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Cost Benefit Analysis of Changes to South Australia's Time Zone

Final Report

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Executive Summary

The Department of State Development commissioned the SA Centre for Economic Studies to undertake a cost benefit analysis (i.e. economic analysis) of the two potential changes to South Australia's time zone, namely shifting half an hour back to "true" Central Standard Time ("true CST) which would be Coordinated Universal Time (UTC) +9.00, or shifting half an hour forwards to Eastern Standard Time (EST), UTC +10.00.

South Australia's current time zone Central Standard Time is equal to the mean time of the meridian of longitude at one hundred and forty-two and a half degrees east of Greenwich. This meridian actually passes through western Victoria and New South Wales, which means that the sun typically reaches its highest point in the sky (solar noon) sometime after 12 a.m. CST, with the difference increasing further west one goes (based on information from Geoscience Australia 2010.)

Shifting to EST would result in fewer morning daylight hours, but longer daylight in the evenings, as well as making collaboration with those in the eastern states easier. Shifting to "true" CST would increase the daylight hours available in the morning, but twilight would come earlier, as well as making collaboration with Western Australia and Asia easier.

Cost benefit analysis is a decision making tool that allows comparison of a diverse range of benefits and costs arising from a new policy or project by first quantifying them and then seeking to identify monetary values for each the streams of benefits and costs. The quantification of benefits and costs is undertaken relative to the base case where the current policy continues. Benefits or costs that occur in the future are converted to present values, allowing them to be compared on a consistent basis.

This cost benefit analysis draws heavily on two earlier studies undertaken by SACES, a recently completed brief review of the potential impacts on businesses undertaken for the Department of State Development and a more detailed report that SACES undertook on this topic in April 2008 (the latter only having assessed the impact of switching to EST).

Some in the South Australian business community (particularly in metropolitan Adelaide) would prefer that South Australia adopt EST by moving clocks forward half an hour. Business leaders assert that such a move would simplify business with the eastern states and the rest of the world. The findings of the most recent exercise with respect to those surveyed in the business sector are similar to the more broad based study of 2008:

- most respondents consider the current arrangements cause little to no inconvenience to their business operations as was the case in the 2008 study;
- the majority of businesses could not identify any significant disadvantages in moving to EST;
- few respondents identified any significant cost or revenue impacts from a move to EST
- more businesses expected significant advantages from a move to EST (14 per cent) than expected significant disadvantages (10 per cent).

Those businesses identifying a significant benefit from a shift to EST were most likely to highlight easier collaboration with colleagues, suppliers or clients located in the eastern states. Those who foresaw significant disadvantages to the move to EST were concerned about the costs/risks of a greater share of their operations taking place before dawn, or of increased time difference from Asia.

There is also a specific range of concerns about a shift to EST raised by businesses in, and residents of, the western parts of the state, particularly those in the Eyre Peninsula and West Coast, relating the shift further away from 'solar time' in these areas if the state's time zone were to shift forwards half an hour.

A range of potential benefits and costs of shifting to either EST or "true" CST were identified for inclusion in the analysis. In most cases the potential impacts were symmetrical with a shift to EST producing a particular type of benefit and a shift to "true" CST producing a related cost, and vice versa. The included impacts were:

Costs to the wider community

- Road crashes caused - intangible costs of deaths
- Road crashes caused - other costs
- Children commuting to school before dawn
- Increased energy usage
- Less time in evenings with family (farmers)
- Disadvantage to people in eastern South Australia (from a change to "true" CST)

Benefits to the wider community

- Improved health from longer sunshine in the evening
- No delay in radio and television broadcasts
- Road crashes averted - intangible benefits of averted deaths
- Road crashes averted - other avoided costs
- Reduction in energy usage
- Reduction in crime
- Fewer people commuting to school and work before dawn
- Health benefits from being closer to natural time

Costs to businesses

- Reduction in trade with eastern states
- Decreased exports to APEC nations
- Decreased sales to WA
- Increased accident rates in construction
- Breaches of curfew by Emirates
- Revisions to airline schedules
- Software costs to implement new time zone

Benefits to businesses

- Reduced business costs
- Increased foreign direct investment
- Increased business revenue
- Reduction in construction accidents

Each shift in time zone is estimated to produce net benefits over its costs, however the shift to EST produces a substantially quantifiable larger net benefit. In net present value terms to shift to EST is estimated to produce net benefits of \$2.5 billion, with a shift to “true” CST estimated to produce net benefits of \$0.3 billion.

The distribution of net benefits also differs between the options, with a shift to EST generating a substantial net benefit for business but a (comparatively modest) net cost for the community. A shift to “true” CST is estimated to generate net benefits for both business and the wider community, but they are each an order of magnitude smaller than the net benefit to business generated by EST.

It should be noted in interpreting the results that a number of the costs and benefits could not be quantified and so are not included in the analysis. This is likely to have a greater impact on the estimated net benefit of a shift to “true” CST than for the estimated net benefit of the shift to EST.

In interpreting the results one must also take into account the sensitivity of the results to modest or realistic variations in parameter assumptions. The results are not particularly sensitive to basic parameter changes such as changes in the discount rate, or shift up or down of costs or benefits by 20 per cent. However, the analysis is *highly* sensitive to the estimates of the benefits arising from increased trade as a result of a matching time zone more closely with a trading partner whether interstate or overseas. The uncertainties of these estimated benefits are high, particularly those relating to the 2008 survey (SACES 2008).

The uncertainties regarding the impact on business suggest that, should either change in time zone be considered for adoption, the government engage in extensive consultations with South Australian businesses that have extensive trade with the eastern states and Asia to confirm whether the results of the 2008 survey, and Stein and Daude's (2007) estimates are representative of South Australian businesses.

Acknowledgements

The SA Centre for Economic Studies would like to acknowledge the businesses and individuals who responded to the survey or consultations undertaken as part of the 2015 study; those businesses who responded to the 2008 survey on the impact of a shift to EST; and BusinessSA for giving permission for the results of the 2008 survey to be re-used in this analysis.

1. Introduction

This report presents a cost benefit analysis (i.e. economic analysis) of the two potential changes to South Australia's time zone, namely shifting to Coordinated Universal Time (UTC) +9.00 ("true" Central Standard Time) or to UTC +10.00 (Eastern Standard Time). The economic analysis assesses the impacts of each potential change in time zone from a whole of community perspective relative to the base case of remaining at the current time zone of UTC +9.30. Impacts are reported in net present values.

The assessment assumes that daylight savings will remain on its current pattern.

This report is structured as follows. Section two provides background information on South Australia's current time zone and the rationale advanced for change including a summary of analysis on the potential impact on businesses recently completed by SACES. Section three presents the economic analysis including the methodology used, assumptions, results of the analysis and sensitivity testing.

2. Background

2.1 Current South Australian Time Zone

In winter South Australia sets its clocks by Australian Central Standard Time (CST) which is 9½ hours ahead of Coordinated Universal Time (UTC). UTC is the accepted international reference point for time zones. It approximately coincides with Greenwich Mean Time, which it has replaced as a reference point for Australian time zones. CST is ½ an hour behind Australian Eastern Standard Time (EST), the time zone which is in use during winter in New South Wales, Victoria, Queensland, Tasmania and the Australian Capital Territory, and 1½ hours ahead of Western Standard Time used in Western Australia.

In summer, South Australia observes daylight saving and has done so on a continuing basis since 1971. This involves setting clocks forward one hour during spring, and setting them back to return to normal Central Standard Time in the autumn. Since 2008 the timing of daylight saving time in South Australia has been coordinated with those eastern states which observe it, New South Wales, Victoria, Tasmania and the Australian Capital Territory. This means that South Australian clocks remain ½ an hour behind clocks in those eastern States when daylight saving is in operation. Queensland does not observe daylight saving, which means that South Australian clocks are actually ½ an hour ahead of Queensland clocks when South Australia is on daylight time.

The eastern States are a major market for South Australian business both as providers of business inputs and consumers of business outputs. The official statistics' coverage of Australian interstate trade is very outdated, with the last published survey results being for 1988-89. That survey showed that South Australia's interstate goods trade was about 3 times as large as its overseas goods trade (South Australian Treasury 1990). New South Wales and Victoria between them accounted for over half of South Australia's interstate and overseas goods trade. If services were taken into account, the share would be even larger, given the predominance of service sectors such as banking, insurance and other financial services in Sydney and Melbourne. While there has been an internationalisation of the South Australian economy in the intervening 25 years, we can be quite confident that the eastern daylight saving States account for a larger share of South Australia's interstate trade than any other single time zone, and by a substantial margin.

South Australia's external commerce relies on communications between local and external businesses and other organisations. The intensity of communications is likely to vary substantially across commodities and services, with bulk commodities such as grain perhaps being less communications-intensive than commodities such as wine or, in the extreme, services such as call centres. To the extent that communication is made more difficult by the existence of a ½-hour time delay there are potential cost and revenue implications for South Australian firms.

The time zone difference may also raise difficulties for other activities such as the scheduling of network broadcasts and major events and the operation of passenger aviation.

Solar time

Central Standard Time is equal to the mean time of the meridian of longitude at one hundred and forty-two and a half degrees east of Greenwich. This meridian actually passes through western Victoria and New South Wales, which means that the sun typically reaches its highest point in the sky (solar noon) sometime after 12 a.m. CST, with the difference increasing further west one goes (based on information from Geoscience Australia 2010.)

Table 2.1 gives some sunrise, solar noon and sunset locations for different South Australian locations at different dates for the current time zone and for ½ hour forwards and backwards.

Table 2.1: Sunrise, solar noon and sunset times for selected South Australian locations under different time zones

	March 21 2015			June 22 2015			September 23 2015			December 22 2015		
Current Time Zone (UTC +9.30)												
	sunrise	noon	sunset	sunrise	noon	sunset	sunrise	noon	sunset	sunrise	noon	sunset
Mount Gambier	7:10 am	1:14 pm	7:18 pm	7:23 am	12:09 pm	4:55 pm	5:55 am	11:59 am	6:04 pm	5:42 am	1:05 pm	7:29 pm
Adelaide	7:19 am	1:23 pm	7:26 pm	7:23 am	12:17 pm	5:12 pm	6:04 am	12:08 pm	6:12 pm	5:59 am	1:14 pm	7:29 pm
Whyalla	7:23 am	1:27 pm	7:30 pm	7:23 am	12:22 pm	5:21 pm	6:08 am	12:12 pm	6:16 pm	6:08 am	1:18 pm	7:28 pm
Port Lincoln	7:30 am	1:34 pm	7:37 pm	7:34 am	12:28 pm	5:23 pm	6:15 am	12:19 pm	6:23 pm	6:10 am	1:25 pm	7:39 pm
Elliston	7:34 am	1:38 pm	7:41 pm	7:35 am	12:32 pm	5:30 pm	6:19 am	12:23 pm	6:27 pm	6:17 am	1:29 pm	7:40 pm
Ceduna	7:39 am	1:42 pm	7:46 pm	7:36 am	12:37 pm	5:38 pm	6:24 am	12:28 pm	6:32 pm	6:26 am	1:33 pm	7:41 pm
"True" CST (UTC +9.00)												
	sunrise	noon	sunset	sunrise	noon	sunset	sunrise	noon	sunset	sunrise	noon	sunset
Mount Gambier	6:40 am	12:44 pm	6:48 pm	6:53 am	11:39 pm	4:25 pm	5:25 am	11:29 am	5:34 pm	5:12 am	12:35 pm	6:59 pm
Adelaide	6:49 am	12:53 pm	6:56 pm	6:53 am	11:47 pm	4:42 pm	5:34 am	11:38 pm	5:42 pm	5:29 am	12:44 pm	6:59 pm
Whyalla	6:53am	12:57 pm	7:00 pm	6:53 am	11:52 pm	4:51 pm	5:38am	11:42 pm	5:46 pm	5:38 am	12:48 pm	6:58 pm
Port Lincoln	7:00 am	1:04 pm	7:07 pm	7:04 am	11:58 pm	4:53 pm	5:45 am	11:49 pm	5:53 pm	5:40 am	12:55 pm	7:09 pm
Elliston	7:04 am	1:08 pm	7:11 pm	7:05 am	12:02 pm	5:00 pm	5:49 am	11:53 pm	5:57 pm	5:47 am	12:59 pm	7:10 pm
Ceduna	7:09 am	1:12 pm	7:16 pm	7:06 am	12:07 pm	5:08 pm	5:54 am	11:58 pm	6:02 pm	5:56 am	1:03 pm	7:11 pm
EST (UTC +10.00)												
	sunrise	noon	sunset	sunrise	noon	sunset	sunrise	noon	sunset	sunrise	noon	sunset
Mount Gambier	7:40 am	1:44 pm	7:48 pm	7:53 am	12:39 pm	5:25 pm	6:25 am	12:29 am	6:34 pm	6:12 am	1:35 pm	7:59 pm
Adelaide	7:49 am	1:53 pm	7:56 pm	7:53 am	12:47 pm	5:42 pm	6:34 am	12:38 pm	6:42 pm	6:29 am	1:44 pm	7:59 pm
Whyalla	7:53 am	1:57 pm	8:00 pm	7:53 am	12:52 pm	5:51 pm	6:38 am	12:42 pm	6:46 pm	6:38 am	1:48 pm	7:58 pm
Port Lincoln	8:00 am	2:04 pm	8:07 pm	8:04 am	12:58 pm	5:53 pm	6:45 am	12:49 pm	6:53 pm	6:40 am	1:55 pm	8:09 pm
Elliston	8:04 am	2:08 pm	8:11 pm	8:05 am	1:02 pm	6:00 pm	6:49 am	12:53 pm	6:57 pm	6:47 am	1:59 pm	8:10 pm
Ceduna	8:09 am	2:12 pm	8:16 pm	8:06 am	1:07 pm	6:08 pm	6:54 am	12:58 pm	7:02 pm	6:56 am	2:03 pm	8:11 pm

Source: Geoscience Australia (2010), *Compute Sunrise, Sunset & Twilight Times*, accessed 16/04/2015, <http://www.ga.gov.au/geodesy/astro/sunrise.jsp>, calculations SACES

2.2 Options considered

Base case – Do Nothing Scenario

The base case is for South Australia to remain in its current time zone of UTC +9.30, with daylight savings time coordinated with those eastern states that observe it.

There are no additional benefits or costs for the base case

Option 1 – Shift to Eastern Standard Time (UTC +10.00)

Option 1 would be for South Australia to adopt Eastern Standard time, moving its clocks forward 30 minutes.

This would make coordination with the eastern states easier, and remove any confusion generated by the unusual ½ hour time difference. However it would make coordination with Western Australia and with South East Asia more difficult. It would also move the state, particularly the western parts of the state, further from its “solar” time.

It is assumed under this option that daylight savings arrangements remain unchanged.

Option 2 – Shift to “true” Central Standard Time (UTC +9.00)

Option 2 would be for South Australia to adopt a new time zone at UTC +9.00, moving its clocks back 30 minutes.

This would make clock time, particularly in the Western parts of the state, more in sync with solar time and make communication with Western Australia and with South East Asia easier. However, it would increase the time difference to the east coast states making communications more difficult.

It is assumed under this option that daylight savings arrangements remain unchanged.

2.3 SACES 2015 study

The Department of State Development commissioned the South Australian Centre for Economic Studies (SACES) to investigate the impact of a change in the South Australian time zone following a more detailed report that SACES undertook on this topic in April 2008 (the latter only having assessed the impact of switching to EST). These two studies form the basis for the assessment of potential impacts in this cost benefit analysis, particularly with respect of the impacts on business.

The SACES (2008) report was focussed on South Australian businesses and the impact of moving to Eastern Standard Time (EST). This included a large scale telephone survey of South Australian businesses who were members of Business SA. No data was collected on the impacts of shifting to “true” central standard time.

SACES (2015) also collected data from businesses on the potential impacts of a change in time zone, in this case covering both a move to EST and a shift back 30 minutes to “true” CST. Due to time and resource constraints the survey was of a smaller scale than SACES 2008, with information gathered from a survey distributed at a gathering of business, from an email mail-out, from face-to-face interviews (including on the West Coast) and a random walk to gather individual and business reactions to any proposed time zone change.

Some in the South Australian business community (particularly in metropolitan Adelaide) would prefer that South Australia adopt EST by moving clocks forward half an hour. Business leaders assert that such a move would simplify business with the eastern states and the rest of the world.

The findings of the most recent exercise with respect to those surveyed in the business sector are similar to the more broad based study of 2008:

- most respondents consider the current arrangements cause little to no inconvenience to their business operations as was the case in the 2008 study;
- the majority of businesses could not identify any significant disadvantages in moving to EST; and
- respondents do not readily identify any significant cost or revenue impacts from a move to EST.

There is no conclusive evidence that business is significantly disadvantaged under current arrangements especially as advances in technology help to overcome the tyranny of distance and time. Some respondents propose a move back half an hour to link more closely into Asia rather than forward to EST.

Equally, there is considerable support on the West Coast to move back a half an hour so that South Australia is effectively on Central Standard Time one hour behind the East Coast and one hour ahead of the West Coast (similar to the four zones in the continental USA). If the decision was to move to EST then communities on the West Coast argued that existing daylight saving arrangements should cease early in March of each year.

Impact of moving to Eastern Standard Time

Similar to SACES (2008), the majority (69 per cent) of respondents foresaw no disadvantage in moving to EST, 10 per cent thought such a move would cause major disadvantages and 21 per cent thought it would cause minor disadvantages. The main form of disadvantage (67 per cent) was that more work operations would occur in the dark. If more operations occurred in the dark, one might consider this could cause safety issues and require companies to invest in safety infrastructure (such as more lighting), however no respondent indicated new physical infrastructure would be necessary.

Table 2.2: Disadvantages of changing to Eastern Standard Time, per cent

	Major disadvantages	Minor disadvantages	No disadvantage
Level of disadvantage	10.4	20.8	68.8

Note: Total may not sum to 100 due to rounding.

Table 2.3: Nature of disadvantages of EST

Disadvantages	Per cent
More work operations would be carried out in the dark	66.7
Fewer work operations would be carried out in the dark	4.2
Most employees would not like such a change	20.8
Tasks would become harder	20.8
New physical infrastructure would become necessary	0
Business would have to change how it delivers services or products	12.5
Business would no longer be able to produce some products or services	0
Other	37.5

Note: Totals do not sum to 100 as some respondents selected multiple options.

For the 10 per cent of respondents who thought that changing to EST would cause major disadvantages the principal reason was that more work operations would be carried out in the dark and 63 per cent indicated tasks would become harder. Similarly, of those who thought changing to EST would cause minor disadvantages, 60 per cent indicated more work operations would occur in the dark.

Some 14 per cent of survey respondents indicated that there would be major advantages in a move to EST. For those who indicated a change would be advantageous, the main advantage (83 per cent) was that there would be better synchronisation of South Australian work time with the eastern states. A large proportion (40 per cent) indicated staff communications would work better and 19 per cent indicated some staff tasks would become easier.

Table 2.4: Advantages of changing to Eastern Standard Time, per cent

	Major advantages	Minor advantages	No advantage
Level of advantage	14.3	48.1	37.7

Note: Total may not sum to 100 due to rounding.

All respondents who expected major advantages foresaw that there would be better synchronisation of South Australian work time with the eastern states and 55 per cent indicated staff communications would work better; the same reasons were provided by those who suggested there would be minor advantages in moving to EST. It seems the argument for moving to EST is the convenience of being aligned with businesses in the eastern states.

As with the previous report, most South Australian businesses do not anticipate that moving to EST would have a financial impact on their business. The majority (88 per cent) did not think that moving to EST would have any cost impact on their business, 6.5 per cent thought that there would be cost savings and 5.2 per cent thought that their costs would increase. The majority of respondents (90 per cent) did not think that there would be any impact on their revenue; only 7.8 per cent thought that they would have revenue gains, the remaining 2.2 per cent thought that they would experience revenue losses.

Table 2.5: Nature of advantages of EST

Advantages	Per cent
Better synchronisation of South Australian work time with eastern states	83.3
More of your operations would be carried out in the dark	4.2
Less of your operations would be carried out in the dark	2.1
Most workers would like such a change	10.4
Some staff tasks would become easier	18.8
Some of your physical infrastructure would become unnecessary	4.2
Staff communications would work better	39.6
It would be possible to deliver existing services and products in new ways	6.3
It would be possible to offer new products or services	6.3
Other	6.3

Note: Totals do not sum to 100 as some respondents selected multiple options.

Table 2.6: Financial impacts of switching to EST

Type of impact	Impact	Per cent
Cost	Overall cost saving	6.5
	Overall cost increases	5.2
	No cost impact	88.3
Revenue	Overall revenue losses	2.6
	Overall revenue increases	7.8
	No revenue impact	89.6

Note: Totals may not sum to 100 due to rounding.

It seems that there is a level of support for moving to EST by those surveyed in the South Australian business community. Overall, 45 per cent of respondents thought their organisation would support a change to EST, 30 per cent thought a change would not be supported and 25 per cent did not know.

Table 2.7: Support for Eastern Standard Time, per cent

	Yes	No	Don't know
Level of support	44.7	30.3	25

Note: Total may not sum to 100 due to rounding.

Impacts of moving half an hour backwards

An alternative to EST is to move South Australia's time zone half an hour backwards thus moving our time closer to the broader Asian region and Western Australia. When this was posed to respondents:

- 39 per cent indicated that there would be no advantage to their organisation;
- 12 per cent foresaw major advantages;
- 16 per cent foresaw minor advantages;
- 16 per cent foresaw major disadvantages; and
- 21 per cent foresaw minor disadvantages.

A number of respondents indicated changing by half an hour would cause IT/software issues; presumably as it would involve moving to a novel time zone. Whilst UTC +9.00 is the time zone of Japan and South Korea, and therefore included in any general software that uses time zones, neither country observe daylight savings time (and if they did would do so at the opposite time of the year to Australia). Therefore a custom time zone may need to be created for South Australia if it switched to UTC +9.00 and continued to observe daylight savings time.

Table 2.8: Advantages and disadvantages of moving backwards half an hour

Advantages/disadvantages	Per cent
Major advantages	11.7
Minor advantages	15.6
No advantages	39
Major disadvantages	15.6
Minor disadvantages	20.8

Note: Totals do not sum to 100 as some respondents selected multiple options.

View of those in the West of South Australia

Overall, respondents were opposed to moving to EST preferring instead, if change was inevitable, to go back half an hour to Central Standard Time (CST) arguing that this was more logical with respect to other states and international business times zones, notably here to include Singapore, Hong Kong, Indonesia and China.

A number of those interviewed and the random walk contributors suggested that if South Australia did move to EST then it was imperative that daylight saving concluded at the start of March each year (back from early April). This in itself suggests a potential trade-off for the West Coast, should South Australia move to EST, that daylight saving conclude at the start of March each year.

There is strong view that the case for change has not been made and three comments were consistently made in this regard.

The first is that people get up when the sun rises and go to bed when the sun sets; that is to say, the 'body clock' should be the rationale for any change, not the needs of business. This then led to the statement that it would be preferable to switch clocks back half an hour (not forward) so that Western Australia was at 9.00 am, South Australia (and Central Australia) at 10.00 am and the eastern states at 11.00 am. Excluding the two remote time zones- the Hawaiian and the Alaskan- the USA mainland has 4 major time zones (Pacific, Mountain, Central and Eastern) each one hour apart from the next.

The second comment related to current business practices where many local business conduct trade and supply negotiations interstate and into Asia via e-mail, the internet, and phone on a daily basis, particularly the fishing industry and fish processors. Given current technology most respondents disputed business logic for change, where it was argued that "technology has overcome the tyranny of distance and time". Again, if change was inevitable then the proposed solution was for "South Australia to stay a true central standard time regardless of daylight saving". A benefit of this position was that if you want to encourage business to establish in South Australia, "what better choice do you have than being able to bridge Australia and it will be the only capital city of commerce that aligns best with Asia".

The third comment related to the impact on children and families across the West Coast, where to go the EST (and further to retain daylight saving) would have implications for children and all activities related to school participation, commencing in the morning in the dark and causing disruption to sleep patterns in the evening. This might be summarised as a secondary body clock issue where people's ability to work and learn is affected and there are families who have made difficult adjustments to the current time difference (with daylight saving). The preferred position of those with young families was again three time zones.

3. Economic Analysis

3.1 Methodology

Cost benefit analysis is a decision making tool that allows comparison a diverse range of benefits and costs by first quantifying them and then seeking to identify monetary values for each the streams of benefits and costs. This quantification of benefits and costs is undertaken from the point of view of the broad community, irrespective of the incidence of those costs and benefits. The impacts are measured relative to the base case of the 'business as usual' scenario.

For the purposes of the economic evaluation we are interested in the value of resources (broadly defined) that are created or consumed. Although information about transactions may be used to value resources, we are not directly interested in transactions that occur. For example, if the South Australian Government provided a subsidy to a project the subsidy would not be regarded as a benefit of the project; the benefit lies in the service stream produced by the project

Costs and benefits that occur in the future are brought into the analysis by converting them to a present value; that is, by discounting them to reflect that benefits or costs that occur in the future are less valuable than those that occur in the present. The cost benefit analysis was conducted over a period of 30 years commencing in 2015/16. A discount rate of 7 per cent was applied to the analysis. It includes impacts on business through cost savings or cost increases, and revenue increases or decreases, impacts on road crash number and impacts on the demand for electricity.

The analysis is conducted in real terms and all cash flows are entered in 2013/14 prices. Therefore no assumptions need to be made about actual inflation outcomes

Only first round impacts of any change are considered. This is done in order to avoid any potentially contentious issues arising from multiplier effects.

3.2 Nature and scale of potential impacts

Impacts of moving forwards half an hour

Cost savings and increased revenues for businesses dealing with the eastern states (benefit to business)

SACES (2015) found a number of South Australian businesses thought better synchronisation of South Australian work time with that of the eastern states was a benefit of moving half an hour forwards. Synchronisation is a benefit for companies requiring effective and regular communication with interstate employees, customers and suppliers. SACES (2015) found a number of businesses in South Australia thought this would be an advantage of moving to Eastern Standard Time. Businesses also reported that they expected some staff tasks would become easier after a shift to EST and that it would allow them to deliver new products and services and find new ways to deliver existing products and services.

SACES (2008) also found that respondents felt navigating the half hour time difference was a particular challenge for people and businesses outside of Australia, and it would be easier if international contacts could think of South Australia as the same time as Melbourne or Sydney. The amount of business lost due to this confusion is not clear. However, one would expect that eliminating this confusion would increase trade with South Australia.

This is consistent with SACES (2008) which found that although many expected no change, in aggregate, businesses expected to experience substantial revenue increases and substantial net cost reductions from a shift to EST.

Shifting South Australia's time zone back to UTC +9.00 is likely to have the opposite effect on revenues, making trade and collaboration with the eastern states more difficult.

SACES (2008) found that jet lag associated with traveling across time zones can be a hassle to South Australian businesses. SACES (2008) also found that traveling a day early to attend a morning meeting interstate can also be a hassle. Coordinating South Australian time with the eastern states will eliminate this hassle and make interstate travel easier.

Impact on workplace safety in the construction sector (cost to business)

SafeWork SA (2007) found that extending daylight saving would have adverse safety impacts on the building and construction industries as more work would be carried out in the dark. This would also cause some tasks to become harder. A possible cost would be lost productivity due to increases in workplace injuries.

These safety impacts could be mitigated with investment in more lighting. This would also be a cost, however, as no respondent to SACES (2015) or SACES (2008) indicated that investment in new infrastructure would become necessary, it seems likely that few if any businesses would adopt this solution.

Time difference with Western Australia will increase (cost to business)

The increased time difference with Western Australia will mean that there will be less crossover of South Australian working hours with those of Western Australia, which could result in reduced trade between the two states.

Impacts on airline schedules (cost to business)

SACES (2008) found that changing the South Australian time zone would require airlines to revise their schedules. Aircraft cannot take off from or land at Adelaide Airport between 11:00 pm and 6:00 am (subject to some exceptions). Curfew restrictions at Adelaide Airport would have to be revised or airlines would need to alter their departure time (which may not be possible if there exists inflexibility in take-off/landing slots at other airports). Changes to airline schedules could impact on congestion at other Australian airports.

In a submission to the community consultation on potential time zone changes in 2015, the SA Tourism Commission noted the following impacts from a change in the time zone to EST:

- departure times from overseas airports will be unlikely to change due to flow on effects. Flights will therefore arrive half an hour later;
- if one airline decides to depart earlier to arrive at the current scheduled time, slots at Adelaide Airport may become congested – a short term logistical consequence;
- Emirates leave Adelaide Airport at 10:35 pm (after landing at 9:05 pm and refuelling, restocking and loading passengers), Eastern Standard Time would have them leaving after curfew (and therefore facing potential fines for curfew breaches) because they cannot change the arrival time into Adelaide as the departure from Dubai is linked to a number of connecting flights;
- Cathay Pacific flights would continue to arrive during curfew; and
- a review of curfew regulations would be required, as changing domestic flights to leave Adelaide half an hour earlier would cause congestion at other Australian airports.

Talkback radio and television (benefit to business)

SACES (2008) reported that there often is a delay in broadcasting talkback radio in South Australia. Due to the time difference, South Australian listeners often miss calling in. Changing to Eastern Standard Time would eliminate this problem.

SACES (2008) also found a potential benefit to television broadcasters from changing to Eastern Standard Time. When transitioning from a live telecast to a delayed telecast there is a need for 'filler programs'. If South Australia were on Eastern Standard Time, there would not be a need to broadcast such 'filler programs'.

Later start times for primary producers (cost to community)

More darkness in the morning will result in later starting times for farmers or more farming being carried out in the dark. Neilson (2007) found that a change in working patterns creates problems for managing stock and crops.

Calandrilla and Buehler (2008) cited studies in the United States into extended daylight saving in the 1970s that found extra darkness in the morning resulted in farmers "killing time" in the morning waiting for morning dew to evaporate off crops. Dew evaporates later in the working day than during non-daylight saving time. This is a cost to farmers.

A later sunrise will mean that some primary producers will have to start work later and finish work later resulting in reduced time with their families.

Changes to the number of road deaths and injuries (benefit to the community)

All other factors being equal, the probability of a road crash occurring at a given time of day will be higher if the level of natural light is lower, e.g. dark at night time or partially lighted at twilight or dawn. Changing time zones will change the time of day at which natural light is available and therefore change road crash risks. For example, a switch to EST would mean that in Adelaide on March 21 it would be dark for the period 7.19am to 7.49am, whereas previously natural light was available. This would increase the accident rate for those travelling at this time. Conversely, on that day, sunset would not occur until 7.56pm, rather than 7.26pm under the current time zone, reducing the accident rate for anyone travelling between 7.26pm and 7.56pm. A switch to "true" CST would have the opposite effect, decreasing accident risks in the morning and increasing them in the evening.

Whether either of these changes would lead to a net increase or decrease in road crashes would depend on the accident levels at the time of day that is affected.

Ferguson et al. (1995) found that in the United States daylight saving (resulting in increased daylight at the end of the day) reduced the number of fatalities on roads, with the impact particularly large for pedestrians. Coate and Markowitz (2002) found that having daylight saving time all year in the United States would have reduced net pedestrian fatalities by 13 per cent and motor vehicle occupant fatalities by three per cent over the potentially affected hours of 5 am to 10 am and 4 pm to 7 pm. Similarly, the Royal Society for the Prevention of Accidents (2005) reported that when the United Kingdom had year round daylight saving from 1968 to 1971, accidents in the hours studied (7 am to 10 and 4 pm to 7 pm) decreased in net terms by 11 per cent in England and Wales and 17 per cent in Scotland. The increase in accident rates in the morning was more than offset by a larger reduction in the evening.

More energy usage (cost to community)

Kellogg and Wolfe (2007) found that extending daylight saving in Victoria in 2000 led to decreased demand for energy in the evening but that this was more than offset by increased demand in the morning, with a small increase in overall demand. Kotchen and Grant (2008) found that in Indiana daylight saving time resulted in savings of energy used for lighting but increases in energy used for heating and cooling. However, there is international research that finds decreases in energy usage due to daylight saving – see for example California Energy Commission (2001) and Hillman (1993).

Lifestyle benefits (benefit to community)

Hillman (1993) states that people generally engage in leisure activities in the evening. Therefore, increased daylight at the end of the day should cause more people to engage in leisure activities.

Numerous reports on the impact of daylight saving have found that when there is more light at the end of the day people engage in more outdoor activities, such as outdoor sports and exercise. Benefits accrue to sporting bodies, which should expect to have more members. Those people engaging in activities would also have health benefits.

On the introduction of daylight saving in Queensland, Worthington (2005) suggested that it would lead to a shift from indoor leisure to outdoor leisure and Neilson (2007) found that being able to sleep longer would be a lifestyle benefit.

All of these benefits are likely to have an equivalent cost should the state shift to "true" CST.

Moves South Australia further away from the natural time zone (cost to the community)

As well as impacts of changes relative to solar time on activities, it is possible that shifting further from solar time (which would be the case for the western parts of the state under EST) could impact on (actual or subjective) well-being more generally.

More travel to school and work in the dark (cost to the community)

Moving half an hour of daylight from the morning to the evening will increase the likelihood of people travelling in the dark in the morning. Literature on daylight saving has shown an increase in accidents in the morning but as explained in the benefits the number is compensated for by the reduction in evening accidents. However, there could be a cost in terms of emotional wellbeing of people travelling in the dark. This is a particular concern of residents of the Eyre Peninsula and West Coast.

Impacts of moving back half an hour**International trade with East and South East Asia (benefit to business)**

Studies assessing the factors influencing international trade have shown that, all other things being equal, smaller differences in time zones between countries increases the value of trade. For example Stein and Daube (2007) found that the impact of being 1 hour smaller difference in time zone increased trade by between 7 and 11 per cent. Changing South Australia's time zone to UTC +9.00 would reduce the time difference to South Australia's Asian trading partners, and would be expected to increase trade.

Conversely, shifting to EST would be expected to reduce trade with East and South East Asia by an equivalent amount.

Increased foreign direct investment (benefit to business)

Stein and Daube (2007) found that time zones differences have a negative impact on foreign direct investment (FDI), with each additional hour of difference (all other factors being equal) reducing FDI by between 17 per cent and 26 per cent. It would be expected that a shift to UTC +9.00 would increase FDI from Asia due to the smaller time difference.

Trade with Western Australia (benefit to business)

A shift backwards half an hour will place South Australia's time closer to that of Western Australia. As it has been shown that decreases in time zone differences are positively correlated with trade (see impact on international trade, above) this would be expected to increase trade between South Australia and Western Australia.

Software customisation (cost to business)

SACES (2015) found that changing the time by half an hour would cause some issues with software. This would be a cost to business, as they would have to upgrade software to address the change to a novel time zone (as opposed to the shift to EST which in almost all cases can be handled straightforwardly by changing the time zone set on the computer's operating system).

Potential difficulties to businesses located near the border with Victoria or New South Wales (cost to business, cost to community)

Moving South Australia half an hour backwards will place businesses operating near South Australia's eastern borders at a disadvantage. They will be operating a further half an hour behind their counterparts across the border this has some business disadvantages. Additionally, the time will be further ahead than solar time in these parts of the state, for example in Mount Gambier midday (according to clocks) would occur approximately 20 to 30 minutes before solar noon (when the sun is midway between sunrise and sunset).

Fewer people (including children) will have to get ready and start work (or school) in the dark and go to bed in daylight (cost to community)

Changing the time zone will result in South Australian time being closer aligned to the movement of the sun (solar time). The current time zone does not run through the middle of the state. Moving half an hour backwards will move the time closer to solar time for a majority of South Australians.

This will mean that fewer people need to have sleep patterns that are out of harmony with the sun (e.g. children travelling to school before dawn and going to bed whilst it is still sunny). This benefit is particularly concentrated amongst residents of the Eyre Peninsula and West Coast.

Easier to remember (benefit to business, benefit to community)

South Australia is one of a handful of half an hour time zones. Changing half an hour backwards would eliminate confusion when calculating the time in South Australia.

3.3 Valuing the potential impacts

Cost savings and increased revenues for businesses dealing with the eastern states (benefit to business)

Estimates for the net cost savings, and net revenue increases, from a shift to EST were taken from SACES (2008) and converted to 2015 values using the CPI.

It was assumed that the revenue increase from shifting to EST would be matched by an equivalent revenue decrease from shifting to "true" CST as the increase in time difference reduced interstate trade.

A substantial minority of businesses responding to the survey undertaken as part of SACES (2015) indicated that they would experience business benefits as a result of a shift to "true" CST. Unfortunately the survey in SACES 2015 did not value these benefits. As an approximation we have assumed that business experience costs savings from a shift to "true" CST equivalent to the ratio of businesses reporting business benefits from a shift to "true" CST compared to those experiencing business benefits from a shift to EST.

Impact on workplace safety in the construction sector (cost to business)

No data was available to allow this to be quantified.

Time difference with Western Australia will increase (cost to business)

The estimate of the increase in trade with Western Australia as a result of shifting to “true” CST (see below) was treated as a cost of reduced trade for the shift to EST.

Impacts on airline schedules (cost to business)

No data was available to allow this to be quantified.

Talkback radio and Television (benefit to business)

Estimates of the benefits to business of avoiding this cost are included in the estimated cost savings to business from shifting to EST from SACES (2008).

No data is available to quantify the community cost of not being able to (or it being more difficult to) participate in live events such as radio phone-ins, or the cost of live sporting events being shown at less convenient times or shown on a delay.

Later start times for primary producers (cost to community)

No data was available to allow this to be quantified.

Changes to the number of road deaths and injuries (benefit to the community)

South Australian road crashes for 2013 (by severity) were allocated to hours of the day by assuming the distribution was the same pattern as the 2010 data (which is the most recent year in which crash data is available by time of day), and were regionalised based on population shares.

The changes to sunrise and sunset times under the alternative time zones set out in Table 2.1 was then used to identify the number of crashes that occurred at a time of day that would shift from daylight to dark, or vice versa, under a shift to EST.

The same calculation was made for the shift to “true” CST.

Based on the estimates made by the Royal Society for the Prevention of Accidents (2005), it was assumed that for those periods of day where the time zone change would shift the natural light from day light to dark, accident rates would increase by 11 per cent, and for those times of day where the change would be from dark to daylight that the accident rate would fall by 11 per cent.

The value of a statistical life for any road crash deaths calculated as being caused or averted by a change in time zones was valued using SACES (2011). Other road crash costs (including other costs of fatality accidents) were taken from BITRE (2008) and converted to 2015 values.

More energy usage (cost to community)

Data on current energy use in South Australia (excluding large industrial users), and on the projected trends in usage, were taken from AEMO (2013).

Expected changes in retail prices for the next five years was taken from AER (2015). Current charges of AGL, the largest electricity retailer in South Australia were used as a proxy for current average unit costs of electricity.

The impact of a shift in time zone was derived from Kellogg and Wolfe (2007), as it was thought that an Australian study was more likely to be reflective of the impact on Australian energy demand, but adjusted to allow for the smaller change in clock time relative to solar time, and the longer duration of the change.

Lifestyle benefits (benefit to community)

No data was available to allow this to be quantified.

Moves South Australia further away from the natural time zone (cost to the community)

No data was available to allow this to be quantified.

More travel to school and work in the dark (cost to the community)

No data was available to allow this to be quantified.

International trade with East and South East Asia (benefit to business)

Data on exports from South Australia to East and South East Asia was taken from ABS (2014).

The estimated impact of a change in timezone was taken from Stein and Daude (2007).

Increased foreign direct investment (benefit to business)

No data was available to allow this to be quantified.

Trade with Western Australia (benefit to business)

Data on interstate trade is no longer published by the ABS. As a proxy for the change in value of trade with Western Australia, the estimate of net increased revenue from a shift to EST was factored down by the ratio of Western Australian GSP to the GSP of the eastern states that observe daylight savings time.

Software customisation (cost to business)

No data was available to allow this to be quantified.

Potential difficulties to businesses located near the border with Victoria or New South Wales (cost to business, cost to community)

No data was available to allow this to be quantified.

Fewer people (including children) will have to get ready and start work (or school) in the dark and go to bed in daylight (cost to community)

No data was available to allow this to be quantified.

Easier to remember (benefit to business, benefit to community)

No data was available to allow this to be quantified.

3.4 Results of the economic analysis

The results of the economic analysis are summarised in Table 3.1. It shows, by stakeholder, the incremental costs and benefits of the shift to EST and to “true” CST relative to the Base Case scenario.

Each shift in time zone is estimated to produce net benefits over its costs, however the shift to EST produces a substantially quantifiable larger net benefit.

The distribution of net benefits also differs between the options, with a shift to EST generating a substantial net benefit for business but a (comparatively modest) net cost for the community. A shift to “true” CST is estimated to generate net benefits for both business and the wider community, but they are each an order of magnitude smaller than the net benefit to business generated by EST.

In interpreting the results one must also take into account the sensitivity of the results to modest or realistic variations in parameter assumptions, which is the focus of the next section.

Table 3.1: Results of the Economic Analysis
Net benefits of the two options relative to the Base Case over 30 year horizon (\$'000)^(a)

	Move to EST	Move to true CST
Community		
Costs		
Road crashes caused - intangible costs of deaths	15,435	17,372
Road crashes caused - other costs	11,146	8,015
Children commuting to school before dawn	nq	
Increased energy usage	118,501	
Less time in evenings with family (farmers)	nq	
Disadvantage to people in eastern South Australia		nq
Total costs to community	145,082	25,387
Benefits		
Improved health from longer sunshine in the evening	nq	
No delay in radio and television broadcasts	nq	
Road crashes averted - intangible benefits of averted deaths	17,161	12,263
Road crashes averted - other avoided costs	17,165	8,015
Reduction in energy usage		118,501
Reduction in crime	nq	
Fewer people commuting to school and work before dawn		nq
Health benefits from being closer to natural time		nq
Total benefits to community	34,326	138,780
Net community benefits/costs	-110,756	113,392
Businesses		
Costs		
Reduction in trade with eastern states		6,977,179
Decreased exports to APEC nations	4,099,747	
Decreased sales to WA	2,086,176	
Increased accident rates in construction	nq	
Breaches of curfew by Emirates	nq	
Revisions to airline schedules	nq	nq
Software costs to implement new time zone		nq
Total costs to businesses	6,185,924	6,977,179
Benefits		
Reduced business costs	1,826,753	951,724
Increased foreign direct investment		nq
Increased business revenue	6,977,179	6,185,924
Reduction in construction accidents		nq
Total benefits to businesses	8,803,931	7,137,648
Net business benefits/costs	2,618,008	160,470
Total Costs	6,331,006	7,002,566
Total Benefits	8,838,257	7,276,428
Net Benefits/Costs	2,507,251	273,862
Cost Benefit Ratio	1.4	1.0

Note: ^a Present values calculated using a 7 per cent discount rate.

nq Indicates that a particular benefit or cost is expected for the option in question but that it could not be quantified, blank cells indicate no benefit of cost is expected.

It should also be noted in interpreting the results that a number of the costs and benefits could not be quantified and so are not included in the analysis. This is likely to have a greater impact on the estimated net benefit of a shift to "true" CST than for the estimated net benefit of the shift to EST.

Table 3.2 sets out the various cost and benefit items underpinning the cost benefit analysis in a single year.

Table 3.2: Estimated impacts relative to the Base Case in a single year (2014/15 values)

	Move to EST	Move to true CST
Community		
Costs		
Road crashes caused - intangible costs of deaths	998.4	1,123.7
Road crashes caused - other costs	839.5	603.7
Children commuting to school before dawn	nq	
Increased energy usage	10,601.9	
Less time in evenings with family (farmers)	nq	
Disadvantage to people in eastern South Australia		nq
Total costs to community	12,439.8	1,727.4
Benefits		
Improved health from longer sunshine in the evening	nq	
No delay in radio and television broadcasts	nq	
Road crashes averted - intangible benefits of averted deaths	1,110.1	793.2
Road crashes averted - other avoided costs	1,292.8	603.7
Reduction in energy usage		10,601.9
Reduction in crime	nq	
Fewer people commuting to school and work before dawn		nq
Health benefits from being closer to natural time		nq
Total benefits to community	2,402.8	11,998.8
Net community benefits/costs	-10,037.0	10,271.5
Businesses		
Costs		
Reduction in trade with eastern states		525,482.0
Decreased exports to APEC nations	308,770.0	
Decreased sales to WA	157,119.1	
Increased accident rates in construction	nq	
Breaches of curfew by Emirates	nq	
Revisions to airline schedules	nq	nq
Software costs to implement new time zone		nq
Total costs to businesses	465,889.1	525,482.0
Benefits		
Reduced business costs	137,580.8	71,678.5
Increased foreign direct investment		nq
Increased business revenue	525,482.0	465,889.1
Reduction in construction accidents	nq	
Total benefits to businesses	663,062.8	537,567.7
Net business benefits/costs	197,173.7	12,085.7
Total Costs	478,328.9	527,209.3
Total Benefits	665,465.6	549,566.5
Net Benefits/Costs	187,136.7	22,357.1
Cost Benefit Ratio	1.4	1.0

Note: nq Indicates that a particular benefit or cost is expected for the option in question but that it could not be quantified, blank cells indicate no benefit of cost is expected.

3.5 Sensitivity analysis

An economic analysis will almost always involve substantial uncertainty as to the assumptions made and due to the inherent uncertainty of data sourced from surveys. One approach to dealing with this is to undertake sensitivity analysis by changing key parameters and assumptions embodied in the analysis one at a time.

Table 3.3 sets out the net benefits (relative to the base case) of a switch to EST or “true” CST under a range of alternative assumptions.

The results do not change materially with variations in the discount rate chosen, a 20 per cent change in the estimated benefits or a 20 per cent change in the estimated costs (although in the case of a 20 per cent increase in costs the quantifiable net benefits of a shift to “true” CST become negative).

However the analysis is much more sensitive to the estimates of the benefits arising from increased trade as a result of a matching time zone more closely with a trading partner whether interstate or overseas, and the uncertainties of these estimated benefits are high, particularly those relating to the 2008 survey (SACES 2008).

There are a number of ways in which the uncertainty could be modelled.

One approach would be to use the upper and lower bounds of the 95 per cent confidence intervals from the 2008 survey to change the estimated increase (or decrease) in revenue due to greater (lesser) trade with the eastern states. For the net increase in revenue as a result of adopting EST, the 95 per cent confidence interval is a range from an annual impact of between -\$464 million to +\$1,364 million. Either of these extremes seem extremely unlikely (the lower bound as it seems implausible that in net terms businesses in the state would lose significant revenue from moving to the same time zone as our largest trading partners of Victoria and New South Wales, the upper bound as the scale of the benefits seems implausibly large). However, in interest of highlighting the degree of uncertainty these are presented in the table below. In the case of the lower bound estimates, the shift to EST has a significant net cost to the state, with the shift to “true” CST becoming a significant net positive. For the upper bound estimates, the shift to EST is a very significant net benefit, and the shift to “true” CST a significant net cost.

Table 3.3: Sensitivity of estimates to changes in assumptions and parameters

	Move to EST	Move to true CST
Main results	2,507,251	273,862
Sensitivity to discount rate		
4 per cent real discount rate	3,396,081	370,616
10 per cent real discount rate	1,957,829	214,231
Sensitivity to benefit assumptions		
Benefits are 20 per cent lower	1,976,785	341,149
Benefits are 20 per cent higher	1,976,785	92,109
Sensitivity to cost assumptions		
Costs are 20 per cent lower	3,773,453	1,257,140
Costs are 20 per cent higher	1,241,050	-709,416
Uncertainty of 2008 survey		
Lower bound on net revenue	-9,564,855	5,164,864
Upper bound of net revenue	12,421,308	-9,640,195
Only survey respondents experience net benefits	-2,173,046	4,954,160
Only survey respondents experience net benefits, no impact of change in time zone on trade with Asia	1,926,701	854,412

An alternative assumption to make would be that the sample of firms who responded were anomalous, and that those who responded were the *only* firms in the state which would experience an increase or decrease in revenue with a change in the time zone. In this case the impact depends on the assumption made regarding the impact of a change in time zone on trade with Asia. If this is assumed to be affected by a change in time zone (the assumption made in the core analysis), then using revenue benefits only from respondents to the 2008 survey without extrapolating them to the broader population

of South Australian firms would result in a significant net cost from shifting to EST, and a significant net benefit from shifting to “true” CST. If it was assumed that the small revenue increase from shifting to EST was because South Australian trade is essentially not affected by small changes in the time zone, then the estimated result would be either a shift to EST or “true” CST would result in net benefits.

The uncertainties regarding the impact on business suggest that, should either change in time zone be considered for adoption, the government engage in extensive consultations with South Australian businesses that have extensive trade with the eastern states and Asia to confirm whether the results of the 2008 survey, and Stein and Daude's (2007) estimates are representative of South Australian businesses.

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