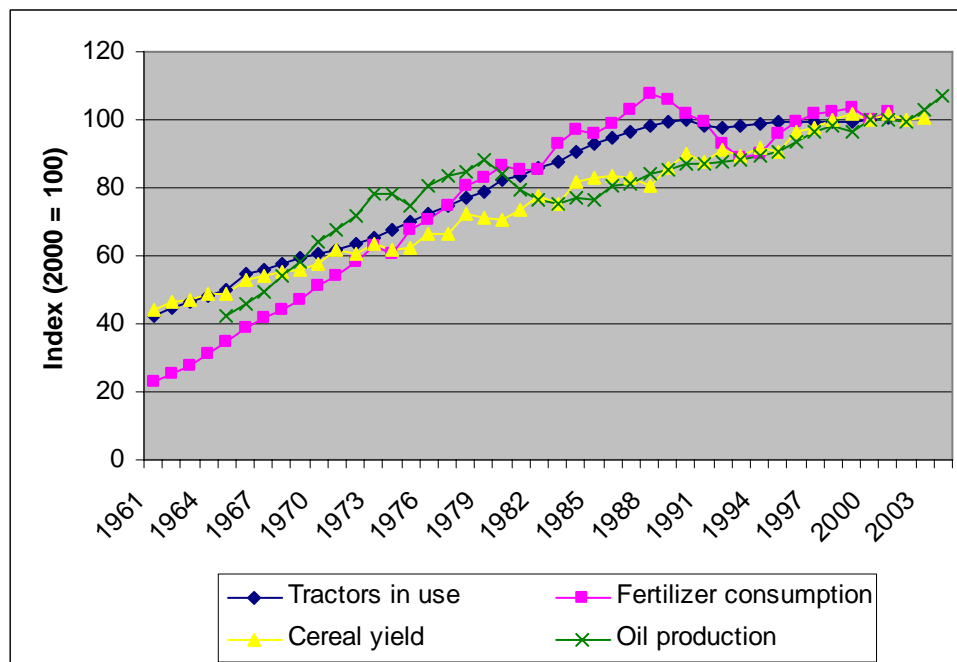
2.6.3 Agriculture

Just as for energy, growth in the world population and per capita incomes are raising the demand for food. The population growth rate has recently begun to decline, but annually some 80 million people are still added to the world population. China and India’s rapid industrialisation means that their populations are gradually moving up the food chain, increasingly demanding more resource-intensive items beyond traditional staples such as rice and wheat.

On the supply side, global food production per capita has been rising since the industrial revolution began, and especially since the so-called ‘green revolution’ of the 1960s when chemical fertilizers, herbicides and pesticides began to be used extensively in developing countries. Figure 4 below shows how world grain yields

have increased over the past half century in tandem with key inputs (e.g. use of fertilizers and tractors). The upward trends are broadly consistent with the trend in oil production. The levelling off of tractor and fertilizer use since about 1990 probably reflects a slowing rate of expansion of arable land.

Figure 4: Cereal yield, agricultural inputs and oil production, 1961-2004



Source: FAO (2005), BP (2005)

Commercial agriculture, particularly in OECD countries, is highly mechanised and therefore critically dependent on oil. Moreover, fertilizers and pesticides are produced from oil and natural gas, and so diminishing supplies of these fossil fuels will result in falling yields. Global meat and fish production per capita have also been rising steadily since 1960. As with grains, however, these foodstuffs are also partially dependent on fossil fuels, especially oil, since livestock and aquaculture require feed (which is grown using fertilizers, etc.) and the marine fishing fleet relies on oil for fuel. We can thus expect significantly falling agricultural production and rising food prices after oil production peaks. Currently, only a handful of countries (including the US, Canada, Australia and New Zealand) are significant net food exporters. Their exportable surplus will shrink at the same time as importing countries will require even more produce from abroad. On the other hand, the shifting terms of trade in favour of agricultural products may in fact benefit small-scale producers in developing countries who do not rely heavily on oil, and food exporting countries in general. However, rising transport costs will add to food price increases and reduce the overall volume of international agricultural trade. This will bring serious food security concerns, especially for food-importing countries. Even food-exporting countries will need to be prudent about how much they export, and the diversity of their agricultural production.

To make matters worse, the biological base for food production across the globe is deteriorating, as documented by Brown (2001). This includes falling water tables as aquifers are overdrawn, declining quality of rangelands, loss of arable land due to spreading urban centres, salinisation and soil erosion, and declining fish stocks.

According to Brown (2001: 50), “[a]n estimated 36 percent of the world’s cropland is suffering a decline in inherent productivity from soil erosion.” Furthermore, “[w]orldwide, almost half of all grasslands [which support livestock] are lightly to moderately degraded and 5 percent are severely degraded” (Brown, 2001: 60). According to Halweil (2005: 26), “roughly two thirds of the world’s major [marine fish] stocks are now fished at or beyond their capacity, and another 10 percent have been harvested so heavily that fish populations will take years to recover.” These forms of environmental degradation and over-use have yet to impact on global per capita food production, but that does not mean that they never will; simply extrapolating past trends is a very naïve method of forecasting.

As in the case of fossil fuels, we must consider whether new sources or forms of food production are likely to offset falling per capita agricultural volumes in the future. Aquaculture is a much-vaunted industry which has indeed been growing rapidly in recent years and now comprises approximately 30 percent of fish production (Halweil, 2005: 27). However, aquaculture itself requires inputs in the form of land-based food resources, and so there is no free lunch for fish (or free fish for lunch).

A more controversial development of recent years is the biotechnology industry. Smith (2004) documents evidence to show that in contrast with claims and advertising from the biotech companies, the science of genetic engineering is still very poorly understood, with significant health risks attached. Claims that genetically modified (GM) crops have much higher yields are contested; and in any case they are still overwhelmingly dependent on fossil fuels in the form of mechanisation, fertilizers and pesticides. Furthermore, biotechnology promotes monoculture crops, which are more susceptible to plagues and therefore carry greater risks of disaster. Perhaps most serious, biotech companies are aiming for complete control of the world’s seed stocks through patenting. This has massive implications for food security across the world, if control over the food base is captured by a handful of multinational corporations. The European Union and many African countries have thus far resisted GM foods for these reasons, with the result that some GM crops (e.g. maize) sell for much less than their non-GM counterparts.

2.6.4 Manufacturing

The volume of manufacturing production will also be affected by rising oil prices. Goodstein (2004: 15) writes that “ninety percent of the organic chemicals we use – pharmaceuticals, agricultural chemicals, plastics – are made from petroleum”. The list of everyday consumables that rely on plastics is astounding: according to Bell (2005: 17), “[n]inety percent of the past holiday season’s gifts [in the US] contained plastic material in some form or the other, right from dolls, toys, bicycles, helmets, DVDs, CDs and games, to packaging material used for wrapping gifts, like cellophane, plastic wires and plastic peanuts.” Bell goes on to list some common plastic products, including “Celluloid, Bakelite, Cellophane, Nylon, PVC, Saran, Teflon, polyethylene, Silly Putty, and Velcro”. The petrochemicals industry will clearly be hard hit by declining oil volumes and rising prices. Moreover, factories are overwhelmingly powered by electricity, but most of this electricity is produced from fossil fuels. North America in particular is highly dependent on natural gas (and to a lesser extent oil) for electricity generation.

2.6.5 Restructuring international trade

In all of these sectors, then, declining oil supply will most likely lead to falling production levels and rising prices. As a result, the aggregate volume of international trade flows is likely to decline significantly as demand drops, although the effects on trade revenues will depend on elasticities. If peaking oil production triggers economic recession, as seems likely, this will further reduce trade flows.

Furthermore, we can expect shifts in the terms of trade and in sectoral patterns of trade. In general, all energy-intensive production and services will increase in price but decrease in volume relative to non-energy-intensive activities. Labour-intensive sectors will benefit while capital-intensive sectors will decline. Primary commodities (especially agricultural products, but other resources as well) are likely to become relatively more expensive. International (as well as domestic) tourism will be less attractive and affordable as air fares and other travel costs mount. The airline and automobile industries are already experiencing serious financial difficulties, at least in the United States (for example, both General Motors and Ford have reported losses of over \$1 billion this year, while several airlines have filed for bankruptcy). Some sectors will no doubt benefit from the rising energy costs. In particular, telecommunications is likely to receive a boost as physical commuting is curtailed. Similarly, intra-industry trade will make less and less economic sense (it is doubtful whether it ever made ecological sense, if one factors in externalities such as greenhouse gas emissions and other forms of pollution).

Perhaps most significantly, the down-slope of the oil curve may force the globalisation process – at least in terms of goods trade – to reverse. Increasingly, local production and consumption will become more competitive relative to the current highly globalized system of trade. Although sacrificing efficiency – at least as conventionally measured, i.e. ignoring environmental and social externalities – such a move toward localisation could bring substantial socio-economic benefits to many regions, especially poorer ones. It could, for example, encourage more labour-intensive local production, thereby helping to reduce unemployment rates, inequality and poverty. However, this positive outcome depends critically on whether production patterns can change quickly enough to avoid systemic recession or depression as energy prices rise.

2.6.6 Geopolitical risks

The continued globalisation of trade is also threatened by geopolitical risks. Competition over dwindling energy and food resources looks set to increase dramatically in the years ahead, with the US and China in particular appearing to be on a collision course. This may well precipitate trade wars in the future. More seriously, in a worst-case scenario – which Heinberg (2004) for one sees as the most likely outcome – the occurrence of military wars over resources may rise. As the world's military and economic superpower, the path taken by the US will affect the entire globe. US foreign policy under the Bush Administration has been stridently unilateralist, evidenced most clearly by its invasion of Iraq without United Nations approval. Engdahl (2004) makes the case that not just the latest Iraq war, but also the First and Second World Wars, were fought – at least in part – over access to oil reserves. ABSA (2004: 4) states that the “Iraqi war may be the first of a series of conflicts over global oil resources.” It goes without saying that wars will disrupt trade,

to an extent which depends on their geographical coverage, but especially if they involve disruptions to oil supply.

It is also reasonable to expect an increase in international terrorist activity in the future. As long as the US-led coalition retains its forces in Iraq, it will continue to foment geopolitical tensions. With over 60 per cent of the world's officially remaining oil and gas reserves, the Middle East will most likely see a rising amount of foreign interest and involvement by major energy-importing nations. Partly as a result, radical Islamization is on the rise, with Iran in the vanguard, and this poses a huge threat to oil-dependent Western nations (see Rifkin, 2002). According to ABSA (2004: 2), "[i]n Saudi Arabia, terrorist attacks on oil installations have highlighted the intentions of Al-Qaeda to disrupt oil exports from that country, raise oil prices and thereby damage the economic interests of the industrial countries." Britain, at least, appears to be taking this threat seriously. A recent report entitled "Britain's Energy Future: Securing the Home Front" (Plesch, Austin & Grant, 2005) has garnered support from the Deputy Prime Minister, John Prescott. The report recommends 'energy wardens' to police conservation measures in a bid to reduce Britain's dependence on oil imports from the Middle East.

As Roubini (2005: 1) argues, "terrorism is an important geostrategic risk that affects the global economy and financial markets." For instance, following the London terror attacks on 7 July 2005, stock markets and currencies of geopolitically vulnerable countries such as the UK and US took a knock. As Roubini (2005: 1) puts it, "[t]hese market reactions are also consistent with the expected economic impacts of terrorism: by reducing confidence and increasing the risk aversion of consumers and firms, terrorism also leads to lower consumption and lower real investments; it can thus trigger an economic slowdown if not an outright recession." This perspective is borne out in reality in the effects of the 9/11 attacks in New York, whose resulting "loss of confidence had an adverse self-reinforcing effect on growth in the United States and Europe" (Brück & Wickström, 2004: 3-4, citing Baily, 2001).

In addition to such broad economic repercussions, terrorism has already impacted directly on trade through its effects on the airline and tourism industries. For example, many airlines around the world have experienced financial problems following the September 11 terrorist attacks. This is mainly attributable to a sharp rise in risk aversion amongst potential travellers. Another way terrorism might affect trade is through heightened security threats at key infrastructure terminals, especially ports and airports. This will become even more of a concern if and when natural gas shipments increase to substitute for declining oil supplies, since gas is inherently less stable and hence more vulnerable to bombs. More generally, Brück & Wickström (2004) note that the policy responses to terror attacks raise transaction costs for international (and domestic) trade. One study, by Nitsch and Schumacher (2004), finds that "a doubling of terror incidents reduces bilateral trade by 4 per cent" (Brück & Wickström, 2004: 6). Roubini (2005: 3) goes as far as to say that "[t]errorism could have long-term consequences if it leads to a slow-down or reversal of globalisation."

3 Climate Change

A second category of risks to global trade, also within the realm of environment and resources, are those posed by global warming and climate change. The majority of scientists researching the issue agree that the Earth is warming and that it is highly probable that much of this warming is human-induced through the burning of fossil fuels (see IPCC, 2001). The evidence of global warming is mounting day by day: icecaps and glaciers are melting (e.g. the Arctic sea ice has shrunk considerably and in summer no longer covers the North Pole), and air and sea temperatures are rising. The effects of global warming on the Earth's climate are already evident, manifesting in increasing prevalence and severity of heat waves, droughts, floods and storms. The subject of climate change is vast, and its potential economic impacts are complex, wide-ranging and uncertain. Nevertheless, some speculations as to possible impacts of climate change on international trade are offered below.

Agriculture is one of the sectors most vulnerable to climate change. Although some regions (especially cooler areas such as northern Canada, Europe and Asia) may actually benefit from climate change in terms of agricultural productivity, Brown (2003: 62) states that on balance, climate change is expected to reduce crop yields on a global scale. Indeed, some crops – such as grapes and maize – are highly vulnerable to higher than average temperatures.⁵ Less stable and more extreme weather means greater susceptibility to droughts and floods, as well as greater uncertainty inhibiting agricultural investment. Furthermore, the melting of glaciers threatens stable water supplies for agriculture (as well as industry and private consumption) in some areas. In addition, rising sea levels may compromise agricultural production in some critical regions, such as low-lying southern Bangladesh, which produces about half of that country's rice (Brown, 2001: 36). Some regions are already experiencing worsening droughts, such as Southern Africa, the Sahel in North Africa and northwest China. At present there is evidence of an impending famine in Southern Africa, which has been estimated by the United Nations to affect some 10 million people (Sunday Independent, 2005a).

Global warming may also threaten fish stocks. British scientists recently warned that carbon dioxide is dissolving in the oceans and raising their acidity level, and that this may threaten the existence of zooplankton, the basis of the entire marine food chain (Weekend Argus, 2005). It is already widely known that coral reefs, which support an abundance of fish species, are dying off due to warmer sea temperatures.

Overall, climate change increases vulnerability and threatens water and food security in many regions. Thus, as far as international trade is concerned, climate change is likely to exacerbate the effects of oil depletion and declining agricultural production discussed in the preceding sections.

In addition, the increasingly destructive power of storms has negative implications for infrastructure supporting international trade. This includes both shipping activity as well as energy supplies. The latter issue has been highlighted recently by the effects of hurricanes Katrina and Rita on oil production and refining facilities in the Gulf of Mexico, and consequently on oil prices. According to Emanuel (2005), hurricanes in

⁵ See Sunday Independent (2005b).

the Gulf of Mexico have increased markedly in duration and intensity over the past thirty years, just as measured surface sea temperatures have risen as a result of global warming. Weather disruptions such as these would also tend to increase uncertainty surrounding trade logistics and the economic costs associated with this. In the longer term, rising sea levels resulting from melting glaciers and polar icecaps as well as thermally-driven expansion of the oceans may threaten port infrastructure around the world, particularly in low-lying areas such as Western Europe. At the very least, this is likely to raise the costs of shipping.

Furthermore, destruction caused by storms means that more resources have to be diverted to reconstruction efforts. For example, a US Congressional team estimated the costs of rebuilding New Orleans after the destruction wrought by Hurricane Katrina to be in the order of \$150 billion, which represents nearly one third of the US budget deficit and one fifth of its trade deficit in 2004. Hurricanes Rita and Wilma each caused estimated losses of around \$10 billion.⁶ Such huge costs will place an increasing burden on the US's twin deficits, which are the subject of the next section.

Global warming may inhibit trade in a more indirect manner as well. The climate change issue is an increasingly prominent part of the mainstream political, economic and policy discourses. For example, British Prime Minister Tony Blair has recently championed climate change mitigation, most visibly in his chairmanship of the G8 countries this year. Although the Kyoto Protocol's target of a 6% reduction in 1990 emission levels are currently extremely modest in relation to the scale of the problem, and the US has thus far refused to ratify the agreement, this may change in the future. If significant CO₂ emission reductions do materialise, this will almost certainly constrain economic activity in industrialised countries and thereby reduce the amount of foreign trade.

The discussion of Peak Oil raises questions about the validity of long-term climate change forecasts, which assume continued economic growth and rising emissions. If indeed the peak turns out to occur in just a few years' time, this may imply that carbon dioxide emissions will decrease irrespective of mitigation policies such as voluntary emission reductions or those agreed to under the Kyoto Protocol. On the other hand, increasing reliance on coal – especially by developing countries such as China and India that are not bound by the Protocol – which produces more CO₂ per energy unit than oil and gas, may mean increasing net emissions. Either way, however, it may be that the process of global warming already has sufficient momentum that possible reductions (whether voluntary or involuntary) will not curb the effects on the climate in a substantial manner. Scientists have recently hypothesized that there may be a tipping point in the melting of Arctic sea ice, after which the warming process will be irreversible (The Star, 2005). This is because as the ice melts, the amount of sunlight reflected by the ice decreases, and more energy gets absorbed by the darker ocean. The release of methane gas from thawing tundra presents a similar positive feedback loop. The South African Department of Environmental Affairs and Tourism (2004: iv) notes that, “[a]ccording to the IPCC Third Assessment Report, climate change is already happening, and will continue to happen even if global greenhouse gas emissions are curtailed significantly in the short to medium term.”

⁶ Independent Newspapers (2005).

Clearly, climate change and its effects are fraught with uncertainty, and yet the enormity of the issue is becoming increasingly apparent. This suggests that more attention needs to be given to assessing its possible economic effects and the range of potential adaptation and mitigation strategies that can be adopted. Some such options will be discussed in section 6, but before then we consider the third major risk to world trade, namely global monetary imbalances.

4 Global Monetary Imbalances and the US Economy's Unsustainable Trajectory

Accounting for nearly a quarter of global GDP, the US economy – which is dominated by consumption spending – drives world growth. In recent years, the sustainability of the US's massive and growing twin deficits (i.e. its budget and current account deficits) has become an increasing source of concern amongst macroeconomists.⁷ The Federal budget, which was in surplus by the end of the Clinton Administration, has been negative and growing since 2001. The two main reasons for the expanding fiscal deficit are President Bush's huge tax cuts, and the costs of financing the wars in Afghanistan and Iraq and the 'war on terror'.

The current account deficit, on the other hand, has been growing since the early 1990s, and reached a massive \$660 billion (5.7% of GDP) in 2004 (Obstfeld & Rogoff, 2005). Two-thirds of this amount was effectively financed through loans provided by the world's central banks at low interest rates (Roubini & Setser, 2005: 2). China, Japan and other Asian countries are increasing dollar and US Treasury holdings so that they can continue to export large volumes of goods to the US. Meanwhile, OPEC countries are stockpiling dollars – and increasingly euros – received from their windfall oil exports. And Europe is helping to prop up the dollar so as not to lose too many jobs. The system whereby Asian countries peg their currencies to the US dollar and effectively finance American consumers has been referred to as 'Bretton Woods II' (Roubini & Setser, 2005: 2).

Given the artificially low value of Asian currencies in this Bretton Woods II system, there is a risk of increasing protectionist backlashes in OECD countries (especially the US and EU) to cheap Asian imports, most especially from China. Both the US and EU already impose quota restrictions on Chinese clothing and textile imports. Roubini & Setser (2005: 14) argue that "the U.S. politically cannot allow its manufacturing base to decline as sharply as a sustained Bretton Woods 2 system would imply, particularly since Chinese production is moving up the value-added chain." American and European voters' jobs are in increasing jeopardy, and rising unemployment and casualisation of work opportunities is eroding living standards at the lower end of the income distribution in many OECD countries.

⁷ This concern is evidenced in the number of papers being written on this topic and circulated on the Internet, as well as attention in the weblogs of some prominent macroeconomists, which are too numerous to list here. Many of the papers have been written this year and have yet to appear in published journals. See, for example, Obstfeld and Rogoff (2005), Roubini and Setser (2005), and papers available at: <http://currentaccount.lafollette.wisc.edu/>.

Added to the twin deficit problems in the US are immense levels of private and national debt, and signs of a possible housing market bubble. The private savings rate is extremely low, and many American households have taken advantage of historically low interest rates to re-mortgage their houses in order to finance current expenditure.

If indeed the US economy is on an unsustainable path, an important question is what events could trigger a correction? Four main risk factors can be identified, two of which emanate from within the US itself, while the other two are international in nature. First, US interest rates have been rising steadily over the past two years, and if this trend continues – which seems likely given inflationary pressures from high oil prices – it may at some point burst the property bubble and cause a debt crunch for consumers. This would lead to a substantial drop in demand. Second, rising costs associated with natural disasters are placing increasing strain on the Federal (and State) budgets. As mentioned earlier, estimates of the costs resulting from the three recent hurricanes run into the tens – if not hundreds – of billions of dollars.

Third, there is an increasing risk of a collapse in confidence in the dollar as international reserve currency. At some point, countries like China, Japan and South Korea may decide that the exposure risks of continuing to support the dollar outweigh the benefits in terms of boosting their exports, in which case they would limit their purchases of US Treasuries (Roubini & Setser, 2005). Roubini & Setser (2005: 3) argue that “the current renminbi-dollar standard is not sustainable: the scale of the financing required to sustain the US current account deficits is increasing faster than the willingness of the world’s central banks to continue to build up their dollar reserves” and that “there is a meaningful risk the Bretton Woods 2 system will unravel before the end of 2006.” A similar situation faces the European Central Bank, although in this case political considerations are probably as important as economic ones: Europeans are growing weary of indirectly financing America’s war in Iraq and its citizens’ excessive consumption. Moreover, certain significant oil producing nations (including some OPEC nations and Russia) may decide to switch the denomination of their oil exports to Euros. Iran is probably one of the most likely suspects in this regard, given its mutually hostile relationship with the US.

Fourth, rising oil prices are putting additional strain on the US’s trade balance, since the majority of their oil consumption is imported. Even if the US economy manages to keep going for several years, it will eventually encounter the effects of peaking oil production, which, as we saw earlier, may occur as soon as 2010. That event is likely to be the final straw for both consumers and the government. While there is significant potential for energy savings, the US Government is clearly not (yet) following a policy of energy conservation. The neo-conservative Bush Administration has instead opted to use its military to ensure continued access to oil resources, most obviously in the Middle East. The costs of maintaining this military presence may rise in the future as imported sources of oil become increasingly important, which will compound its current account imbalance.

All in all, the weight of evidence suggests that the US economy is on an unsustainable trajectory. The landing, when it comes, may be ‘soft’ and drawn out, but the more time elapses and the greater the deficits and debts become, the higher the likelihood of a sharp adjustment and overshooting. What would be the implications of a hard

landing? One immediate result would clearly be a significant devaluation of the dollar and a consequent fall in US imports. Given that the US is the world's foremost importer by far, this would hurt many exporting countries, especially those in East Asia. More seriously, if there is a collapse of property and consequently equity prices in the US, this would lead to curtailed investment and economic recession. It is not inconceivable that such a slump in the US would induce a worldwide recession. Given the dollar's status as international reserve currency, this might in turn cause a worldwide systemic financial crisis and possibly even another Great Depression.

5 Economic and Social Implications for South Africa

We now turn to consider the implications of the risks to global trade for South Africa, based on this country's socio-economic profile. The discussion is again tentative due to the complexity and uncertainty of the situation. At the very least, the likelihood of some very serious negative outcomes seems high enough to warrant more detailed and rigorous investigation and debate. Of particular concern is the impact on the poor, who are likely to suffer far more than their more well-off compatriots. While the potential implications of the risks are very diverse, this section focuses on five important socio-economic spheres, namely trade, other macroeconomic effects, energy and food security, and social stability.

5.1 Trade

The main consequences for international trade of the risks identified in the preceding three sections may be summarised as follows: higher transport costs, lower agricultural and manufacturing production, and reduced overall demand following the global peak in oil production; increased transaction costs and uncertainty due to the effects of climate change; a reduction in world demand for exports as a result of US current account rebalancing; higher transactions costs because of terrorist threats; and increased protectionism in response to both geopolitical tensions and economic fallout from the other factors. Together, these factors are likely to reduce the overall volume of international trade, and also to alter the sectoral composition and terms of trade. The impact of these two effects on South Africa will be discussed in turn.

In common with many other developing countries, export orientation is a key aspect of South Africa's growth strategy. Exports in 2004 comprised 26.6 per cent of GDP (SARB, 2005). A significant reduction in global trade therefore puts an export-led development path potentially at risk. In general, South Africa will have to become more self-sufficient in a range of sectors if or when international trade becomes relatively more expensive. Higher transport and other transaction costs will tilt the balance between tradeable and nontradeable sectors in favour of the latter. This is especially true for South Africa given its considerable distance from its main trading partners (Europe, the US, the United Kingdom and Japan). Trade with more proximate countries will also suffer, however, given the high costs of land-based freight transport, especially in Africa. On the plus side, more costly international trade presents South Africa with significant import substitution opportunities. This applies across the board where the costs of international trade rise, but is especially pronounced in certain sectors where South Africa has comparative advantage.

As far as sectoral impacts are concerned, as mentioned in section 2 peaking oil production is likely to shift the terms of trade in favour of primary commodities (e.g. minerals and agricultural products). In periods of economic downturn and inflation, resources such as gold and other minerals tend to do well, and South Africa is clearly well placed in this regard. This resource endowment buffered the South African economy to some extent from the 1970s oil shocks. However, minerals today comprise a much smaller portion of both exports and GDP and South Africa's economy is considerably more open than was the case in the 1970s. Nonetheless, South Africa is presently the world's third-largest coal exporter and has the seventh largest coal reserves in the world. Much of these coal exports go to Europe, while some are destined for neighbouring countries in Southern Africa. The coal and uranium mining and electricity generation sectors are likely to benefit from higher energy prices in the future, and will to some extent balance the effects of higher oil import costs. However, the DEAT (2004: iv) cautions that South Africa's coal and mining sectors are vulnerable to the steps taken by developed countries to mitigate climate change through reducing greenhouse gas emissions.

In addition, the costs of transporting our raw materials (such as agricultural products and mineral ores) to ports for export are very substantial. According to the IEA (2004: 178), for instance, "transport costs account for a large share of the total delivered price of coal". In December 2003, mining and quarrying products together with coke and petrochemical products accounted for 42 per cent of goods transported by road by private sector enterprises in South Africa, based on tonnage (StatsSA, 2004). On the positive side, government's recent desire to see more domestic beneficiation of minerals and metals is likely to be given a boost by rising transport costs.⁸ The domestic petrochemicals industry relies partly on coal for feedstock in addition to crude oil, and thus may better withstand higher oil prices than in other countries.

Agriculture currently accounts for a very small share (around 5 per cent) of South Africa's exports. The long-term decline of this sector has mirrored the international situation, in which world food exports as a proportion of total merchandise exports decreased from 19.8 per cent in 1962 to 7.2 per cent in 2002 (World Bank, 2004). As will be seen below, South Africa may experience falling agricultural production in the coming years due to climate change, and therefore this sector's contribution to export revenue is likely to decline further.

Finally, South Africa's tourism and hospitality sector will suffer reduced revenues as international transport becomes more expensive – particularly considering South Africa's distance from wealthier nations whose citizens can (at least now) afford to travel. This puts in jeopardy the recent growth of this sector, which recently surpassed gold mining in terms of export revenue.

5.2 Other macroeconomic effects

The overall effect of the preceding sectoral shifts on South Africa's balance of payments is hard to predict. While manufactured export revenues are likely to fall, these may be counterbalanced to some extent by rising receipts in the mining and possibly agricultural sector (provided the country is still able to produce significant quantities for export in the face of climate change and oil depletion). While the rising

⁸ I owe this point to Anthony Leiman.

cost of oil imports may impose severe balance of payments constraints on some oil-importing countries, particularly in a milieu of reduced trade, South Africa is in the fortunate position of not being overly dependent on oil imports. This is due in small part to modest domestic oil and gas reserves and in large part to Sasol's successful synthetic fuels industry, which exploits our abundant coal reserves. Sasol is the largest synthetic fuels producer in the world (ABSA, 2004: 3). Oil constituted only 10 per cent of South Africa's energy needs in 2002, and imported oil currently makes up about 60 per cent of South Africa's annual liquid fuel consumption (EIA, 2005). Nonetheless, oil imports constitute approximately 6 per cent of total imports and are the single largest import item (ABSA, 2004: 5). As mentioned above, a rising oil import bill will be partially offset by higher coal exports.

Another critical factor in South Africa's future trade prospects is the path taken by the rand exchange rate. A gradual weakening of the dollar against other currencies as the US current account rebalances (as surely it must eventually do) could strengthen the rand, which has stronger bonds with the Euro. However, if the US economy experiences a hard landing with a sharp dollar depreciation, as mentioned in section 4 this could trigger the withdrawal of portfolio investment from emerging markets, including South Africa, which are considered by investors as inherently risky. Perceptions of risk in SA are magnified by its complex socio-economic problems, including HIV/Aids, poverty, and political and social unrest (of which there has been increasing evidence this year, not least surrounding the indictment of Jacob Zuma on corruption charges). In addition, fluctuating oil prices may cause a certain amount of exchange rate instability. Greater volatility would exacerbate uncertainties for exporters and importers alike, and thus hamper both trade and investment.

Experience has shown, especially in 2001-2, how a sharp depreciation in the rand exchange rate can cause a rapid rise in domestic price inflation. A second important inflation risk is rising fuel costs and associated second-round price effects, driven by higher crude oil prices. According to ABSA (2004: 5), "with a USD/ZAR exchange rate of R6,50, a \$1 per barrel rise in international oil prices raises local petrol prices by about 8 cents per litre." Given the strict inflation targeting framework being pursued by the South African Reserve Bank (SARB), realisation of either or both of these inflationary pressures would most likely prompt an interest rate hike. This in turn would inhibit consumer demand, investment and economic growth. Indeed, the SARB has recently indicated that it may raise the repo rate towards the end of 2005 as a result of concerns about the inflationary impact of high oil prices. As argued in section 2, this sort of response is likely to exacerbate the adverse impact of oil price shocks, and to mask important relative price changes by dampening overall demand.

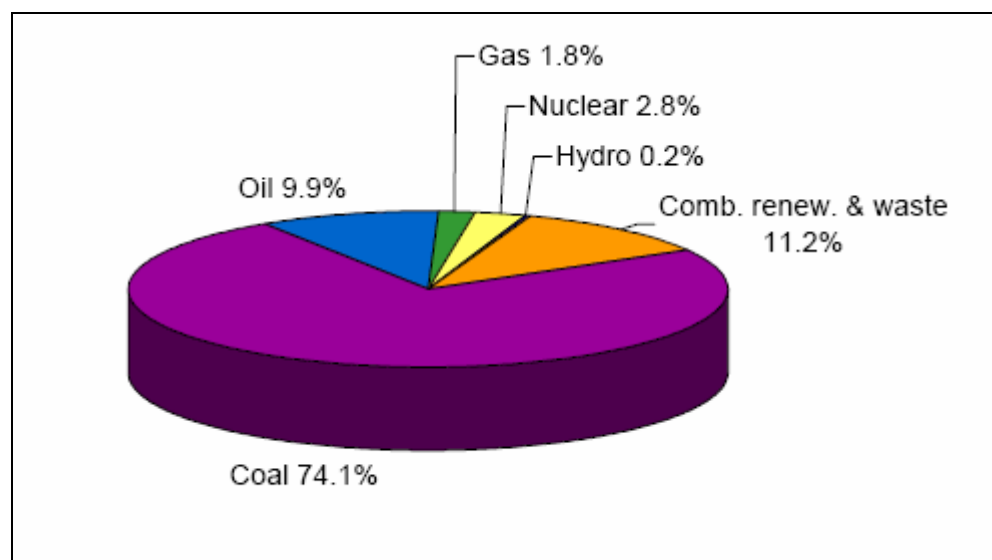
The medium-term prospects for economic growth and employment hinge on many factors, not least of which are when the peak in world oil production passes, and whether the correction of global monetary imbalances results in a world-wide recession. When the US dollar does finally adjust, we can expect a significant reduction in demand for exports by the US, which is South Africa's second largest trading partner after the EU. If overall volumes of international trade do fall, as was argued in section 2, then export sectors will most likely contract and thereby lead to a slow-down in economic growth and a loss of employment.

In sum, the macroeconomic effects for South Africa of some of the risks to trade are uncertain, and in some instances may be positive, but overall they seem likely to be negative as far as growth is concerned. However, the concern should not only be with aggregate economic growth, but also with energy and food security and the impact on the poor. These issues are taken up in the following subsections.

5.3 Energy security

South Africa relies on its abundant coal reserves for some three quarters of its total energy requirements (IEA, 2005), and as mentioned above only 10 per cent of energy needs are met by oil (see Figure 5 below). It also has a well-developed synthetic fuels industry. At first glance, therefore, the country's energy future looks reasonably secure. However, the transportation sector is overwhelmingly dependent on oil, accounting for some 80% of domestic liquid fuel consumption. This in turn means that a wide range of goods prices are affected by oil prices, which are determined by world markets. The issue of transport infrastructure will therefore require critical attention from government.

Figure 5: Shares of total primary energy supply in South Africa, 2002



Source: IEA (2005)

South Africa is unlikely to be the site of major international conflict over energy as it does not possess significant oil or gas reserves. Although this country does have very significant coal reserves (some 5 per cent of the world total), it seems unlikely that this poses a geo-strategic risk since many high-energy consuming countries (including the US, Europe, Japan, China and India) either possess large domestic coal reserves or are geographically proximate to countries that do. While other countries in the Southern African region do depend on South Africa for energy, it seems improbable that they pose a significant military threat.

In the coming years, South Africa faces difficult decisions about the use of its abundant coal reserves as it increasingly experiences the effects of climate change. As one of the regions of the world expected to be most severely affected by climate change, the South African authorities really need to demonstrate to the international

community their commitment to tackling the issue through reducing carbon emissions. This presents a significant structural challenge to the South African economy, which has been accustomed to cheap electricity derived from burning low-grade coal.

5.4 Food security

Climate change is perhaps of greatest concern when it comes to food security. South Africa is currently in the fortunate position of being a net food exporter, selling maize to neighbouring countries and fruit to Europe. Agriculture accounts for about 8 per cent of total exports. However, the IPPC (2001) has singled out South Africa as being one of the regions of the world likely to be hardest hit by climate change. In general, average temperatures are expected to rise throughout the country by between 1 to 3 degrees Celsius, while rainfall is predicted to decline by between 5 to 10 per cent in the summer rainfall area (DEAT, 2004: 2). The occurrence of both droughts and floods is expected to increase. Many agricultural crops, such as maize and grapes, are sensitive to slight changes in average temperatures. Climate change therefore presents a threat to South Africa's food security.

Rising oil prices also pose a risk to food security, as they incentivise some farmers to switch from food production to the production of biofuels. For instance it may become more profitable for maize farmers to supply their produce for biomass fuels such as ethanol and biodiesel rather than for food. In addition, SASOL has plans to construct a new plant at Secunda "to convert 400 000 tons of soya beans a year into 80 000 tons of diesel fuel" (ABSA, 2004: 5). These trends, along with increasing transport costs, are likely to push up domestic food prices dramatically, just as international food prices are rising due to higher input costs. Such price increases will have serious consequences for the poor in South Africa and her neighbours. Already, as mentioned in section 3, Southern Africa is facing a massive famine – affecting up to 10 million people – as a result of severe drought.

5.5 Social stability

Rising food and transport costs will affect the poor most, thereby exacerbating already high levels of inequality. Increasingly, satisfaction of the poor's basic needs will be in jeopardy. HIV/AIDS mortality will be rising and will be compounded by hunger, malnutrition, and increasing joblessness. This in turn will place increasing strain on social services. At the same time, the provision of such services will be hampered as economic activity contracts and costs mount. This year has already witnessed an increase in social protests over lack of service delivery, so the scene is set for heightened social tensions in the future.

The relative size and strength of South Africa's economy in the context of Southern Africa means that this country is something of a regional magnet in times of crisis. Unless significant foreign food aid arrives, South Africa can expect an increasing flood of refugees from neighbouring countries suffering from the effects of droughts, HIV/AIDS and Zimbabwe's economic collapse. This would place a massive extra burden on already over-stretched social services.

In sum, the probable impacts on South Africa of the major risk factors are wide-ranging and in many cases uncertain in both magnitude and direction. While some sectors (such as energy and resources) stand to benefit, it seems clear that the poor

will suffer significantly unless specific ameliorative policies are implemented. Some possible responses are considered in the following section.

6 Policy Response Options for South Africa

Given their systemic nature, the risk factors will potentially affect all sectors of South African society, including business, government and ordinary citizens. As such, every individual and organisation would be wise to consider the likely impact on them, and to prepare accordingly as best they can. This section, however, limits itself to a consideration of (some of) government's possible responses to these risks. Section 7.1 briefly discusses two major alternative strategies, namely adaptation and mitigation, and argues for a combination of the two. Section 7.2 details a number of specific policy response options.

6.1 *Adaptation and mitigation*

There are (at least) two related debates about the ways of responding to economic risks. One is between proponents of state intervention and those who favour market forces (*laissez-faire*). The other is between adaptation and mitigation. In general, advocates of market forces emphasize adaptation, while interventionists often promote mitigation strategies. However, proponents of government intervention may also support adaptive policy measures.

Neoliberal ideology tends to oppose state intervention in favour of allowing market forces (the price mechanism) and technological innovations to coordinate adjustments. This view is premised on the belief that markets are more efficient than governments in allocating resources. However, market failures are well known and are especially prevalent during economic downturns, when factors of production are underutilised. In addition, price signals are distorted by a range of existing taxes and subsidies, as well as asymmetric information, and for the most part do not account for externalities such as environmental and social costs. These distortions are especially relevant in the case of fossil fuels. Moreover, prices reflect a combination of current scarcity and expectations of future scarcity, which may or may not be accurate reflections of longer term realities. For example, the conventional view (as propounded by the IEA and most governments, for example) is that oil supplies will not begin to decline for several decades, whereas this paper argues this view is overly optimistic. A further problem with relying purely on market forces is that they tend to favour those who already have access to resources and to prejudice the poor, who are far more vulnerable to economic shocks. This is particularly relevant in South Africa given our extremely high unemployment and poverty rates.

On the other hand, neoliberals are correct to point out that a variety of government failures (e.g. inadequate implementation, rent-seeking behaviour and corruption) may in some cases aggravate economic problems. This depends on many factors within a particular country and should be taken into consideration when designing policies. It is also true that governments are responsible for many (but not all) price distortions in the economy. A pragmatic view is that government intervenes as it is, so it might as well be encouraged to do so in the most sensible (prudent) manner.

The choice between adaptation and mitigation is partly a matter of time preference. Adaptation measures tend to focus on the short term (reactively coping with the immediate situation), while mitigation strategies are generally based on a long-term perspective (proactively reducing the risk of negative outcomes in the future). It is often argued that mitigation measures are warranted if the risks are very substantial, and indeed peak oil, climate change and global financial instability are massive threats to the world and local economies. A common argument against mitigation efforts is that these will place excessive costs in the short term, for instance in terms of economic growth foregone. A counterargument is that the long-term costs of not taking mitigating action against severe risks are likely to far outweigh the short-term opportunity costs of such measures.

The South African government has committed itself to the principles of sustainable development, which inherently takes a long-run view and recognises the rights and needs of future generations in addition to those of the present. It may seem to some observers that mitigating indeterminate risks (such as those described here) is less urgent than immediate concerns such as existing poverty and the HIV/AIDS epidemic. However, postponing appropriate medium-term interventions (such as described below) will merely compound these same problems in the long run. It is vitally important that investments such as these be made *before* the risks materialise into full-blown economic problems, otherwise sufficient resources will not be available to do the job. For example, sky-high oil prices will make it much harder to build a replacement energy and transport infrastructure. A couple of quotes from the Hirsch Report (2005) on risk management relating to peak oil are instructive:

“with adequate, timely mitigation, the costs of [oil production] peaking can be minimized. If mitigation were to be too little, too late, world supply/demand balance will be achieved through massive demand destruction (shortages), which would translate to significant economic hardship” (Hirsch *et al*, 2005: 59).

“The world has never confronted a problem like this, and the failure to act on a timely basis could have debilitating impacts on the world economy. Risk minimization requires the implementation of mitigation measures well prior to peaking.” (Hirsch *et al*, 2005: 60).

A similar argument applies to the risk of global financial instability. Climate change, however, is already having various tangible effects and therefore requires adaptation strategies – in addition to mitigation efforts to attenuate the future impact. Likewise, high oil prices are already affecting the domestic economy, and especially the poor.

Thus successful management of the risks identified in this paper arguably will require both mitigation and adaptation strategies, and involve both market signals and government intervention. Broadly speaking, three avenues for effecting positive change are available to the authorities: the use of economic incentives such as taxes and subsidies; regulatory measures prescribing and proscribing certain kinds of activities; and education to raise public awareness and understanding of the issues. All three of these options should be utilised in a coordinated fashion for maximum effect. The following section outlines a variety of possible specific policy responses to the key socio-economic challenges identified in the previous section. These suggestions are by no means purported to be a complete set of proposals, but rather a catalyst for discussion.

6.2 Precautionary policy measures

Numerous spheres of government policy are relevant to this discussion, but the focus here is on trade, fiscal, monetary, transport and social welfare policy. Each of these areas is considered in turn, where after some comments are made about synergistic policies and the need for government collaboration with domestic and foreign partners. The emphasis is on mitigation strategies, partly because adaptation will to some extent occur naturally as a result of market forces, and also because a long-term view is taken so as to minimize the negative impact of future risks.

The main implication for trade policy (as indeed for other domains of government policy) is that it should not be premised on the status quo – highly globalised trade – necessarily being maintained. For the sake of prudence, South Africa's policy-makers and trade negotiators acting within the WTO and bilateral or multilateral forums should be informed by the future risks to trade. Trade policy should acknowledge the trade-off between the efficiency of specialisation and the security of self-sufficiency. Where feasible under WTO rules, trade liberalisation should be limited in vulnerable and strategic sectors so as to maintain production capacity for the time when cheap imports are no longer available. In other words, policy should be geared towards avoiding deindustrialisation (e.g. in the clothing and textile sector) as it will be much more difficult to re-establish such industries if and when the risks materialise (since these will likely induce recessionary conditions). At the same time, it will be important to try to ensure a sufficient stream of export revenue to finance purchases of necessary imports such as capital equipment and oil. This may involve selected support of key export industries.

A range of other government policies will also help to mitigate the effects of declining international trade. Fiscal policy should not attempt to buffer the effect of rising oil prices by subsidising petroleum, as this action will be unsustainable after the oil peak is passed. Rather, subsidies and taxes should be used to promote renewable energy sources, especially wind and solar. These will have the added benefit of making energy more affordable to the poor, particularly in off-grid regions such as rural areas. The Treasury could also consider ways to boost domestic demand (especially for manufactured goods) since in future the export market is likely to contract substantially.

In terms of monetary policy, the SARB would be wise to avoid excessive interest rate hikes in response to energy price rises. Rather, it should let the relative price changes occur (which realistically will only happen through overall inflation) so that they reflect changing scarcity patterns. Otherwise, the dampening effect of high energy (and related) prices on demand will be compounded by higher borrowing costs, and may worsen recessionary forces. However, if the oil price shocks are particularly severe, the SARB should obviously guard against hyperinflation. There are also good reasons for the SARB to take steps to shore up the capital account against excessive volatility. This could take the form of prudent exchange controls on portfolio flows, such as Malaysia has instituted, or the introduction of a Tobin tax. Such measures will help to reduce the uncertainty facing exporters and importers. Finally, the SARB would be well advised to diversify its foreign exchange holdings away from the US dollar, otherwise it faces a capital loss when the dollar adjusts to correct the US current account deficit.

Transport policy is another crucial area in light of the threat of rising oil prices and other transaction costs on trade. The government has already committed itself to expanding infrastructure spending over the next five years, and has earmarked considerable funds for this purpose. This golden opportunity should be utilised to upgrade and extend freight and public transport systems, particularly those which do not rely heavily on oil (e.g. electric rail networks). Such systems should not be geared only or mainly to existing, large-scale industries, but should also target underdeveloped local areas which lack infrastructure. Such steps should also be supported by energy conservation measures, which could include reduced road speed limits, dedicated car-pool lanes, and park-and-ride facilities in urban areas. In addition, efficiency of fuel use could be encouraged, although the price mechanism will in large part take care of this.

In the era of oil depletion, the reduction of distances between producers and consumers will to a large extent be unavoidable, but active policy steps can and should be taken to facilitate local economic development. This could include supply side measures such as municipal infrastructure projects and extension of basic services to underpin local trade. It will also require intensive training programmes to support import substituting industries as resources shift from the tradable to the nontradable sector. However, the demand side will also require attention, as noted above. This could involve job creation programmes and extension of credit facilities or income support to the poor.

Financial support for the poor will be vital not just to boost local demand in order to stimulate supply, but also to alleviate chronic poverty, which as argued in section 5 is otherwise likely to worsen considerably as a consequence of peak oil and climate change. Measures to enable the poor to afford food, energy and other basic necessities include expanded social grants (such as a basic income grant), or tradable fuel rations.⁹ We have already mentioned the importance of protecting industrial capacity and jobs where feasible; this is no more important than in the area of poverty alleviation since wage income is so crucial in this respect. Job creation, already one of the country's top policy issues, will most likely become even more important in the future. The government will also need to be careful that biofuel production does not crowd out food production to an extent that threatens food security. Accelerated land reform plus training of small-scale farmers in organic and permaculture production techniques, will be another way of alleviating poverty and coping with rising fossil fuel prices.

While many of these policy options would no doubt face substantial logistical hurdles and involve considerable costs, the social costs of not doing anything may be vast as joblessness, hunger and HIV/AIDS reinforce each other. Wherever possible government should design and implement synergic policies, which will simultaneously address several problems in a co-ordinated manner. Investing in renewable energy resources is foremost among these, since it will simultaneously reduce dependence on dwindling fossil fuels, reduce greenhouse gas emissions, and empower local communities and economies. Another is land reform and the promotion of organic farming, which obviates the need for fossil fuel based fertilizers and pesticides while also absorbing more labour. A third is energy rationing, which

⁹ See Feasta (2005) on energy rationing.

could help to cut down carbon emissions (if the total amount of rations declines over time) while protecting the poor from the impact of rising energy costs.

Action will need to be taken at all levels of government, including local, provincial and national. In addition, the government will need to co-operate both with domestic business, labour and civil society organisations, and forge stronger partnerships with foreign governments and multilateral agencies to deal with these challenges. The onus, however, is not just on the state, but also on firms, NGOs, communities and individual citizens to make appropriate behavioural adjustments.

7 Concluding Remarks

This paper has identified several major areas of risk facing global trade, including natural resource, environmental, financial and associated geopolitical factors. The main uncertainty is arguably around the timing of these events, and not the probability of their occurrence. Oil depletion is a living reality, and it is just a matter of time before the peak in global production is reached, after which the price will become more volatile around a rising trend. Climate change, as a result of global warming and changing land-use patterns, is already producing visible and costly effects, and these are set to worsen substantially over the coming decades. The American current account deficit cannot continue to grow indefinitely, and the dollar must therefore adjust at some point.

Each of these risk factors could in its own right have substantial negative consequences for economies and societies, and in particular seriously inhibit the international flow of goods and services. Together, they present a mine-field of potential hazards which could coalesce into a 'perfect storm'. This is because there are several complex feedback loops among the risk factors, which raise the probability and magnitude of adverse outcomes. Taken together, the system – like the global climate itself – is perhaps best characterised as complex, dynamic and nonlinear. As such, modelling it is an extremely difficult exercise. However, one does not have to be mathematically precise to grasp the nature of the interactions and their importance. Some of the main linkages may be summarised as follows:

- Declining fossil fuel energy resources (especially oil) will likely lead to:
 - higher costs of long-distance trade and therefore reduced exports and imports;
 - declining world agricultural yield in the face of rising population and food requirements;
 - increased use of coal, which would accelerate the global warming process; on the other hand, renewable energy resources will become more financially attractive, and this could help to reduce carbon emissions;
 - increasing pressure on the US dollar and therefore raise the systemic risk to the global financial system;
 - intensified competition over resources, possibly provoking trade wars or military wars, which would further weaken the global economy and trade.

- Climate change is likely to:
 - raise the transaction costs associated with international trade and cause logistical disruptions;
 - cause more frequent and severe droughts and floods and therefore reduce crop yields;
 - create streams of environmental refugees, which will concentrate pressure on resources in certain countries and regions and thereby heighten geopolitical tensions;
 - further pressure nations to reduce energy consumption so as to limit greenhouse gas emissions, and thereby place an additional brake on economic activity;
 - cause more frequent natural disasters and thereby put increasing strain on the world economy and financial system.

- Global macro-economic instability may:
 - result in a hard landing for the US and world economy, reducing trade in particular;
 - diminish the capacity of economies to invest in renewable energy resources and therefore compound the looming energy crisis;
 - foment geopolitical tensions by causing economic hardship; on the other hand it could in the long term help to rebalance trade and financial flows and the international distribution of wealth.

If this complex web of risks is not managed appropriately, there is a significant likelihood of a downward spiral of economic depression, conflict and suffering. As a result of the interconnected and systemic nature of the risks, they need to be addressed in an integrated manner. It is also important to acknowledge the large uncertainties surrounding possible outcomes. The role of technological change has always been central to economic development, and it will no doubt play a key role in the future as humanity grapples with these challenges. Indeed, many of the technologies needed to overcome these challenges are already available. However, the potential of technology depends on the political will to use it and the wisdom with which it is applied. Similarly, relying exclusively either on markets or on government intervention is likely to fail; a co-ordinated response involving both is essential.

The implications for South Africa are diverse and uncertain, but there are several probably negative outcomes, particularly for the poor. Ignoring these risks in the short term may lead to severe problems in the medium to long term. The South African government would be well advised to implement mitigating strategies. Adaptation measures will also be required, such as are already being formulated in the case of climate change.

Perhaps the main conclusion this paper draws is that extensive further research on these issues is warranted, given the relatively low level of attention they are currently receiving, from economists in particular. One aspect would be quantifying the impact of oil price and financial shocks on the South African economy through macro-econometric and computable general equilibrium models. Another would be an engagement of economists with climate change scientists to thrash out the economic implications of global warming and adaptation and mitigation strategies. A third would be assessing the likely impact on the poor of the three main risk factors.

Finally, not all of these challenges are entirely negative. In some ways they represent opportunities to shift to a more democratic, egalitarian and ecologically sound global and local economic system than that which prevails at present. Whether these positive opportunities can be realised will depend on the active participation of and cooperation between all sectors of society, including government, business and civil society, at both national and international levels. The future is ours for the making.

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