

Commonwealth of Australia

**A Submission to the
Parliamentary Standing Committee on
Industry and Resources
Inquiry into Resource Exploration Impediments.**

An inquiry into and report on any impediments to increasing investment in mineral and petroleum exploration in Australia, including: An assessment of Australia's resource endowment and the rates at which it is being drawn down.

A submission entitled:

**Factors affecting Australia's rate of crude oil resource use and lessons
from the past for future decision-making.**

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Summary

In the 1970s and again in the 80s the Australian petroleum exploration industry predicted that a rapid decline in local oil production was imminent (within 5 yrs). Those repeated predictions proved excessively pessimistic because they were based on static analysis of the crude oil market that assumed local demand and supply both to be fixed in the long term. As such these predictions failed to take into account the dynamics of oil supply and demand of the crude oil market, and the dynamic nature of what is really measured by the 'productive life of remaining reserves'.

In fact Australia didn't run out of oil in the time frame predicted by the local industry and we would have had a superior economic outcome over the past 40 years if a range of 'market corrections' been totally avoided. Our economic oil reserves remain at levels similar to that evident since the 1970s even if the measure of their productive life has decline since 1990.

The life of economic remaining reserves is a highly sensitive measure that is readily influenced by the world market prices. The modest real price levels evident on the market in the past few years have contributed to the decrease in these reserves. Any increase would readily result in a revision of these reserves and a change of outlook based on this measure alone. Use of this measure in decision-making or in predicting impending local oil shortages is not recommended without consideration of the dynamic nature of the crude oil market.

In the 1970s and 80s some groups in the exploration industry sought to alleviate their predicted oil shortage by exploring for new oil fields in major frontier areas, such as the Exmouth Plateau. Such decisions were poorly based technical judgements which resulted in major, expensive and unsuccessful exploration programs which deterred the rest of the petroleum industry from further considering frontier areas in Australia for a considerable period thereafter.

At present and in the future the benefits available from crude oil resource use in Australia would be maximised if we maintained a completely open-market arrangement for crude oil pricing and exploration rights allocation system, provided it does not distort the pattern of resource use which would take place under long-term world market conditions. We have moved from the highly regulated oil market of the 1970s and 80s, which periodically constrained either local supply or price incentives that would have resulted in incremental exploration.

We now have the opportunity to make resource use choices using the price signals evident from long term trends in the world oil market where oil prices are modest in real terms. A competitive open-market for crude oil will provide the superior level of economic welfare and, if combined with non-discriminatory taxation or subsidy of resource use, provide the most efficient means of determining the pattern of either oil or gas resource use.

There is some merit in the argument that long-term development of our unfertilised gas reserves for domestic and export markets represents an economic benefit which has been postponed by the availability of local oil resources that are now in short-term decline. Gas development represents, in the minds of some, part of a logical transition from an oil based economy to a gas based one, a transition which is underway both in Australia and around the globe.

Long term world oil prices are a key indicator of when and to what extent the available oil and gas resources can be utilised and developed. Gas resources remain a significant resource asset on which future natural economic advantage may be based. Oil resources can be sourced from the world market while long-term price levels are modest and a gradual switch made to wider use of gas reserves.

The transition to exploring for oil in (high cost) frontier areas have proved to be problematic in the past with oil exploration results that have been disappointing. In the future, such areas may provide some positive results albeit at high relative cost. Assessing the cost and risks associated with frontier exploration are best left to the decision-making processes made by the petroleum industry. Any attempts to guide or support the industry into such areas ahead of the incentives provided by the market are, in the long term, likely to deter more exploration than it encourages.

The relative benefits and costs associated with current petroleum exploration title conditions have been the subject of ongoing debate. Considerable support for cash bidding, rather than the existing work program bidding, has appeared in the economic literature in the past 10 years. Work program bidding has an advantage in that it guarantees some exploration over title areas, the current cash bidding arrangements do not do so. Until a detailed study of the two schemes can be undertaken using local information the debate on this issue will continue.

Introduction

The pattern of use of Australia's crude oil resource has been a focus of discussions from many sources over many years. Most notable of all have been the ongoing calls for action to avoid the pitfalls of an imminent decline in domestic production and the consequent inferred impacts upon the balance of trade.

Since 1974 the local industry have predicted that local production was limited and would soon go into significant decline unless new high-grade deposits of crude oil are discovered and developed. The same views suggested that discovery and use of

additional major oil fields were the only means by which such an imminent fate could be avoided.

Since 1974 we haven't found the major new oil fields of the size required and the major decline in oil production took much longer to eventuate. The predicted balance of trade blow out didn't take place, not from oil demand anyway, and domestic oil demand moderated through greater fuel efficiency and price related substitution. What went right and will we still be able to avoid an ongoing decline in domestic oil production?

Are we running out of oil?

The most recent answer to this question is partially evident from the edition of the publication Oil and Gas Resources of Australia 2000, compiled by Geoscience Australia 2002 (<http://www.ga.gov.au/pdf/OC0023.pdf>).

"Remaining oil reserves are approximately unchanged since 1970. Most (391 of 709 GL) of the increase in initial oil reserves since 1970 is due to growth in reserves in fields discovered before 1970. During the same period, remaining gas reserves have increased more than eight times, mainly due to discoveries of major gas resources off north-western Australia. Reduction in reserves through production have been more than offset by discoveries and reassessment of identified fields since 1 January 1998.

Major changes to the Category 1 figures are due to commercialisation of Bonaparte oil reserves and revisions to Carnarvon oil and gas reserves. Decreases in the Gippsland Basin are due to oil and gas production. Category 2 oil volumes have decreased primarily through transfer to Category 1. Undeveloped gas reserves in the Browse Basin have been reduced through reassessment, while those in the Bonaparte Basin have increased after further appraisal drilling.

Recent gas discoveries in the Browse Basin have the potential to significantly add to Australia's gas resources. Press reports at the time of discovery indicated a resource of up to 280 Bcm (10 Tcf) of gas and 95 GL (600 million barrels) of condensate may be present in the greater Gorgonichthys area. Recent discoveries have also identified large additional gas reserves in the Carnarvon Basin.

Estimates by the Geoscience Australia of future crude oil plus condensate production suggest production in 2001 at between about 81.0 and 114.5 GL/d (510 000 and 720 000 bbl/d) and a decline to between about 25.4 and 55.6 GL/d (160 000 and 350 000 bbl/d) in 2015... "

"Crude oil and condensate remaining economic demonstrated resources at the end of 1999 could sustain production of 30.3 GL per year for 16.8 years. This average

production level was calculated for the period 1990 to 1999. The consumption of crude oil and condensate in 1999 could be sustained by remaining economic demonstrated resources for only 11.8 years."

While the thought that if nothing else happened oil and condensate (liquids) might run out in 11.8 years is potentially worrying, any decisions based on that figure alone are premature and lack an understanding of the dynamics of both the petroleum markets and what factors can affect the level of 'remaining economic demonstrated resources' in Australia.

Similar predictions of imminently declining oil supplies from local fields were made over 20 years ago and were subsequently proved incorrect, why? Largely because they were based on a view that local oil supply is fixed and determined by physical parameters alone. In actual, fact commercial production from an oil field is determined by market and commercial decisions well before the physical limits of production are attained.

How then have we been spared much of the shortages that were always being predicted? Some of the answers can be seen from previous examples. In November 1974 the Chairman of Esso Australia Ltd, Mr Ken Richards, addressed a symposium on energy resources at the Academy of Science in Canberra. He suggested that as a result of well known characteristics of the all the major oil fields, which Esso-BHP operated in Bass Strait, by the late 1970s a major decline in the supply of crude oil from local fields would take place unless major new deposits were found.

Esso's made a major exploration move soon after by acquiring the rights to explore new 'deep water' frontier of the Exmouth Plateau off the North West Shelf along with a number of other international groups. All the explorers who participated in these endeavours failed to find any significant oil deposits but several strategic gas fields were discovered and which remain undeveloped to this day.

Despite a lack of major new fields by 1980 no significant decline in local production took place in the time frame predicted by Ken Richards. How could he have been so off target with his prediction? Esso were at the time the most successful oil exploration company in Australia. The reasons why his predictions were wrong is that he didn't take into account dynamic nature of oil supply and demand and the impacts of market intervention measures that applied at the time.

In addition, the size of the known oil fields was underestimated at the time of Ken's prediction. Secondly, growth in demand for crude oil into the future was overestimated, and thirdly the balance between local supply and demand is actually determined by the level of world crude oil market prices, not by local demand or supply alone. Hence when world prices increase some increase in local production potentially can take place, increasing the size of recoverable reserves. Prices increases will also reduce local demand to some degree. Hence, the rate of self-sufficiency will be higher when oil prices rise and lower when they fall or remain at low levels for extended periods.

In the period immediately after a rapid rise in oil prices the productive life of oil reserves will initially increase and then decrease over time. Thus the predictions based on a static view of the oil market, such as those commonly made by industry spokes people, are generally overly pessimistic in retrospect.

One of the reasons for increased production from oil local fields since 1974 is that a rise in the price of crude oil makes it commercially feasible to recover more reserves over the life of known fields. Thus price increases can lead to 'reserves growth' over time. Secondly, improved technology may lead to increases in reserves over the life of a field. Again both the oil market and technology serve to increase oil supply when adequate price signals are available to producers. At the same time it helps them if they maintain an ongoing campaign of pessimism to governments.

So what did Esso do when they were wrong in 1974 and didn't find any oil on the Exmouth Plateau? In 1980 Ken Richards again predicted that by 1985 local oil supply would decline significantly unless major new fields were found because "the supply of oil from existing discoveries is a soundly based forecast and can be viewed with some certainty" and "it is unlikely that the supply of oil from existing fields will change".

Esso again in the early 1980s sought to locate oil in major new frontier regions but this time it was in some widely varying parts of the onshore and offshore parts of Australia. Like the earlier Exmouth Plateau exploration campaign, this program was commercially unsuccessful, partly as a result of the haste with which it was planned and the programs undertaken over the areas selected.

Contrary to Esso's two previous dire predictions by 1983 domestic oil supply actually rose to record levels. The reason being that local supply had up until that point also been constrained by a discriminatory pricing scheme and a ban on exports of local crude oil. By 1989 the then Chairman of Esso Australia noted that the supply from Esso fields in the Gippsland Basin region did not decline until 1986. In fact Australian production continued to grow until 1994 due to the added output from oil fields in the Timor Sea.

Since 1994 the repeatedly postulated decline in local oil production has taken longer to eventuate and the world oil price levels have resulted in increased recovery while demand has changed as well. A considerable improvement in the efficiency of oil use has resulted in lower real energy costs.

But just because the local petroleum industry was wrong 20 years ago doesn't mean that the production decline will never occur. The balance between local supply and demand is greatly affected by the world crude oil world market (imports) and responsiveness of local demand for refined products to changes in price, substitution and improvements in fuel efficiency. All of these elements have affected the level of local crude oil self sufficiency and they will continue to do so well into the future.

Why then has the local industry continued to postulate ongoing decline when this has been slow to take place? Firstly, no one was going to criticise the industry for getting it

wrong. Secondly, if the industry experts were right the nation was going to be economically much worse off in a very short period. So, being wrong had a better economic outcome for the nation than if the industry experts had been correct. Are they right now? The answer is yes in part.

The proposed solution of finding a new frontier with high-grade oil fields could remain a prohibitive and inefficient option. It is correct that without further oil discoveries we will eventually run out of oil but it will take a lot longer than most expert opinions give credit for because of the dynamic nature of the factors involved. The most important of these factors is the effect of world oil market on both demand and supply.

The life of our current reserves is limited but would increase immediately with further increases in real world oil price levels by (price) transfer of some sub-economic reserves to the economic reserves category. Similarly, local production may increase because of a shift in the balance of marginal production (cost vs. revenue) of existing fields. Increases in world oil prices will decrease demand (in the short term). Hence, world market price rises increase production from local fields while reducing local demand; closing the gap between local supply and demand. At the same time local production increases the life of existing reserves (in the short term). The converse is true for a lowering of world oil prices. A consequence of a long period of low or static world oil prices is that the life of local oil reserves will gradually dwindle, as was evident in the late 1990s.

The postulated decline in local production predicted in 1974 and 1908 has also been further offset by a combination of increased recovery from known major fields (discovered prior to 1980), the removal of impediments associated with oil market regulation measures, and changes in factors affecting demand for crude oil.

While some have been quick to claim that much of increased output from local fields is due to 'reserves growth' alone, it would appear to have more to do with the combined dynamics of the prices received by producers, improvements in recovery technology and changes in the marginal costs of production. Despite greatly increased knowledge about the geological history of many areas of the Australian continental shelf in the past 20 years we have had limited success, discovering only modest, but commercially significant new oil fields, in offshore regions of the continent.

Since 1975 support to help facilitate the discovery of new oil fields in frontier or other areas has not produced exploration success on a scale to match that previously attained in the early stages of offshore exploration in the Gippsland Basin. There is no guarantee that additional 'assistance to explorers' or specific market intervention measures will produce even one incremental barrel of crude oil. The answer to our energy future may be extensive and underutilised gas reserves.

Australia's oil resource

The features of Australia's crude oil resource can be summarised by the following :

- how much of the resource is known and presently available,
- where is this located and what is its quality,
- how much more of the resource might be discovered,
- how costs of finding more compare with developing known gas reserves?

Australia's oil resource endowment comprises both discovered (known) and undiscovered resources. The discovered resource has either been produced or is present in known fields and can either be produced for commercial return, or will be unrecovered due to high costs or physical limitations of production technology.

Much of the identified oil stock in Australia has been found in the offshore Gippsland Basin (over 70 %). Other significant but smaller deposits have been identified along the offshore North West Shelf, in the Bonaparte and Carnarvon Basins. Remaining deposits are relatively small and present in onshore basins (Canning, Cooper, Eromanga and other basins). An average of 200 million barrels (MB) of crude oil has been discovered in new deposits each year since 1975 but 250 million barrels (MB) of crude oil is required to satisfy domestic demand. The balance is maintained between these two items by increases in the recognised size of known deposits and imports of heavy-grade crude.

Market price and technology determine what proportion of available oil stock will be extracted. Available oil stock can be subdivided into economic or non-economic, depending on market price and available technology. High-grade deposits will typically be economic at low market prices but for each price level very low-grade deposits will remain uneconomic. Changes in market price thus change the size of economic and sub-economic components of the available oil stock up or down, depending upon world market price levels.

While the limited extent of Australia's available oil stock is one aspect of ongoing debate, estimates of the Australian oil resource which remains to be found (undiscovered oil stock) gives an indication of likely future resource availability and cost/benefit comparisons.

Results of assessment of Australia's undiscovered oil stock indicate that at least another 1000 million barrels of oil would be found Australian but it may be as much as an additional 5000 million barrels. Such estimates are illustrated as a cumulative probability curve - the average of the assessment is approximately 2400 million barrels (MB). The assessment indicates that the bulk of Australia's undiscovered oil stock is present in the Gippsland, Bonaparte and Carnarvon Basins.

A major feature of the results of petroleum exploration in Australia since the late-1970s has been that less than 200 MB of new oil deposits have been found each year. Results of exploration drilling in Australia show that an average of one in every 12 wells drilled in offshore areas discovered some form of petroleum.

In contrast, a success rate of one discovery well in every 20 wells drilled is evident in onshore areas. It is also evident that while more wells have been drilled in onshore sedimentary basins, of the wells drilled in offshore areas, each discovery well found a deposit with at least 50 MB of oil, whereas new oil deposits discovered in onshore areas average 7.5 MB of oil.

A comparison of the oil deposits found in offshore and onshore sedimentary basins indicates that any new oil deposits which might be discovered by future exploration in Australia will be equal to in size or smaller than those already identified. It also suggests that the largest single deposits likely to be found were identified during the earliest phase of exploration in offshore areas. The trends evident suggest that unless major new petroleum-bearing areas are available for exploration, Australia's future supply of crude oil from as yet undiscovered deposits, will be from a large number of relatively small deposits, rather than several large high-grade deposits.

Of greater interest to an open-market economy such as Australia's is whether it is better to encourage incremental expenditure exploring for 'oil in frontier areas' in the hope of finding addition large high-grade fields, or, should encouragement be given to the development of the extensive gas reserves already discovered but not yet developed.

To date market signals shown by the willingness of the industry to take either option are not clear, although gas reserves have been the subject of more discussion than looking for 'oil in frontier areas'. The latter being more popular with those who are tied to the view that we can avoid future scarcity if we try to repeat the (Gippsland Basin) discoveries of the past. If the 'oil in frontier areas' option is encouraged the decision should be taken with full recognition that the quality of such fields are unlikely to match that shown by the early fields discovered in the Gippsland Basin in the 1960s and 70s.

The most likely outcome of the 'oil in frontier areas' option is the discovery of modest high cost fields which will continue the present dynamic balance between domestic demand and supply from both local and world market sources. Any further oil discoveries are likely to be light grade and not the heavy grade crudes required for some refined outputs that we have always had to import. As any incremental discovered reserves will be traded on the open market, any net economic gains will depend upon price and volumes differences resulting from market trading.

Some might argue that any encouragement to discover additional high cost oil reserves in frontier areas will encourage over investment for limited if any return. Indeed, some see no need for these frontier oil reserves in the gradual transition to a gas-sourced energy economy and the inherent environmental benefits which this might bring. Such views see the gas resource as one of our natural resource advantages that should underpin our economic development well into the present century. These views are not without some value as we have seen the comparative benefits of our previous underutilisation of large reserves of iron ore until the 1960s, despite their being recognised in the early part of the 20th century.

Australia's oil resource in context

Australia's available oil relatively small and comprises less than 0.2 percent of the world's available oil. Over 60 percent of the world's available oil stock is present in deposits located in the Middle East.

A significant development in the world oil market has been the increase in production from non-OPEC (Organisation of Petroleum Exporting Countries) nations since the major oil price rise of late 1973. The second major feature of the world oil scene is that present exploration activity is identifying smaller and lower-grade deposits, a trend similar to that evident in Australia.

Over 70 percent of the world's available oil stock is present in approximately 500 'giant' deposits each of which contains in excess of 1000 MB. Only two such deposits have been identified in Australia, the Kingfish and Halibut/Cobia deposits in the Gippsland Basin. The decline in the size of deposits being discovered, both in Australia and overseas, indicates that there is only a low probability that additional 'giant', high-grade deposits will be found in Australian or other sedimentary basins around the globe.

What lesson can we learn from our past experiences?

Of the identified oil stock in Australia about 40 percent remains available for current and future use. Only part of this available oil stock can, however, be economically extracted at current prices and with available technology. An increase in price or improvement in technology would increase the economic component, a price decrease would reduce it. Likewise, improvements in technology increase the economic component and extend the resource, quite apart from any price fluctuations.

The results of previous exploration, in both onshore and offshore parts of Australia, appear to show that there is only a very limited chance of discovering additional large, high-grade oil deposits. New deposits will generally be small in size and discovered as a result of a more concentrated search of known petroleum-bearing regions. Other less well explored regions may have some additional reserves but the costs of finding these must be balanced against the opportunity cost of developing other known petroleum reserves, particularly the extensive known gas resource.

It is apparent that world market prices and available technology play key roles in determining which part of the known oil resource can be economically exploited under market conditions. To be fully informed it is necessary to understand that Australia's crude oil resource base is more dynamic than commonly perceived.

The size of the economic oil resource at any point in time is determined by the combined effects of; additions to it from new discoveries (exploration), the upgrading of the size of known new discoveries (appraisal), reductions to it from extraction (production) and downgrading of known accumulations, as well the nature of available technology and rise and falls in world oil market prices.

Over the past 20 years the level of oil reserves in Australia have been in a state of dynamic equilibrium with major producing fields producing more than originally expected and only modest new fields of limited size being found to replace them. Of considerable concern is the limited potential for incremental production from the known fields. Oil prices are at modest levels (in real terms) and the technology employed for newly discovered fields has a high marginal production cost associated with it.

It also is a matter of considerable uncertainty whether any further direct support for oil exploration will locate major new oil deposits of the size and quality of those previously discovered. It is most likely that future discoveries, while commercially attractive, will remain modest in size and most effectively located by the use of technologies which have inherently high marginal production costs associated with their use.

Alternative options include greater use of the existing and extensive gas reserves. With such a resource already available there may be some merit in ensuring that these resources are utilised before any incremental 'support' for further oil exploration in high cost and remote locations.

Despite the expectation of an impending decline in local production there has been no major debate as to what is the optimal pattern of use for the Australian petroleum resources. Instead, discussions have largely been based on the unchallenged premise that maximising Australian self-sufficiency will inherently yield the highest level of overall national welfare. Arguments for greater oil self-sufficiency may be inherently flawed if our undiscovered oil potential is actually very limited, or if the costs associated with finding the oil resource are excessive compared to using the existing gas reserves.

A key point outlined above is that Australia has a limited stock of crude oil available for extraction from indigenous deposits (available crude oil stock). In addition to inherent scarcity, further exploration is not expected to discover major new, high-grade deposits of sufficient size to replace the depleted resource base. As a result, major points of discussion concerning the current use of Australia's crude oil resource are:

- (1) What rate of depletion will maximise economic welfare of the nation, and,
- (2) Does market intervention (incentives) or removal of impediments, which would otherwise represent a subsidy under open market conditions, best attain it.

Intervention in resource markets is often supported as a means of promoting economic efficiency (and possibly equity), to correct externalities, or to provide public goods. Imperfect competition is considered undesirable for the effect on prices, either elevated or depressed, and pattern of resource extraction.

Not all regulatory intervention has a compelling economic justification. Specific public or private interests may also motivate it. Generally, however, most regulatory measures are considered desirable because of welfare or equity improvement, or the promotion of desirable public or private interests.

Regulation of the tenure and work obligations required to maintain exploration property rights, the collection and dissemination of information on the occurrence, size and quality (grade) of Australian oil deposits, as well as the regulation of extraction and distribution of crude oil are measures which have or are currently applied in Australia. The impacts of such measures are often forgotten by a new generation that weren't around to experience their complexities or their unintended outcomes when they were applied in the past.

Before 1957 some spasmodic petroleum exploration was undertaken in Australia but it was greatly accelerated by the implementation of a Government-funded subsidy scheme which continued until 1974.

The discovery of major oil deposits on the southeast Australian continental shelf in 1965 and 1966 led to the development of legislation to regulate the exploration for, development and production of crude oil and other petroleum products (Petroleum Submerged Lands Act 1967 and related legislation).

Early development of the Australian crude oil market was dominated by the potential market power, which the major producer group Esso Exploration and Production Australia Ltd., (EEPA) and the Broken Hill Proprietary Co. (BHP) held. In order to avoid such market failure, a complex crude oil market regulating marketing scheme was progressively implemented at a Federal level after 1963 and finally abandoned on 1 January 1988 in favour of a deregulated market.

What pattern of oil use was best for Australia?

A significant feature of Australia's available oil stock is that it is continually changing as a result of technological improvements and the discovery of additional deposits, as well as depletion and changes to the world market price. Additional stock is generally available from the resource base provided that the cost of finding and extracting the resource is not prohibitive. Given the dynamic nature of this variable the following questions are significant:

- (1) what pattern of oil resource use will result in maximum economic return to the Australian community?
- (2) what is the actual pattern of resource use in Australia?, and,
- (3) how does the pattern of maximum welfare generation compare with Australia's actual pattern of resource use?

A partially closed-market has been applied in the early days of oil production in Australia (no exports and limited oil imports) but it alone could not generate conditions of 100% self-sufficiency in local crude oil. In contrast, movements towards greater open-market conditions by 1983 lead to increased production and local resource use in line with

developments on the world market including, periodic major price fluctuations related to the market-power of the OPEC-group.

The historical marginal cost of extracting Australian crude rose in the mid to late 60s when the known (small) deposits exhibited rapidly rising marginal costs ($> \$3/\text{barrel}$) as result of the limited scale of production and a rapid physical decline in the productivity at existing price levels. This changed by 1970 with the commencement of production from high-grade deposits in the Gippsland Basin. Costs decreased and remained low until 1980 when a physical decline in productivity of some deposits occurred. Since 1980 rising nominal costs have only partially been offset by the development, since 1983, of new deposits but the limited size of these deposits have resulted in short-lived cost decline.

The historical pattern of supply of Australia's crude oil resource shows that only minimal extraction from known deposits occurred prior to 1966. Only after 1969 when production from the Gippsland Basin commenced did the rate of extraction exceed 15 million barrels per year. However, after 1969 the actual extraction rate escalated rapidly to over 100 million barrels (by 1972) reaching a peak output of over 177 million barrels in 1977. Extraction rates declined from 1977 to 1982 by a total of approximately 20.8 million barrels but increased each year after 1982.

These changes indicate that local supply varied in a manner that was not in direct response to local or world market prices. As such the Australian domestic pattern of actual resource use is not a simple case of supply increasing after new deposits are found, or declining as known deposits were depleted. Instead, regulated price and other market intervention measures have had a significant effect on the pattern of actual resource at particular times during our history until these measures were totally removed in 1990.

The following key points are relevant:

- (1) prior to 1970 only limited local production took place when the closed-market required preference be given to the local resource,
- (2) in the period 1970 to 1977 a minor divergence between the closed-market and actual patterns is evident as the major Gippsland fields were brought into production and,
- (3) a major divergence between the closed and actual patterns is evident after 1982. Since 1982-83 the greatest divergence between closed-market and actual patterns has developed as a result of a major increase in actual resource use.
- (4) the pattern of open-market use is now constrained by cost and world market price levels.

Factors contributing to divergence between the patterns are as follows.

Lessons from Australian crude oil market

The Australian crude oil market developed from an initial situation where imports supplied all domestic demand (pre-1963) and it was not until the late 1960s that more than 20 percent of total demand was supplied from local sources. Initial market intervention in the form of regulated pricing, at slightly above import parity levels, preferential allocation of local output, and a subsidy for exploration.

By 1975 sufficient local crude oil stock had been discovered and developed to satisfy up to 70 percent of domestic demand. While the initial market intervention measures were aimed at developing local supply, a major rise in the cost of imported crude in the late 1970s and early 80s required new measures which were implemented from 1975 onwards - aimed at preventing local producers from over-extracting the available oil stock, and earning 'windfall' profits as a result of local prices rising in response to increases on the world market.

Discriminatory pricing (1975-78) and excise taxes (1978 onwards) were applied to local output with the aim of encouraging further exploration, moderating actual resource use as well as raising revenue. 'Old' oil discovered before 17 September 1975 received a substantially lower return than 'new' oil discovered after that date. As a result major production efforts were diverted from depletion of 'old' oil deposits and into the search and development of 'new' oil deposits. As a result, domestic supply declined from 1977 to 1982 - insufficient 'new' oil was immediately available to replace the decline in output of 'old' oil from the larger Gippsland basin deposits.

By 1982-83, however, a sufficient number of 'new' oil deposits had been discovered to replace the declining output from 'old' oil deposits and all domestic demand for light grade crude oil was met from local production for the first time. By late 1983 when the local market was incapable of absorbing any additional output (exports were banned), producers commenced cutting back production of 'old' oil - that is, 'new' oil output started to displace 'old' oil from the domestic market and this had a short-lived but significant impact on Commonwealth Government excise revenue (from 'old' oil).

In late 1983, to avoid major loss of excise revenue, a ban on exports was lifted, together with some of the regulated allocation arrangements for domestic output. As a result, local production increased dramatically from late 1983 onwards and the rate of actual resource use has remained significantly higher than both the open and closed-market patterns. The high rates of extraction have been maintained since 1988 when a system of production quotas was abolished. The level of supply from the 'old' oil deposits remained constrained by high marginal rates of excise until the discriminatory taxation treatment of 'old' and 'new' oil was removed in 1990.

World market effects

As local crude has and is priced at or near parity with imported crude, the world market price level at any point in time represents the opportunity cost of domestic output.

The availability and price of imported crude has impacted on the pattern of local crude supply. During periods of low world prices limited incentive has been available for the production of local crude and conversely for periods of high market prices.

Compared to the price of crude oil on the world market (Arabian light crude) the price of local domestic crude (Gippsland), remained lower than the closed market price path up until after 1972 when world market prices rose considerably. As a result, no local supply would have been possible had not an exploration subsidy as well as regulated pricing and allocation arrangements been available to domestic producers. This is also reflected in the pattern of open-market use where no domestic output would have been possible until after 1971.

By pricing local crude either at or near parity with the low world market prices (which existed between 1963 and 1969) local production rates were, even with the assistance of a subsidy, lower than those identified by the closed-market pattern of resource use. As world prices rose above closed-market price levels in the 1970s and 80s, actual resource increased but never exceeded the closed market pattern until 1983 when an export ban was lifted.

The impact of world oil prices on domestic resource use through parity pricing is well recognised but Australian demand, or supply, has no major influence over world market conditions. Domestic supplies increased in the early 1970s as major Gippsland deposits were brought on-stream and other new deposits were found. Demand growth slowed due to the impact of increased world market prices - imports fell from 95 percent of domestic demand in 1965 to 40 percent in 1975 and domestic supply expanded from less than 5 million.

Market intervention impacts

As noted previously in this study, the historical pattern of Australian crude oil resource use has been marked by the effects of intervention. Between 1965, when significant indigenous crude oil production commenced, and the end of 1987, the domestic crude oil market was under the direction of a regulated scheme aimed at developing and ensuring priority for domestic oil production. The regulated market arrangements guaranteed sale of indigenous crude at a price comparable to imported crude. As such, the major forms of market intervention were; a regulated allocation of output and an administered pricing structure. In the strictest sense, the supply curve under such arrangements would not be a smooth curve but rather a discontinuous function, the various segments of which would represent the regulated quantities and prices which producers had available to them under the scheme.

The impact of regulation on resource use comprised a voluntary arrangement between producers and refiners/marketeers, coordinated by government. Refiners were required to accept domestic crude under an allocation formula but as refinery operations do not lend themselves to the complexities of an 'equitable' allocation scheme, a system for the

informal exchange of crude oil allocation rights also developed to minimise costly movements of crude.

The market allocation scheme required that "all crude oil produced in Australia be processed by Australian refineries" and an embargo on the export of indigenous crude was lifted. The effect of the allocation scheme up until 1983 was that it allowed all potential suppliers to sell their output at a guaranteed price and it effectively restrained the exercise of market power by major producers and refiners.

By late 1983 production of 'new' oil from deposits was sufficient to displace production of some 'old' oil. In order to maintain excise revenue from 'old' oil the government responded in 1983 by removing an export embargo. As a result, Gippsland and other 'new' oil production in excess of local requirements, was exported to Asian and Pacific refineries, thus gaining much needed export income. A dramatic rise in the level of domestic production occurred after 1983 to levels well above the previous output is due to the higher price levels available on the world market.

The pricing policies of successive governments have therefore, had a major impact on the pattern of oil resource extraction. Between 1963 and 1975 regulated pricing arrangements for supply from each deposit were based on price parity with imported oil of equivalent grade, a freight allowance and an additional margin as an incentive to exploration.

Prior to 1970 domestic supply (actual resource use) was below the closed-market level of resource use because of the availability and relatively low cost of imported oil. Even though prices for local crude were set slightly above parity with imports, it was not sufficient to attain closed-market levels of output. From 1970 to 1975, when world market prices rose above the closed-market price path, actual use was less than the closed-market pattern because local prices were not adjusted rapidly, because of a lag between Arabian and Gippsland prices.

In 1975, in response to a decline in exploration activity after the cessation of the government subsidy scheme, and rising world market price for crude the price paid to producers for oil from 'new' deposits discovered after 17th September 1975 ('new' oil) was set at world market parity levels (minus a \$2/barrel levy). The price of crude from known, or 'old' deposits, was set by Government discretion on the basis of "economic and technical considerations applying to each field" but has always been lower than import parity prices. Production from deposits known but not developed before late 1975 was to be priced in a similar manner ('old' oil prices). As a result, producers were, from late 1975 onwards, to obtain substantial greater return from production of 'new' oil compared to 'old'. The discriminatory pricing scheme was also intended to limit the 'windfall' gains which producers could obtain from major price increases on the world oil market.

The reduced return on production of 'old' oil did not have a significant impact on domestic supply until 1978 when the first major deposit of 'new' oil was identified (the Fortescue deposit - Gippsland Basin). From that point onwards the Gippsland producers

sought to develop the 'new' oil as rapidly as possible to the neglect of 'old' oil output. As a result, domestic output declined in each year after 1977 until partial deregulation of the market in 1983. The discriminatory pricing measures reduced the returns on developed deposits of 'old' oil, and for the first time since 1969, actual resource use declined to levels similar to the closed-market pattern.

The impact of the 'new'/'old' oil pricing system impacted on the domestic crude oil market between 1975 and 1980. After September 1975 any increases in domestic supply were smaller than that which would have taken place if full parity pricing applied to all oil output. The results of such an arrangement is that a net deadweight economic loss and distortion of supply occurred until the discriminatory pricing treatment ceased.

The second effect of 'new'/'old' oil pricing was that it encouraged a switch of resources to the extraction of 'new' oil; the supply of 'old' oil declined markedly as its regulated price to the producer was below world market parity level. It is evident that between 1977 and 1980 total domestic supply declined between 4 percent per annum or a total of 14.2 million barrels over the whole period as a result. Included in this figure is however, the small additional output from newly producing 'new' oil deposits discovered between 1978 and 1980, so that 14.2 million barrels is the difference between the decline in 'old' oil production and the increase in output of 'new' between 1977 and 1980.

The major price escalation in world market prices (and import parity 'new' oil prices) in 1979-80, encouraged a reduction in total Australian oil demand by switching to substitutes and a reduction in the intensity of crude oil use.

From 1978 to 1980 the pricing arrangements were replaced by equivalent excise levies for 'old' and 'new' oil. Refiners were required to pay full import parity prices for all oil but producers were charged a lower excise on 'new' oil. The distortionary effect of this system on oil field development and production practices was identical to that of the pricing scheme. Firstly, in regions such as the Cooper and Eromanga Basins, which had a significant number of undrilled possibly oil-bearing features, resources were diverted from development of known oil and gas fields to drilling of new exploratory wells and the rapid extraction of 'new' oil stock. The second impact was evident in regions where production infrastructure was well established, such as the Gippsland Basin region - resources were diverted to extraction of 'new' oil.

The development of discriminatory 'new' and 'old' oil pricing in 1975 and the modification of this to a system of excise levy charges was the main influence on the pattern of actual crude oil use in Australia in the late 1970s and 80s. Amendments to the 'old' oil arrangements operated between mid-1979 to mid-1983, as an attempt to halt the decline in supply of 'old' oil. They added to administrative complexity by providing different excise levies for small (yearly production < 2 million barrels/year), intermediate (2-15 million barrels/year) and large fields (> 15 million barrels/year).

A proportion of annual output 'old' oil was tied to world market price levels ('parity related' component of production) receiving a higher price than the remaining portion of

annual output - the 'controlled component' (\$2.41 to 2.71/barrel). The prices paid were revised at short intervals (6 months) and allowance was also made for changes to the Consumer Price Index. Partly as a result of the scheme, domestic supply did not increase and it was abandoned in late 1983.

As mentioned previously, a minimum amount of heavy-grade crude is imported to produce lubricants and diesel fuel etc. By 1983 'new' oil production expanded sufficiently to meet all local demand for light crude oil. Gippsland producers cut back production of 'old' oil so that continued expansion of their 'new' output was fully absorbed by the domestic market. The cutback in 'old' oil output reduced receipts of excise revenue, so much so that 'new' oil excess to domestic requirements was permitted to be exported and local supply levels would no longer be constrained by the domestic demand for light crude oil. Hence the major increase in supply (including exports) after 1983.

In the post-1983 Australian crude oil market the development of an intermediate excise rate for part of the 'old' oil output increased supply of this part of the resource while 'new' expanded as fast as could be physically allowed. The post-1983 crude oil market arrangements had a segmented supply pattern made up of 'old', 'intermediate' and world oil prices and local energy intensity largely determined domestic output.

An attempt to avoid the supply distortion arising from the excise scheme was made in 1984-86 with the introduction, in 1986, of a resource rent tax (RRT) on offshore ('greenfields') petroleum projects which had not reached development stage, thus excluding all of the Gippsland Basin and North West Shelf areas. The first revenue to be paid under RRT was received in May 1990 as a result of the significant volumes of oil have been extracted from the Jabiru oil deposit since mid-1986. The supply curve for oil produced from RRT liable projects was similar to the world oil supply curve as all local oil production was traded on the world market.

The major factors that have affected the pattern of oil resource use in Australia are the influence of the world market, the extent and nature of intervention in the crude oil market, the impact of broader macroeconomic factors. Each of these factors has either led to market intervention measures or contributed directly to the divergence between closed, open-market and actual resource use.

The development of a discriminatory pricing (and subsequently an excise scheme) after 1975 resulted in a decline in domestic oil supply between 1977-83, a period during which world market prices rose. The decline was due to producers allowing 'old' oil output to decline as it had a price ceiling lower than world market parity price, or a per barrel excise tax which lowered per barrel returns to the producer. 'Old' oil output declined so that output of 'new' oil, which had full parity pricing or a lower excise tax, could be maximised. The initial inelastic supply of 'new' oil gradually changed to an elastic supply pattern by 1983, so much so that it displaced some output of 'old' oil from the domestic market. This led the first lifting of a ban on the export of crude oil as well as a lowering of excise charges for some 'old' oil as a means of reversing the decline in 'old' oil output.

Removal of a ban on crude oil exports resulted in a major increase in domestic output and the abandonment of regulated crude oil marketing arrangements but the distortionary effect on supply resulting from discriminatory excises remained until this and regulated price-setting was abandoned in the late 1980s.

Issues and options in oil resource use

Comparison between use of Australia's crude oil resource in closed and open-market conditions suggest that, apart from world market effects, differences largely result from market intervention. The open-market is overall calculated to have the superior welfare outcomes for the use of our local oil resource. Any economic losses evident under the actual pattern of resource use highlight the significant welfare cost and impact of market intervention measures.

The initial focus for petroleum policy in Australian in the post-war years was the development of an indigenous crude oil supply, largely for reasons of security. The initial cost of an exploration and search subsidy scheme was considered moderate, despite the superior welfare from resource use in open-market conditions. Over time, changes were made to the conditions of the subsidy scheme, to limit growth in cost; the conditions were made more stringent once significant discoveries were made.

In the period 1972 - 1975 government sought to moderate the impacts of world market price rises using 'new'/'old' oil pricing, excise taxes and regulated marketing of crude oil production. For most of the 1980s the focus was on oil prices, the size and timing of possible oil price 'shocks' and the likelihood and timing of a decline in the productivity of the Gippsland Basin deposits. In the 1970s and 80s industry forecasts of the level of domestic self-sufficiency suggested that local oil supply would decline rapidly within 5 years. Despite the predictions of imminent decline local production peaked in 1986 and rose even higher in 1989 to 557,000 barrels per day. In the first quarter of 1990 local production averaged 600,000 barrels/day, confounding all previous predictions and reaching an ultimate peak in 1994.

Growth in the oil resource as a result of price increases is one reason why local industry predictions have been pessimistic. In addition, since 1983 local supply has had access to export markets and is no longer confined to limits set by local demand for light-grade crude oil. By 1990 at least one major industry figure indicated that with few, if any, changes to domestic and world market conditions, Australia's level of self-sufficiency could be maintained for several years, contrary to previous industry scenarios.

In 2002 what should be the appropriate response to the now imminent decline in local oil production? In addition to moderating world market fluctuations, some suggest that government should intervene in the local market to offset the unfavourable effects of limited knowledge, risk aversion and lack of information by generating more pre-competitive information for oil explorers. The views suggest that low levels of exploration activity might result from market imperfections unless there is government involvement in exploration and research and the development of exploration concepts.

Such views further suggest that by government gathering and disseminating information, particularly where data or exploration is rudimentary, the exploration industry may become more active and willing to actively explore for oil deposits, despite low real price levels.

Alternative views suggest that, in the long term, markets alone provide sufficient incentive to undertake successful exploration. Intervention, as such, represents an incentive to over invest in exploration and over-extract a scarce resource. The prospect of non-renewability of the oil resource should ultimately provide the required market-driven incentive to the pattern of resource use through the price mechanism.

In an open economy such as Australia's, theory suggests that the rights to explore for crude oil are best vested with groups and individuals who seek to maximise the value of their resource wealth in an open, competitive market even if market conditions result in short term periods of limited exploration activity.

The rights to explore, or develop and produce crude oil in Australia are firstly allocated on the basis of willingness to undertake exploration and development at the earliest opportunity (mainly Work Program Bidding). Some views of this system suggest that it could be expected to cause exploration and development to be conducted earlier, and involve larger investments, than is consistent with open-market conditions. Alternatives such as cash bidding provide a contrast with the work program allocation of exploration rights.

The importance of both work program and cash bidding systems cannot, however, be totally isolated as they are combined with other measures impact on the pattern of resource use. Another factor impacting on the value of exploration rights is the externality of information spillover. Exploration in any given area may provide useful information to holders of adjacent (permit) tracts. A common means of internalising such spillovers is by data exchange arrangements - a common feature of the local industry but also a significant source of incentives to undertaken additional exploration in areas adjacent to newly-discovered fields.

Overview

Past regulatory and taxation measures form crude oil production and taxation have resulted in significant losses in economic welfare and have, at times, seriously impinged on the level of crude oil production as well as causing distortions of the pattern of crude oil use. Given that OPEC and world market conditions are often blamed for such results, it is unlikely that a market-driven pattern of resource use will always be adopted in the future.

Economic welfare from open-market oil resource use has, in some instances, been superior to actual oil resource use in Australia because of the nature of the market and the highly regulated nature of many market intervention measures that have been applied to deal with short term issues.

Some authors suggest the current system of allocating exploration rights results in an incentive to over-invest in exploration and development. A precise evaluation of this has not yet been possible in the limited time available. It is however a key point which needs to be further evaluated. What is evident is that enforcement of work program conditions to meet required drilling commitments has, in rare instances, resulted in the discovery of an oil field by an otherwise cautious operator.

The long-term pattern of oil resource use in Australia which maximises economic welfare is to likely to follow that set by an open competitive world market. World market conditions will provide the most efficient long-term signals as to when it is appropriate to develop either oil from high cost frontier areas, or make the long-term transition to development of our natural endowment in gas resources.

Like our experiences in the punctuated development in other resources such as iron ore, natural gas has been recognised for a considerable period but remains underutilised until world market changes facilitates its wide use. It remains to be seen whether we are ready to make to such a transition, or if the world oil market can provide sufficient signals to encourage additional oil-oriented exploration in new 'frontier areas'.

Past expensive, unsuccessful exploration programs in frontier areas, that have been encouraged by a diversity of reasons, have in some instances proved to be an impediment to other international explorers who wish to avoid making similar 'errors of judgement' and who thus avoid working in Australia as a result. We should now be cautious to avoid repeating such decisions just as we should avoid making decisions based on a limited understanding of the dynamics of our now very open crude oil market and petroleum trading patterns.

It is the long-term market signals we need to pay most heed too rather than the short-term issue-driven signals. In making choices we should always avoid those measures that distort the pattern of resource use and result in long term economic losses such as we have experienced in the past.

Our recent history is littered with examples of market intervention in the name of improved efficiency or market correction. In some cases our economic welfare would have been far superior if we had have refrained from any market intervention at all. We should resist any attempts to gain support or have incentives granted to those who wish to save us from an 'imminent decline in local oil production'. Such static-market views have proved wrong in the past and are likely to be so again. The petroleum industry appears no closer to describing the workings of its own market but the pessimistic outlooks which such static analysis generates have proved useful in generating concessions and market intervention.

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