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The economic effects of an ethanol mandate

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Executive summary

- High oil prices, increased reliance on imported oil, and environmental concerns have led to calls for mandating the blending of domestically-produced ethanol with petrol ('fuel ethanol'). The most common proposal is for a blend with 10 per cent by volume of ethanol (E10). Mandate advocates cite fuel security, a smaller trade deficit resulting from lower oil imports, regional development, and environmental benefits as reasons for adopting a mandate. Concern that the domestic industry would not be able to compete with imports is also a factor behind the calls for a mandate.

- Reduced oil imports are only one effect of an ethanol mandate on the trade account. Any diversion of feedstock from exports or increased imports of feedstock needed to meet the mandate would increase the trade deficit.

- A mandate is only one way of reducing reliance on imported oil. Importing ethanol, for example, would be less economically costly than a mandate, and would diversify geographic supply sources and the composition of fuel.

- The evidence suggests that the costs of creating jobs under an E10 mandate would be high. A mandate could also adversely affect other rural industries.

- The Biofuels Taskforce that the Howard Government established concluded that greenhouse gas benefits alone would not warrant further assisting biofuels given the availability of much cheaper carbon reduction options.

- The additional demand for feedstock under a mandate might lead to competition for land from other uses such as food and exports. Views differ on the potential for competition for land use in Australia.

- A mandate could benefit the economy if domestic ethanol could compete with imports without government assistance.

- Even though a comprehensive cost-benefit analysis of an ethanol mandate has not been undertaken, no prima facie economic case for a mandate has been established.

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Introduction

High short-term oil prices, increasing reliance on imported oil, and environmental considerations have prompted calls for the greater use in Australia (and elsewhere) of alternatives to petrol (and diesel). In particular, some advocate mandating the blending of domestically-produced ethanol with petrol (such blends are called 'fuel ethanol'). This Research Paper examines some of the economic arguments for and against a mandate.

Mandate objectives

Mandate advocates in Australia such as the Australian Cane Growers Council[1] and overseas[2] cite fuel security, a smaller trade deficit, regional and agricultural development, and environmental benefits as reasons for adopting a mandate. In Australia, the most common proposal is a blend containing 10 per cent by volume of ethanol (E10). An E10 mandate would create an annual market of about two billion litres of ethanol.[3] In contrast, ethanol production in 2006–07 was about 130 million litres.[4] Current fuel ethanol use is tiny; in 2006–07, ethanol-blended fuel accounted for only 1.5 per cent of automotive gasoline sales.[5]

How would a mandate work?

A mandate increases demand for ethanol above what market forces (supply and demand) would otherwise determine. It generally costs more to produce ethanol than petrol (allowing for the fact that ethanol contains less energy than the same volume of petrol).[6] In the absence of a subsidy to encourage the use of ethanol, and with a tax regime that is neutral between petrol and ethanol, motorists would prefer to buy petrol rather than fuel ethanol because

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1. See also, Renewable Fuels Australia, *Submission to the Senate Rural and Regional Affairs and Transport References Committee inquiry into Australia's future oil supply and alternative transport fuels*, http://www.aph.gov.au/senate/committee/economics_ctte/petrol_price/submissions/sub23.pdf, accessed 1 December 2006.
2. Randy Schnepf, *Agriculture-Based Renewable Energy production*, CRS Report for Congress, 18 May 2006, http://fpc.state.gov/documents/organization/68294.pdf, accessed 14 November 2007.
3. Based on sales of automotive gasoline in 2004–05 of 19875.7 megalitres. In energy terms, if the energy density of ethanol is 0.68 that of petrol, in theory, replacing 1987.57 megalitres of petrol would require 2923 megalitres of ethanol.
4. Based on the estimated cost of the production subsidy of $50.3 million in 2006–07. See Department of Industry, Tourism and Resources, *Portfolio Budget Statements 2007–08*, p. 38.
5. Department of Industry, Tourism and Resources, *Australian Petroleum Statistics*, Issue 131, June 2007.
6. International Energy Agency, *World Energy Outlook 2006*, Paris, p. 385.

petrol is cheaper.[7] A mandate is thus a form of 'compulsory demand' because it obliges motorists to buy ethanol even when ethanol is uncompetitive with petrol:

> In the case of mandates, biofuels [ethanol and biodiesel] do not have to be competitive with petroleum fuels.[8]

Because it generally costs more to produce ethanol than petrol, a mandate would increase the price of fuel in the absence of an ethanol subsidy. The price increase is a redistribution of income from motorists to ethanol producers. A mandate is, in effect, a subsidy to ethanol producers paid by fuel users.

Australian Government policy

Current

The Howard Government's policy—as contained in the 2004 energy white paper—did not support a mandate for alternative fuels such as ethanol:

> Ultimately these [alternative] fuels must compete on their commercial merits and the government will not mandate the use of alternative transport fuels.[9]

The Howard Government rejected a mandate on the grounds that it would deny consumers the right not to use ethanol[10] and because domestic production capacity was not adequate to supply a mandate.[11] The Howard Government did, however, encourage the use of domestically-produced ethanol. In its 2001 election policy, the Government set a target of 350 megalitres (ML) of biofuels (ethanol and biodiesel) production capacity by 2010.[12] To help reach this target, domestic ethanol production is subsidised. Domestic ethanol and petrol are both subject to excise of 38.143 cents per litre.[13] The excise on ethanol is offset by paying

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7. A neutral tax would tax petrol and ethanol on their energy content.
8. Masami Kojima and Todd Johnson, *Potential for Biofuels for Transport in Developing Countries*, October 2005, p. 97, http://esmap.org/filez/pubs/31205BiofuelsforWeb.pdf , accessed 29 November 2006.
9. Australian Government, *Securing Australia's Energy Future*, Canberra 2004, p. 91, http://www.dpmc.gov.au/publications/energy_future/docs/energy.pdf, accessed 14 November 2007.
10. Hon. John Howard, Prime Minister, 'Statement to Parliament on Energy Initiatives', House of Representatives, *Ministerial Statement*, 14 August 2006, p. 40.
11. Adrian Rollins, 'Storm brews over Joyce's ethanol plan', *Australian Financial Review*, 18 July 2006, p. 5.
12. A megalitre is a million litres.
13. Excise is a tax the Commonwealth imposes on certain goods produced in Australia. In the case of petrol, the rate is set at so many cents per litre.

ethanol producers a production subsidy of 38.143 cents per litre. The subsidy reduces the cost of production and so makes ethanol production more viable relative to petrol, thus increasing demand for ethanol above what it would otherwise be.[14] Imported ethanol is subject to a customs duty of 38.143 cents per litre. Unlike the excise on domestic ethanol, the customs duty on imports is not offset. Consequently imported ethanol bears the full customs duty.

The effect of these arrangements is to redistribute income to domestic ethanol producers from taxpayers (via the production subsidy), and from fuel users (who could buy cheaper imported ethanol but are effectively prevented from doing so by the customs duty). Whereas the cost of the production subsidy is explicit because it is paid through the Budget—it is estimated to cost about $50 million in 2006–07—the customs duty provides an implicit subsidy.[15] The major beneficiary of these arrangements is the Manildra Group, which receives about 90 per cent of the production subsidy.[16]

The subsidisation of ethanol gives it a competitive edge over petrol, and allows retailers to sell fuel ethanol more cheaply than straight petrol. Without subsidisation, the limited market penetration of fuel ethanol would be even smaller than it is now.

The Howard Government also subsidised domestic ethanol production in the form of capital grants to increase production capacity[17] and encouraged service stations to sell fuel ethanol.[18] However, the cost of these programs was relatively small compared with the cost of the production subsidy.

The customs duty protects the domestic industry against imports. Protection is inconsistent with the policy of Australian governments of both political persuasions to reduce protection. Protection is also at odds with Australia's policy of encouraging other countries to lower their trade barriers. However, protection will end on 1 July 2015 when domestic and imported ethanol will be treated the same (see below). Concern that the domestic ethanol industry will not be able to compete with imports when protection is eliminated is a factor behind the calls for a mandate.

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14. There is no reason an ethanol producer would pass the production subsidy on to buyers other than to build market share. The production subsidy offsets the higher production costs of ethanol thus making production more viable, rather than operating as a consumption subsidy.
15. Department of Industry, Tourism and Resources, op. cit.
16. Senate, *Questions on Notice*, 'Fuel: Ethanol (Question No. 255)', 9 February 2005, pp. 183–4.
17. Hon. Joe Hockey, (acting Minister for Industry, Tourism and Resources), *Biofuels to create regional jobs*, media release, 25 July 2003.
18. Hon. John Howard (Prime Minister), 'Energy initiatives', op. cit.

A difference between a mandate and current arrangements relates to transparency. Whereas the cost of the subsidy and capital grants is explicit and detailed in Budget papers, the cost of a mandate to consumers would be implicit.

Proposed policy

Under the Howard Government's fuel tax proposals, which were contained in the energy white paper, ethanol—domestic and imported—will receive a long-term advantage by being taxed less than petrol. Under the proposals, on 1 July 2011, the effective rate of excise on ethanol will be 2.5 cents per litre. The effective rate will increase to 12.5 cents per litre on 1 July 2015.[19] The excise on petrol will, however, remain at 38.143 cents per litre. The 'discounted' rate of 12.5 cents per litre will thus continue to advantage ethanol relative to petrol.

Also from 1 July 2015, domestically-produced and imported ethanol will attract the same effective rate of excise and customs duty respectively. This will eliminate the current protection of the domestic ethanol industry.

Biofuels Taskforce

On 30 May 2005, the Howard Government announced the formation of a taskforce to examine, among other things, the scientific evidence on the effects of ethanol and other biofuel use on health and the environment.[20] In August 2005, the Biofuels Taskforce (the Taskforce) reported to the government.[21] This report is the most comprehensive independent analysis of the ethanol industry in Australia and included input from the Australian Bureau of Agricultural and Resource Economics (ABARE). The establishing of the Taskforce followed the release of two earlier reports on the viability of biofuels production.[22]

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19. The precise mechanism for implementing this proposal is yet to be announced.
20. Hon. John Howard (Prime Minister), *Taskforce on biofuels*, media release, 30 May 2005, http://www.pm.gov.au/media/Release/2005/media_Release1407.cfm, accessed 14 November 2007.
21. Australian Government, *Report of the Biofuels Taskforce to the Prime Minister*, August 2005, p. 115, http://www.dpmc.gov.au/biofuels/report/report_full.pdf, accessed 14 November 2007.
22. Department of Industry, Tourism and Resources, *Appropriateness of a 350 Million Litre Biofuels Target*, Canberra, December 2003 and Australian Bureau of Agricultural and Resource Economics, *Revised assessment of biofuels industry viability*, Canberra, April 2004. These studies are discussed in Richard Webb, 'Energy White Paper: fuel excise grants reform', *Research Note*, no. 11, Parliamentary Library, Canberra, 2004–05.

Balance of payments and fuel security

As noted, fuel security is an argument advanced for a mandate. In this context, fuel security is defined as reduced reliance on imported oil (and petroleum products). Mandate advocates also argue that a mandate would reduce the trade deficit with domestic ethanol production replacing some oil imports.[23]

The Howard Government rejected the fuel security argument. The Government's position with respect to fuel security and alternative transport fuels was set out in the energy white paper:

> … there is currently no case for the government to accelerate the uptake of these fuels on energy security grounds. To do so would involve additional costs for consumers, with few energy security benefits.[24]

A reduction in oil imports resulting from a mandate is only one of several possible effects on the trade account. The ability to meet mandate demand for feedstock depends on the availability of supply. The 2002 Fuel Tax Inquiry noted:

> Some submissions to the Inquiry advocated domestically produced renewable fuels as a measure to increase fuel security. As these renewable fuels would be derived mainly from purpose grown agricultural crops or waste products, the inevitable variations in weather patterns affecting agricultural output and market conditions will reduce the certainty of supply from such sources.[25]

A shortfall in the supply of feedstock might result in reduced exports or increased imports of feedstock. Either would increase the trade deficit and so counter the reduction in oil imports. The net effect on the trade account would depend on the specific circumstances. For example, during a drought:

> … if a national E10 target were to be met (eg. by 5.5 Mt of wheat as the feedstock), it could force the import of wheat in drought years.[26]

Imports, by increasing the volume of feedstock available, would reduce domestic prices of feedstock in short supply. However, quarantine restrictions may prevent the import of some commodities. This would result in domestic prices of quarantine-restricted feedstock remaining above international prices. Under a mandate, high domestic prices of quarantine-

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23. What matters is the *net* reduction in oil imports since ethanol production uses oil products as inputs e.g., diesel in tractors.
24. Australian Government, *Securing Australia's Energy Future*, op. cit., p. 124.
25. Australian Government, *Fuel Taxation Inquiry Report,* Canberra, 2002, p. 57.
26. Rural Industries Research and Development Corporation and CSIRO, *Biofuels in Australia – an overview of issues and prospects*, RIRDC publication number 07/071, 21 June 2007, p. 6.

restricted feedstock would increase ethanol production costs. These would flow through into higher fuel prices and inflation unless ethanol producers were able to substitute alternative feedstocks. Higher fuel prices would adversely affect the competitiveness of export and import-competing industries.

The effects of adverse feedstock supply conditions on ethanol production could be similar to those the biodiesel industry experienced in 2006. In this case, drought caused the price of feedstock such as canola to rise, in turn contributing to financial losses in the industry.[27] In periods of drought, a mandate could reduce the availability of feedstock used for other purposes including food production. A reduced supply of food inputs would increase food prices and hence inflation.

More generally, a mandate is a sector-specific, import-replacement argument. As such, it is reminiscent of arguments advanced in the 1950s and 1960s when import replacement was advocated as a means of coping with foreign exchange shortages under the then system of fixed exchange rates. While import-replacement arguments might have had some validity in the era of fixed exchange rates, they have little validity in an era of floating exchange rates:

> Foreign exchange savings remains a frequently cited benefit of domestic biofuel programs. However, foreign exchange benefits are much less important today as more countries maintain flexible exchange rates. If a country is pursuing a market-based approach to setting the exchange rate and the official rate reflects real economic values, then there would be no need to distinguish between local currency and foreign exchange costs or benefits of biofuel programs.[28]

Regional and agricultural development

Advocates argue that a mandate would increase economic activity in regional areas through employment at ethanol plants and increased demand for agricultural commodities. For example, it has been estimated that a full-scale sorghum-to-ethanol plant would require about 200 000 tonnes of grain annually.[29] Another study estimated that:

> The appearance of a new group of domestic grain buyers requiring at least 2.5 million tonnes of grain would also represent a potential increase in total domestic sorghum and wheat use in the order of 35 per cent over average domestic use in the period 2003–04 to 2005–06.[30]

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27. Tracy Lee, 'Biodiesel slides deeper into the red', *Australian Financial Review*, 12 October 2006.
28. Masami Kojima and Todd Johnson, op. cit. p. 97.
29. Hon. Mark Vaile (Minister for Trade), *Address to the Western Australian 500 Club*, 23 November 2005.
30. Graham Love and Clara Cuevas-Cubria, 'Outlook for Biofuels in Australia. The Challenges Ahead', *Australian Commodities*, volume 14, number 1, March quarter 2007, p. 218.

However, as discussed below, the additional demand may be met by diverting grain from other purposes such as exports.

Employment

As noted, the Howard Government had a production target of 350 megalitres of biofuels by 2010. In work undertaken for the Taskforce, ABARE estimated that meeting this target would generate an additional 648 jobs—216 directly and 432 indirectly—in regional areas.[31] The annual cost (in 2004–05 dollars) of each of the 648 jobs was estimated at $182 000 in government expenditure and $139 000 in economic costs. The Taskforce noted that while these costs appear high, they could be offset by other benefits such as emission reductions.[32]

The high cost of job creation (in 2004-05, average weekly ordinary time earnings were about $51 000) means that it would be cheaper to pay each worker average weekly earnings to do nothing than to subsidise them to produce ethanol. Given the cost of job creation under current policy settings, the cost of creating jobs would be likely to be even higher under an E10 mandate.

ABARE also estimated that there would be no net gains to employment nationally from meeting the 350 megalitres target.[33] This is partly because the current subsidisation of ethanol production transfers resources from one group (taxpayers) to another (ethanol producers). While employment rises among subsidy recipients, it falls in other sectors of the economy. That's because the taxes used to subsidise ethanol production reduce consumers' purchasing power and hence spending and job creation in other sectors of the economy. The effects of a mandate on employment could be similar, that is, more jobs in the subsidised sector but fewer in the rest of the economy. A difference is that, under a mandate, resources would be redistributed from motorists rather than taxpayers.

Other rural industries

Some rural industries claim that a mandate would affect them negatively. The Livestock Feed Grain Users Group, for example, has stated:

> We are not opposed to the production and use of biofuels in Australia. We are opposed to the ongoing subsidisation of grain based ethanol in Australia; this will disadvantage our

31. Australian Government, *Report of the Biofuels Taskforce to the Prime Minister*, op. cit., p. 115.

32. ibid., p. 10.

33. ibid., p. 3.

> grain dependent industries, and result in the propping up of an essentially nonviable industry at the expense of successful industries.[34]

The Taskforce addressed this issue:

> The Taskforce considers that, on current policy settings, there is real potential for subsidised grain ethanol plants to have a local impact on feedgrain prices in the short to medium term. In the longer term, fuel ethanol rates of return are likely to drop as the policy settings reduce the subsidies—and as ethanol import competition is allowed in 2011. The fuel ethanol industry will then be placed on a more even footing in its ability to bid for grain against the livestock industry.[35]

A mandate could have long-term adverse effects on other rural industries. A study by the Centre for International Economics for the beef industry found:

> Mandatory blending of ethanol at 10 per cent for petrol and 15 per cent for diesel would permanently increase the average price of grain in Australia by over 25 per cent. This would be well over current export parity prices, and prices paid by Australia's competitors. By 2010, ethanol production would demand an additional 12.1 million tonnes of grain. This is relative to a potential pool of feedgrain of around 28 million tonnes in 2010 …
>
> If grain production fell by 50 per cent in 2010, as it did in 2002-03, total availability of grain would fall to around 14 million tonnes. In this situation grain prices could rise as high as $450 per tonne. This would seriously affect livestock industries that compete directly with other countries on world markets and would have the potential to shut down parts of our leading export oriented industries including beef and dairy …[36]

The report also found that, in a non-drought year, mandatory blending of locally produced ethanol would reduce imports of petrol and diesel but also forego exports and incur additional imports.[37]

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34. Livestock Feed Grain Users Group, Submission to the Senate Rural and Regional Affairs and Transport References Committee inquiry into Australia's future oil supply and alternative transport fuels, http://www.aph.gov.au/SENATE/COMMITTEE/rrat_ctte/oil_supply/submissions/sub55.pdf, accessed 14 November 2007.
35. Australian Government, *Report of the Biofuels Taskforce to the Prime Minister*, op. cit., p. 9.
36. Centre for International Economics, *Impact of ethanol policies on feedgrain users in Australia.* Prepared for MLA on behalf of the Australian Beef Industry, August 2005, pp. ix–xi, http://www.thecie.com.au/publications/CIE-Ethanol_report.pdf, accessed 14 November 2007.
37. ibid.

In short, under a mandate:

> … the government would be subsidising one rural sector, the grains sector, at the expense of another, namely livestock.[38]

Environment

While it is generally more costly to produce energy from renewable resources than from fossil fuels, this does not take account of the costs of 'negative externalities' resulting from fossil fuel use—such as air pollution—nor 'positive externalities'—such as reduced greenhouse gas emissions—of alternative fuels. Advocates argue that the mandated use of fuel ethanol would result in environmental benefits including lower air pollutant emissions and lower greenhouse gas emissions. In 2005, transport accounted for more than 14 per cent of carbon dioxide equivalent emissions.[39]

Fuel use is the single largest contributor to air pollutant emissions in Australia.[40] A study by the Bureau of Transport and Regional Economics estimated that in 2000, motor vehicle-related ambient air pollution resulted in an economic cost of morbidity ranging from $0.4 billion to $1.2 billion while the economic cost of mortality ranged from $1.1 billion to $2.6 billion.[41] This raises the question of what contribution a mandate would make to reducing the costs of air pollution. The Taskforce's review of the studies of exhaust emissions from fuel ethanol found that the benefits are mixed:

> Results from studies that have been conducted throughout the world on exhaust emissions from ethanol-blended fuels are contradictory, making it difficult to generalise on emission outcomes and performance of ethanol blends.[42]

For example, in the case of E10, carbon monoxide emissions are lower but nitrous oxide emissions are higher compared with straight petrol. Further, while E10 results in lower tailpipe emissions of some toxic compounds, it results in higher emissions of others. Consequently, the Taskforce was unable to quantify the health costs and benefits of E10:

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38. Rabobank, *Australian Biofuels: fuelling the future of farming?*, Rabobank Global Focus, spring 2006, p. 5.
39. Australian Greenhouse Office Department of Environment and Water Resources, *National Greenhouse Gas Inventory 2005*, March 2007, http://www.greenhouse.gov.au/inventory/2005/index.html, accessed 14 November 2007.
40. Australian Government, *Fuel Taxation Inquiry Report,* op. cit., p. 69.
41. Bureau of Transport and Regional Economics, *Health impacts of transport emissions in Australia: Economic Costs*, working paper no. 63, June 2005, p. ix, http://www.btre.gov.au/publications/94/Files/wp63.pdf, accessed 14 November 2007.
42. Australian Government, *Report of the Biofuels Taskforce to the Prime Minister*, op. cit., p. 70.

> Given the uncertainties surrounding the level of particulate reduction from E10, it is not possible to quantify the health costs and benefits of E10 use.[43]

It is likewise not possible to be definitive about the benefits of a mandate in terms of reduced greenhouse gases because the benefits would depend on many factors:

> The net impact on greenhouse-gas emissions of replacing conventional fuels with biofuels depends on several factors. These include the type of crop, the amount and type of energy embedded in the fertilizer used to grow the crop and in the water used, emissions from fertilizer production, the resulting crop yield, the energy used in gathering and transporting the feedstock to the biorefinery, alternative land uses, and the energy intensity of the conversion process … In practice, the amount and type of primary energy consumed in producing biofuels and, therefore, the related emissions of greenhouse gases, vary enormously.[44]

With respect to greenhouse gas emissions from the use of fuel ethanol, the Taskforce review of studies found that:

> On life-cycle analysis, savings in greenhouse gas emissions from E10 over neat petrol are generally from 1-4%, depending on feedstock. However, the taskforce considers that a recent life-cycle analysis for a proposed ethanol plant has suggested that savings of between 7 and 11.55 can be achieved with optimum use of non-ethanol products.[45]

These orders of magnitude are similar to those reported in another study:

> When used in an E10 blend, greenhouse gases (compared to unleaded petrol) are lower by 1.7 % (from wheat) to 5.1% (C-molasses using co-generation).[46]

The Taskforce concluded that the cost of obtaining greenhouse gas benefits from subsidising biofuels is high in terms of lower gross domestic product (GDP). Consequently:

> Greenhouse gas benefits alone would not warrant further assisting biofuels, given the availability of much cheaper carbon reduction options.[47]

This suggests that a fuel ethanol mandate would also be a relatively costly way of reducing greenhouse gas emissions. This is consistent with the findings of other studies:

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43. ibid., p. 7.
44. International Energy Agency, op. cit., pp. 391–2.
45. Australian Government, *Report of the Biofuels Taskforce to the Prime Minister*, op. cit., p. 77.
46. Rural Industries Research and Development Corporation and CSIRO, op. cit., p. 5.
47. Australian Government, *Report of the Biofuels Taskforce to the Prime Minister*, op. cit., p. 7.

> The overall cost-effectiveness of biofuels seems to be low in almost all cases. Costs are relatively high per unit of fossil energy or per unit of CO_2 emissions reduced … The implication of these calculations is that one could have achieved far more reductions for the same amount of money by simply purchasing CO_2-equivalent offsets at the market price. [48]

As it is, the environmental benefits of ethanol are being increasingly questioned because the production of ethanol also generates negative externalities. An OECD roundtable on sustainable development concluded:

> The growth of the biofuels industry is also likely to place pressure on the environment and biodiversity. Biomass feedstocks can be most efficiently produced in tropical regions, where suitable and available land is concentrated, and annual yields are highest. However, as long as environmental values are not adequately priced in the market there will be powerful incentives to replace natural ecosystems such as forests, wetlands and pasture land with dedicated bio-energy crops, thus harming the environmental credentials of biofuels.
>
> Even without taking into account carbon emissions through land-use change, among current technologies only sugarcane-to-ethanol in Brazil, ethanol produced as a by-product of cellulose production (as in Sweden and Switzerland), and manufacture of biodiesel from animal fats and used cooking oil, can substantially reduce greenhouse gases compared with gasoline and mineral diesel. The other conventional biofuel technologies typically deliver greenhouse gas reductions of less than 40% compared with their fossil-fuel alternatives. When such impacts as soil acidification, fertilizer use, biodiversity loss and toxicity of agricultural pesticides are taken into account, the overall environmental impacts of ethanol and biodiesel can very easily exceed those of petrol and mineral diesel.
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> … The conclusion must be that the potential of the current technologies of choice – ethanol and biodiesel – to deliver a major contribution to the energy demands of the transport sector without compromising food prices and the environment is very limited.[49]

Feedstock costs

The cost of feedstock is a major factor in the viability of ethanol production: an OECD study found that feedstock accounts for more than half the total cost of production.[50] In Australia, feedstock costs typically represent 60 to 70 per cent of operating costs.[51] In Australia, ethanol

48. Richard Doornbosch and Ronald Steenblik, *Biofuels: Is the Cure Worse Than the Disease?*, Organisation for Economic Co-operation and Development, Paris, 11–12 September 2007, pp. 37–38.
49. ibid., pp. 4–5.
50. OECD, *Agricultural Market Impacts of Future Growth in the Production of Biofuels*, 1 February 2006, p. 14, http://www.oecd.org/dataoecd/58/62/36074135.pdf. Web address accessed 14 November 2007.
51. Graham Love and Clara Cuevas-Cubria, op. cit., p. 214.

is produced from C-molasses and starch. Both are relatively low-value by-products (of sugar and wheat milling respectively). Scope for using these feedstocks to expand ethanol production seems to be limited. CSR, for example, has stated that it is unlikely that molasses will supply the industry:

> The reality of molasses, though, is that it is expensive to transport and it is not produced in quantities large enough at one site to economically produce ethanol … So it is unlikely that molasses will supply the industry.[52]

For the time being, CSR has ruled out using sugar as a feedstock:

> … it is our view that sugar is too valuable as sugar under current and historic scenarios, relative to the price or likely price of oil (or more specifically gasoline) to be viable as a source of fuel ethanol.[53]

What the additional feedstock needed for a mandate might be is unclear but grains (such as sorghum, wheat and barley), oilseeds, and non-food inputs (notably lignocellulose) have been mentioned. These sources may, however, be more costly than C-molasses and wheat starch. The Australian Cane Growers' Council, in its submission to the Senate inquiry into Australia's future oil supply and alternative transport fuels, shows a rising supply cost curve, that is, additional ethanol supply would be forthcoming only by using progressively more expensive feedstock.[54]

Competition for land use

An issue in the mandate debate is whether the capacity exists to supply the additional feedstock needed for a mandate from domestic sources. In particular, a question that arises is whether it is possible to meet demand for feedstock resulting from a mandate as well as for food crops and exports. This could possibly be done by expanding the area under crops.

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52. CSR, Submission to the Senate Rural and Regional Affairs and Transport References Committee inquiry into Australia's future oil supply and alternative transport fuels, submission 148, http://www.aph.gov.au/senate/committee/rrat_ctte/oil_supply/submissions/sub148.pdf, accessed 14 November 2007.

53. ibid.

54. Australian Cane Growers' Council Ltd, *Submission to the Senate Rural and Regional Affairs and Transport References Committee inquiry into Australia's future oil supply and alternative transport fuels*, p. 5, http://www.aph.gov.au/SENATE/COMMITTEE/rrat_ctte/oil_supply/submissions/sub36.pdf, accessed 14 November 2007.

However, meeting mandate demand could result in land being diverted from food crops and exports.[55] The International Energy Agency has noted:

> … production of biofuels can draw crops away from other uses (such as food production) and can increase their price. This may translate into higher prices for consumers.[56]

An OECD study of the effects of the production of biofuels in the US, Canada and the European Union on agricultural markets found:

> The results of these calculations suggest that the three OECD regions, the US, Canada and EU (15) would require between 30% and 70% of their respective current crop area if they are to replace 10% of their transport fuel consumption by biofuels, assuming unchanged production technologies, feedstock shares and crop yields, and in the absence of international trade in biofuels or use of marginal or fallow land. However, only 3% would be required in Brazil.[57]

Whether land availability in Australia would limit growth in biofuels production based on sugar, grain and other crops may be another matter. The potential for land diversion under a mandate would depend on factors such as the feedstocks used, the availability of suitable land, and the size of the mandate (for example, E5 or E10). The Taskforce found:

> While the feedstock for a 350 megalitre biofuel target can be sourced from existing crops, further expansion of the industry may require farming of additional land … However, to the degree that biofuels will draw feedstock away from current uses such as export, there need be no significant additional land use.[58]

Views differ on the potential for competition for land use under a mandate in Australia. The Howard Government's position, as set out in the energy white paper, was that land would have to be diverted from other uses to meet the extra feedstock demand:

> Supplying a substantial proportion of fuel requirements from biofuels would be difficult and require the transfer of land use from other productive purposes. For example, converting the total national oilseed crop to biodiesel would only produce 6 per cent of Australia's current diesel needs.[59]

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55. In the United States, the sharp increase in the demand for corn for use as ethanol feedstock has increased corn prices by about 50 per cent over the past year. See Robert Samuelson, 'Don't pump up biofuel expectation', *Australian Financial Review*, 31 January 2007, p. 55.
56. International Energy Agency, *Biofuels for Transport—An International Perspective*, November 2004, p. 14.
57. OECD, *Agricultural Market Impacts of Future Growth in the Production of Biofuels*, op. cit., p. 5.
58. Australian Government, *Report of the Biofuels Taskforce to the Prime Minister*, op. cit., p. 92.
59. Australian Government, *Securing Australia's Energy Future*, op. cit., p. 123.

In the case of sugar, Rabobank has stated:

> Sugar cane production in Australia is, essentially, stable. There is limited scope for increases in land area planted to cane because of constraints imposed by regulation and geographical suitability. There is scope for some conversion of land from other agricultural uses to cane, depending on the relative price of commodities; however, this potential is limited. Were an ethanol industry to be established based on sugar, there is not the scope to increase cane production substantially. Ethanol would therefore have to compete with the sugar industry for available cane and the pricing of ethanol feedstock would have to be at a sugar export parity price.[60]

On the other hand, the Manildra Group argues that:

> Australia has the capacity to produce all the agricultural products which are required as feedstock for the production of renewable fuels such as ethanol. Major industry participants such as The Grains Council and Australian Wheat Board Ltd have indicated their strong support for the development of a renewable fuels industry.[61]

Renewable Fuels Australia argues that competition for land would be limited. This argument holds that the supply of agricultural commodities is now demand-constrained and, in particular, a lack of export demand has limited domestic production. The additional demand under a mandate would, in effect, activate idle land.[62]

A mandate could increase domestic grain prices by increasing demand for grain. Whether the increase could be sustained is another matter. Australia is generally a 'price taker' on international markets for agricultural commodities, so farmers can export as much as they can sell profitably at international prices. After rising initially, domestic grain prices could fall back to international prices (allowing for factors such as shipping costs) for several reasons: the domestic supply of grain could increase,[63] imports could rise (assuming no quarantine restrictions), and supplies could be diverted from exports to the domestic market. If higher grain prices were sustained, this would drive up ethanol feedstock costs.

Some have likewise questioned whether a mandate would increase sugar prices in the long term:

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60. Rabobank, op. cit., p. 5.
61. Manildra Group, Submission to the Senate Rural and Regional Affairs and Transport References Committee inquiry into Australia's future oil supply and alternative transport fuels, http://www.aph.gov.au/senate/committee/economics_ctte/petrol_price/submissions/sub67.pdf, accessed 14 November 2007.
62. Dr Bob Gordon, 'Biofuel industry talks up future', ABC online, 9 August 2006, http://www.abc.net.au/pm/content/2006/s1711018.htm, accessed 14 November 2007.
63. The magnitude of the additional supply would depend on the elasticity of supply with respect to price.

> … even if sugar were the main feedstock, the price paid by ethanol producers would be just sufficient to bid product away from the export market; cane growers would see little or no benefit.[64]

That's because domestic sugar prices are determined on world markets—that is, Australia is a 'price taker'—and domestic ethanol producers would not pay above the world (export) price for sugar to obtain feedstock.

Economic efficiency

A key issue is whether a mandate would result in an ethanol industry that is competitive without on-going government assistance. As stated by the Taskforce:

> Some submissions argued that biofuels benefit the Australian economy by improving the balance of trade. Substituting locally produced biofuels for imported petroleum products could benefit the Australian economy only if they could be produced and sold competitively with imported alternatives without significant government assistance.[65]

Australia's experience of industry assistance is that it can result in small-scale, fragmented industries unable to compete with imports or export because of high cost structures. The cost to the economy of such assistance is the production foregone by employing resources in the assisted industries rather than in the more productive activities in which Australia has comparative advantage. In other words, GDP is below its potential. ABARE concluded that assisting the biofuels industry to meet the 350 megalitre target will reduce GDP:

> … modelling by ABARE forecasts a reduction in GDP of $90 million in 2009–10 for 350 ML biofuels market penetration, dropping in steps each year to $72 million in 2015.[66]

An E10 mandate would require a volume of ethanol about 5.5 times the 350 megalitre target.[67] In short, while the current system of government support for biofuels can be expected to result in economic costs to the community,[68] an E10 mandate could result in an even bigger reduction in GDP.

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64. David Trebeck, *Agribusiness Policy—A handbrake in business and Development?*, address to the Agribusiness Congress, 28 August 2003.
65. Australian Government, *Report of the Biofuels Taskforce to the Prime Minister*, op. cit., p. 8.
66. ibid.
67. This is based on sales of automotive gasoline in 2004–05 of 19875.7 megalitres. Assuming that ethanol displaces 10 per cent of this total, the volume of ethanol required would be 1987.57 megalitres. This is 5.7 times the 350 megalitre target.
68. Graham Love and Clara Cuevas-Cubria, op. cit., p. 219.

This raises the question of whether the production of ethanol can be viable without on-going assistance. The International Energy Agency, in commenting on the outlook for biofuels globally, stated:

> Higher oil prices have made biofuels more competitive with conventional oil-based fuels, but further cost reductions are needed for most biofuels to be able to compete effectively without subsidy.[69]

Brazil is the lowest-cost ethanol producer.[70] Hence, in economic terms, Australia should import ethanol from Brazil rather than try to produce it domestically. Moreover, it seems likely that Brazil will continue to have comparative advantage in ethanol production for some time:

> While technical progress in agricultural and biofuel production as well as land use changes are likely to improve efficiencies of biofuel production processes, both production costs and area requirements suggest a substantial comparative advantage of Brazil relative to OECD countries.[71]

This suggests that Australian ethanol will not be able to compete against Brazilian ethanol without assistance.

Infant industry

Assistance to ethanol production might be justified on 'infant industry' grounds. This argument holds that assistance can help to establish a new industry. As the industry develops, its costs fall so that it can eventually compete without government assistance. But it is sometimes overlooked that this argument also requires that assistance be temporary lest the assistance result in an uncompetitive industry. A permanent mandate could have such consequences.

Alternatives to a mandate

There is no comprehensive assessment of the economic consequences of an ethanol mandate in Australia. An evaluation of a mandate would also examine alternatives. As noted, a mandate seeks to attain multiple objectives. An assessment of a mandate would examine whether these objectives could be attained by other means and evaluate the relative costs and benefits of each alternative. For example, an alternative to a mandate would be to expand

69. International Energy Agency, op. cit., p. 385.

70. An OECD study found that only Brazil would be able to produce ethanol economically with world crude oil prices of around US$ 39 per barrel, which was the prevailing price in 2004. See OECD, *Agricultural Market Impacts of Future Growth in the Production of Biofuels*, op. cit., p. 5.

71. ibid.

current arrangements. The cost to the Budget of subsidising the volume of ethanol equivalent of an E10 mandate, at the current rate of subsidy, would be in the order of $758 million annually.[72] Direct payments through the Budget would be the most transparent form of subsidy, and would allow spending on subsidies to be weighed against other social priorities.

Environment

The principle of examining alternatives to a mandate applies to environmental outcomes. A cost-benefit analysis of a mandate would take account of all externalities, including the additional greenhouse gases generated from growing additional feedstocks and ethanol manufacture as well as any reductions resulting from the increased use of ethanol.[73] As noted, the net environmental benefits of ethanol are increasingly being questioned.

Further, an assessment of a mandate would examine which method is the least-cost means of obtaining environmental benefits. As the Taskforce observed:

> Any confirmed air quality benefits from biofuels need to be evaluated side by side with the costs and benefits of other approaches to reducing emissions.[74]

For example, to reduce greenhouse gas emissions, an alternative is to tax petrol more heavily. The Fuel Taxation Inquiry concluded:

> The strong relationship between fuel consumption and greenhouse gas emissions makes fuel tax an appropriate instrument for charging for the costs of climate change attributable to fuel use.[75]

Imports

Another alternative to a mandate is to import ethanol. At present the cost of imported ethanol is cheaper than domestically produced ethanol and hence is likely to be less costly in broader economic terms than a mandate. Imports might also help to ensure consistency of fuel

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72. In 2004–05, sales of automotive gasoline were 19875.7 megalitres. Assuming that ethanol displaces 10 per cent of this total, the volume of ethanol required would be 1987.57 megalitres. At the current subsidy rate of 38.143 cents per litre, this translates into an annual production subsidy cost of $758 million.

73. Such an analysis would have to take account of different feedstocks because they yield different reductions in carbon dioxide emissions. An International Energy Agency (IEA) study found that the cost per tonne of greenhouse gas reductions was least from cane ethanol produced in Brazil and highest from grain in IEA countries. See International Energy Agency, *Biofuels for Transport—An International Perspective*, November 2004, pp. 15–16.

74. Australian Government, *Report of the Biofuels Taskforce to the Prime Minister*, op. cit., p. 6.

75. Australian Government, *Fuel Taxation Inquiry Report*, op. cit., p. 73.

supply[76] while diversifying geographic sources of supply and the composition of fuels. Further, the cheaper ethanol is, the more likely it is that motorists will use fuel ethanol. In the United States, where imported ethanol is subject to a tariff, it has been argued:

> … if ethanol is truly to succeed as a motor fuel, it will have to be the cheapest ethanol globally available. And consumers would benefit most if the market, not special-interest politics, decided how much ethanol to use and where it should come from. If lawmakers really want drivers to use ethanol, they must allow free trade in this alternative fuel.[77]

One study found that if the tariff were removed, ethanol prices in the United States would fall by fourteen per cent.[78]

Regional development

As noted, the Taskforce found that the cost of creating each job in regional areas under current policy settings is high at $182 000 in government expenditure and $139 000 in economic costs (in 2004–05 dollars). The high cost of job creation raises the question of whether there are less costly ways of creating jobs in rural areas, that is:

> … whether assistance to biofuels represents the most cost-effective and best-targeted option for assisting regional development.[79]

For example, an option might be to produce ethanol from lignocellulose from trees. A study by the Bureau of Transport and Communications Economics found that the feedstock with the best potential to reduce overall greenhouse gas emissions is wood, and an extensive program to produce ethanol from wood could increase employment in regional areas. Further, potential supplies of lignocellulose in Australia are large. However, the cost is uncertain.[80]

Future

In the future, whether ethanol is competitive with petrol without government assistance will depend on the cost of ethanol production relative to the cost of petroleum-based fuels. High oil prices provide an incentive to develop new technologies for alternative fuel production. But high oil prices are a twin-edged sword because they also increase agricultural feedstock production costs:

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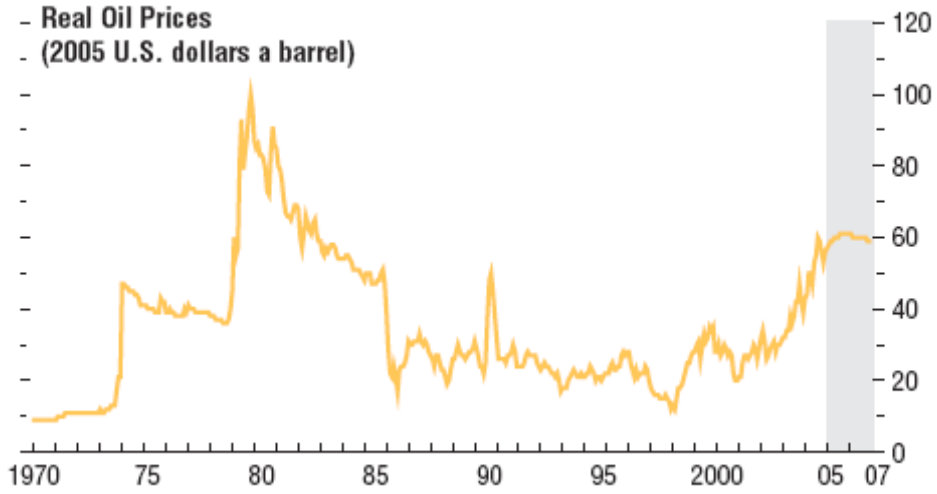
76. Rabobank, op. cit., p. 5.
77. Ben Lieberman, *Let the Ethanol Imports Flow*, Business Week, June 5 2006, p. 136.
78. James Surowiecki, 'Deal sweeteners' *The New Yorker*, 27 November 2006.
79. Australian Government, *Report of the Biofuels Taskforce to the Prime Minister*, op. cit., p. 9.
80. Bureau of Transport and Communications Economics, *Transport and greenhouse. Costs and options for reducing emission*, report 96, July 1996, pp. 294–305.

> The analysis also shows that commodity markets are strongly influenced by crude oil prices. Higher oil prices as currently observed increase production costs in agriculture, but also create higher incentives for biofuel production, thus stimulating demand for feedstock products. The degree to which biofuel quantities would increase strongly depends on parameters that are yet unobserved. Nevertheless, the results of this analysis suggest that the impacts of high oil prices on agricultural markets may well be dominated by their direct effects on agricultural production costs rather than by the increased demand for agricultural commodities.[81]

Fluctuations in crude oil prices, which make it difficult to discern price trends, may also contribute to a reluctance to invest in ethanol production capacity. The following chart shows how real oil prices have fluctuated since 1970.



Source: International Monetary Fund, *World Economic Outlook*, April 2006, p. 72.

Whether ethanol is uncompetitive with petrol without government assistance will also depend on new technologies. In the future, feedstock for ethanol production may be derived from non-traditional sources. The International Energy Agency has observed:

> New biofuels technologies being developed today, notably enzymatic hydrolysis and gasification of woody ligno-cellulosic feedstock, could allow biofuels to play a much bigger role than that foreseen in either scenario. Ligno-cellulosic crops, including trees and grasses, can be grown on poorer-quality land at much lower cost than crops used now to make biofuels. They may also be more environmentally benign. But significant technological

81. OECD, *Agricultural Market Impacts of Future Growth in the Production of Biofuels*, op. cit., p. 6.

> challenges still need to be overcome for these second-generation technologies to become commercially viable.[82]

Similarly, the US National Commission on Energy Policy:

> … believes that ethanol produced from cellulosic (i.e. fibrous or woody plant materials) should be the focus of near-term research … cellulosic ethanol offers substantial energy security, environmental, and long-term cost advantages compared to corn-based ethanol.[83]

The Senate Standing Committee on Rural and Regional Affairs and Transport, in its final report on Australia's future oil supply and alternative transport fuels, commented:

> The committee does not consider that there is any point at this time in mandating a minimum percentage of ethanol in petrol. Unless lignocellulose technology becomes viable with unexpected speed, supply will not be sufficient to produce the necessary quantities of fuel.[84]

Conclusions

An ethanol mandate would have economic costs and benefits. Their precise nature and magnitude would depend on many factors including the specific feedstock, its availability, the effects on other industries—including other rural industries—and the technology used. In the absence of an evaluation of these factors, it is not possible to say exactly where the balance of costs and benefits of a mandate would lie.

A feature of the mandate debate is the lack of discussion of alternatives. As noted, there are other ways of attaining a mandate's objectives. These include increasing fuel taxes and eliminating the tariff on imported ethanol. It would be prudent to evaluate the costs and benefits of a mandate, and the relative merits of alternatives, before adopting a mandate.

The expansion of ethanol production in other countries—notably Brazil and the United States—is sometimes seen as something that Australia should follow. However, it is important to recognise that the existence of ethanol industries in both countries is, to a large extent, the consequence of government assistance. Moreover, the circumstances in other countries differ from those in Australia and it can not be assumed that they can somehow be

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82. International Energy Agency, op cit., Paris, p. 385.

83. National Commission on Energy Policy, *Ending the Energy Stalemate*, December 2004, p. 70, http://www.energycommission.org/files/contentFiles/report_noninteractive_44566feaabc5d.pdf, accessed 14 November 2007.

84. Senate Standing Committee on Rural and Regional Affairs and Transport, *Australia's future oil supply and alternative transport fuels. Final report*, 7 February 2007, paragraph 7.59, p. 131, http://www.aph.gov.au/senate/committee/rrat_ctte/oil_supply/report/report.pdf, accessed 14 November 2007.

reproduced here. In the United States, for example, it would be difficult for ethanol to compete with petrol without government assistance:

> … rising fossil fuel prices improve renewable energy's market competitiveness; however, significant improvement of existing technology or the development of new technology still is needed for current biofuel production strategies to be economically competitive with existing fossil fuels in the absence of government support.[85]

Further, the merit of government support policies in other countries has been questioned.[86] Among the reasons is that:

> … a review of available data suggests that farm-based energy production is unlikely to be able to substantially reduce the nation's dependence on petroleum imports unless there is a significant decline in consumption. Also, other uses (food, animal feed, industrial processing, etc.) of biomass feedstocks are likely to be adversely impacted by rapid growth in use for bioenergy.[87]

85. Randy Schnepf, op. cit.
86. See, for example, Doug Koplow, *Biofuels: At What Cost? Government Support for Ethanol and Biodiesel in the United States*, International Institute for Sustainable Development, October 2006, at http://www.globalsubsidies.org/IMG/pdf/biofuels_subsidies_us.pdf. Web address accessed 14 November 2007.
87. Randy Schnepf, op. cit.