Infrastructure Victoria Second Container Port Advice

Economic advice

24 April 2017

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Glossary

Term	Description
CBA	Cost-Benefit Analysis
CETM	Commercial, economic and transport modelling
FTE	Full-Time Equivalent
GRP	Gross Regional Product
IPART	Independent Pricing and Regulatory Tribunal Home
ISO	International Organisation for Standardisation
IV	Infrastructure Victoria
RRE	Regional Rail East
STSC	Ship to Shore Crane
TEU	Twenty-foot equivalent unit
TKT	Tonne-kilometre travelled
VITM	Victoria Integrated Transport Model
VKT	Vehicle-kilometres travelled
VHT	Vehicle-hours travelled

1 Introduction

This report summarises the results of the economic analysis of a range of port development scenarios to make an informed decision on (i) when and if to build Victoria's second container port and (ii) where to build it.

1.1 Purpose of this report

Infrastructure Victoria (IV) is preparing advice for the Victorian Government on the timing (when) and location (where) of Victoria's second container port.

Locations being considered for the second port are Hastings in Western Port and Bay West in Port Phillip Bay, which covers the area between Point Cook and Point Lillias. The exact location of the Bay West port and channels within this area are yet to be determined.

IV has engaged a number of consultancies including Deloitte, to assist with preparation of this advice. The majority of the work has been broken into four packages:

1. Commercial, economic and transport Modelling (CETM), that is led by Deloitte, with Jacobs providing transport modelling advice
2. Engineering and dredging, led by GHD
3. Navigation and hydrodynamics, led by AECOM and Cardno
4. Environment, led by GHD.

This report brings together the economic advice component of the CETM team that will be utilised by IV to prepare the final evaluation report for the Victorian Government.

1.2 Report structure

The report is structured as follows.

Section 2 outlines the economic methodology that has been used in this report. This methodology estimates the total costs that Victorians will face in the long-term (to 2065) from having a port at alternative locations. The modelling is conducted on two fundamental pathways of port development and eight different Scenarios that were defined during the engagement for the purposes of the modelling. These are shown in Sections 3, along with key assumptions made during the analysis.

Section 4 presents the results and findings on the first question, i.e., timing of opening the second port terminal, while Section 5 contains our findings on the second question, i.e. where to locate the second port.

Section 6 presents the economic impacts on jobs and Gross Regional Product (GRP)[1] of building a second container port on the regional economies that will host these terminals.

[1] Gross Regional Product (GRP) measures the market value of final goods and services produced in an economy in any given year. It excludes the consumption of intermediate goods, and therefore, measures the value added through the production process.

2 Economic modelling approach

A monetised cost effectiveness analysis is used in this report that assesses the economic cost of meeting Victoria's container trade demand using alternative port locations.

Economic costs for the purposes of this report are defined to include:

- Capital costs of expanding capacity at alternative port locations
- Operational and maintenance costs of the underlying assets
- Impacts on travel times of metropolitan road users and associated vehicle operating costs
- The resulting impacts of travel on the environment, road damage and road user safety.

Two port development pathways and eight Scenarios are modelled in this analysis.

2.1 Overview

The economic modelling approach used in this report involves estimating the long-term economic cost (2017-2065) of meeting Victoria's container trade demand at Port of Melbourne versus other proposed alternative locations. Economic cost include port development and operating costs as well as travel time cost, vehicle operating costs, supply chain costs and the impact that vehicular flows induce on the environment and road user safety.

This approach estimates the total economic costs aggregated over from 2017 to 2065 to determine the port development pathway and Scenario that will impose the least cost on society in the long-term (refer to Section 3 for a discussion on pathways and Scenarios). Future costs are discounted to present day values in order to compare costs that arise at different times (refer to Section 2.5 for details).

In economics, such an approach is referred to as a monetised cost effectiveness analysis. This analysis compares the costs and outcomes (effects) of different courses of action. This analysis is applied to the planning and management of many types of activities, ranging from health to defence and energy efficiency. The objective of this analysis is to determine the intervention or option that generates the maximum benefit using least costs.

The rationale for adopting a least cost approach is that meeting Victoria's container demand involves a choice: either continue to use the existing port location (Port of Melbourne) or develop an alternative port location, to accommodate demand that is expected to grow from 2.86 million Twenty-Foot Equivalents (TEUs)[2] in 2017 to 9.5 million by 2061. These options will impose costs on society. The economic approach adopted here identifies the option that imposes the least cost on Victorians in meeting the anticipated future container demand.

2.2 Project costs

Expanding the port at its current location in Melbourne or investing at a new location will involve costs to Victorians. As part of this economic analysis, the following economic costs have been captured:

1) Financial costs (capital and recurrent costs) to build, operate and maintain the port and new landside infrastructure at the alternative port locations, that are disaggregated into:

[2] TEU refers to 'twenty-foot equivalent unit', a standard unit based on an International Organisation for Standardisation (ISO) container of 20 feet length (6.10 m), used as a statistical measure of traffic flows or capacities.

- Port capital costs (including costs related to demolition and relocation, dredging and reclamation, earthworks / groundworks, wharf / terminal, bridge construction, rail / road linkages in port precinct and infrastructure development)
- Landside capital costs (major investments in road and rail landside infrastructure)
- Other project costs (including contractor overheads and design, planning and investigations)
- Infrastructure operating costs including terminal operations
- Infrastructure maintenance costs related to port and new landside transport infrastructure.

2) Container landside supply chain costs on the entire metropolitan network, including:
    - Cost of transporting goods by rail and road between production, consumption and distribution centre locations spread throughout Victoria, and the resulting impacts on traffic flows on the metropolitan road network. This involves estimation of both travel times and vehicle operating costs determined using the distance travelled between origin and destinations.[3]
3) Costs on the broader community imposed by the vehicular flows, including:
    - External effects[4] on the environment due to distance travelled by different vehicles. Effects of air pollution, greenhouse gases, noise, water, nature and landscape, urban separation[5], upstream and downstream costs is captured here.
    - Road damage costs from road traffic
    - Travel time costs of freight and passenger journeys
    - Crash costs imposed due to vehicle operations.

2.3 Exclusions

Other costs will also arise from the decisions to continue having the port at its current location or to operate it from the alternative locations. These costs however, are excluded from the analysis at this stage. The rationale for their exclusion is outlined below.

- Land opportunity costs: moving the port from its current location in Melbourne would free up land in close proximity to the inner city that could be used for other purposes including commercial, residential and recreational uses. This means that continuing to operate the port at its current location results in a notable opportunity cost. At this stage, the Government has made investment plans in other inner city precincts such as Fishermans Bend and E-Gate that may suffice to accommodate population and employment growth in the inner city out to the 2050s. An opportunity cost of the underlying value of land was not available at this stage for this study. The upshot of this is that the case for relocation would be stronger than that presented here if such opportunity costs were taken into consideration.
- Transactions cost for the government to contract with a port operator who may operate a second container port terminal. While the design, planning and investigations costs of building a second container port are included, transactions costs are not. This is unlikely to cause a bias in results, as the magnitude of these costs will likely be the same regardless of the alternative port location, and therefore, exclusion of these costs will not change the ranking of alternative locations.

[3] We looked at impacts of the alternative port locations on traffic movements in the entire metropolitan network, rather than port generated trips only. This is because port generated trips may induce a behaviour change on other users of the transport network due to local area congestion.

[4] Externality effects are the costs and benefits arising from an activity perceived by third parties. In the case of travel decisions, these effects are not reflected in the price of travel and therefore travellers do not factor them when making travel decisions.

[5] Urban separation results from three primary elements: time loss due to separation for pedestrians, lack of non-motorised transport provision and visual intrusion.

- Amenity impacts on neighbourhoods from operating at the different locations. Amenity impacts of the ports at different locations have been assessed qualitatively by Deloitte. Further details are discussed in the accompanying Deloitte report 'Social amenity impacts of port-related freight movement" (Deloitte 2017). Some of these costs have been quantified within the economic analysis, including urban separation costs related to road travel activities.

Furthermore, past investments that have been made at Port of Melbourne that have allowed it to reach a capacity of 4.4 million TEUs throughput are disregarded from this analysis. This is because, past investments made in an asset are already spent and so cannot be affected by future decisions. In economic terms used by the Victorian Treasury these costs are 'sunk costs' and are not included in an economic analysis.

2.4 Similarities and differences to cost benefit analyses

In general, economic analysis aims to capture the full costs to all parts of society and so goes beyond the financial costs of the project itself by considering issues such as environmental costs and transport network effects. Consequently, the decision on when to build a second container port will not be based on an analysis of demand and capacity alone, but rather, the true economic costs of meeting that demand.

The primary benefit of conducting a least cost analysis instead of a cost-benefit analysis (CBA) is that it will provide IV with a structured response to both questions and enable an improved and easier understanding of the outcomes and analysis by the wider stakeholder group.

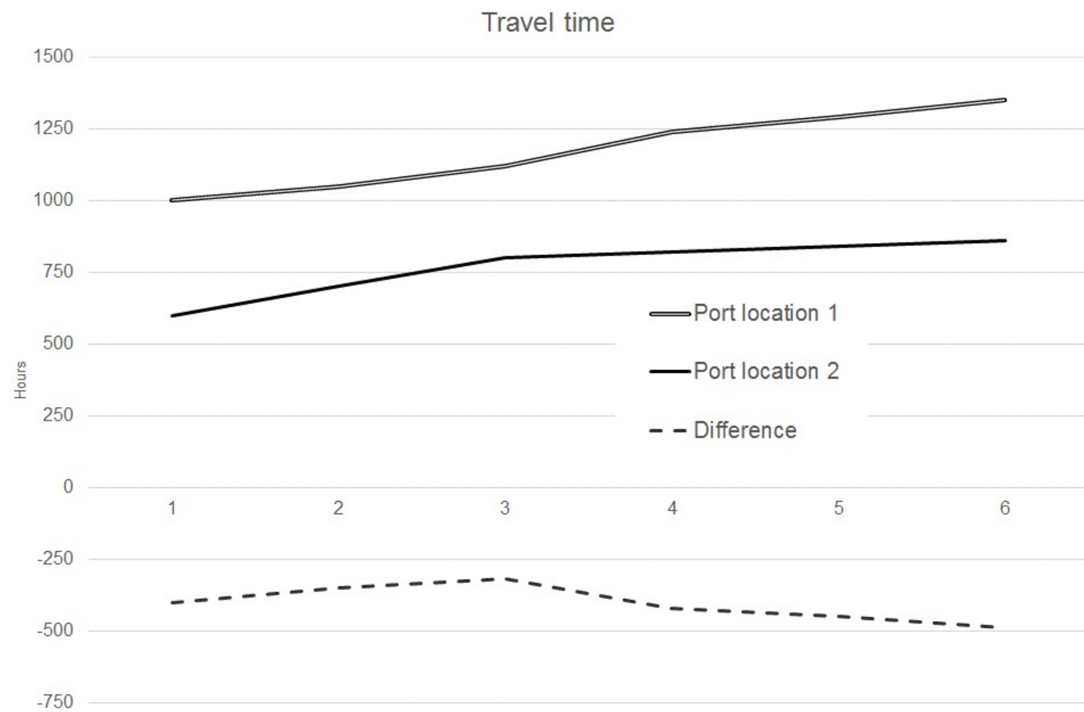
Other economic approaches including a CBA were deliberated for this study; however, the least cost option chosen here was superior to other approaches on two counts:

- This approach does not involve the definition of a hypothetical base case (or a business as usual Scenario) as would be required to conduct a CBA. A CBA compares the costs and benefits of one option compared with a base case, or a business as usual option. Rather than taking a hypothetical position that continuing with Port of Melbourne may be business as usual, this analysis treats the merits of each individual port location in a standalone manner. Continuing to expand Port of Melbourne is not the only reference solution available to the Government. Hence, selection of a reference base case option may be subject to criticism.
- Secondly, this approach is the only available means to adequately respond to the two questions posed by IV, i.e. when to move and where to. Results from the modelling respond to this question by demonstrating the cost of operating at alternative port locations. It determines when a particular port location becomes cost prohibitive to meet Victoria's container needs thereby clarifying the optimal timing of moving to a new location. A CBA would have been a more appropriate economic approach to follow in the case where the optimal timing to move to a new port would have been established before undertaking the analysis.

The approach taken has similarities to a CBA. As in the case of a CBA, it quantifies the same cost and benefit elements. The least cost approach adopted here estimates the costs imposed by each option on travel times, vehicle operations, environmental externalities and crashes. However, instead of comparing these to a business as usual Scenario, as would have been the case in a CBA, this analysis treats them as standalone.

To illustrate, consider that the only costs of two options were travel time costs imposed by two alternative port locations, and as demonstrated in Figure 1. Assume further that port location 1 is the business as usual option. Given that port location 2 entails lower costs compared with Option 1, an incremental analysis such as a CBA would have picked Option 2 as the preferred option relative to Option 1 (the business as usual option), as it would lead to travel time savings compared to the benchmarked option. Importantly, the least cost approach used here will also pick port location 2 as the preferred option as it entails lower costs compared to the alternative.

Figure 1: Example to demonstrate differences between the least cost approach and a cost benefit analysis



In summary, rather than taking difference in costs relative to a business as usual option as a benefit, this approach considers all costs as standalone to determine the least cost option.

2.5 Discounting future values

Discounting of costs and benefits that arise in the future enables direct comparison between options by representing future costs and benefits of options that accrue at different times in the future in a comparable way. It enables a comparison of the costs and benefits of different options on a like-for-like basis, by converting future values of costs and benefits from different time periods to an equivalent amount in today's dollars (present values). Two rationales for discounting include

1. To reflect the fact that the funds could earn a return if not invested into this project.
2. To reflect that costs occurring later are worth less than the same magnitude of costs occurring earlier in the project life.

This is especially important for the purpose of this study where the time profile of investment required to meet Victoria's container demand is different between the alternative port location options. Given the significant past investment at Port of Melbourne and its existing capacity of 4.4 million TEU, the next tranche of major capital investment at Port of Melbourne is some time away. By comparison, the initial capital investment to build capacity at an alternative container port location could occur at an earlier stage.

It is the only recommended approach by the Victoria Treasury to compare between different options which entail costs and benefits at a future date, and is a common approach in economic modelling.

In this analysis, we have applied three different real discount rates - of 4 per cent, 7 per cent and 10 per cent. These are the rates recommended by the Economic Development, Jobs, Transport and Resources (2016) guidelines to use when conducting economic appraisal involving future values.

A discount rate of 4 per cent is generally used for non-commercial investment such as in schools and hospitals where demand risk is rather low. On the other end of the spectrum are commercial risky projects where a higher discount rate is recommended to balance the higher degree of risk. In the case of this project, the investment may be commercial in nature, but risks of future demand are low.

3 Port development pathways and scenarios

3.1 Overview

To meet future container demand in Victoria, the economic costs of three alternative port locations are considered, i.e., expanding the current site at Port of Melbourne, investing in a new location at Bay West or investing in a new location at Hastings.

The economic modelling included two primary port development pathways and several scenarios within each pathway. Each scenario represents a likely path of container capacity development in Victoria to meet the anticipated growth in demand.

The two port development pathways recognise that:

1) Victoria could continue to operate one port site that meets all of its container trade demand or develop a container port at a new location at Hastings or Bay West (**full development pathway**)

2) An alternative pathway might involve building a second container site once it becomes cost prohibitive to accommodate additional container demand at Port of Melbourne, and any demand exceeding this threshold is accommodated at a second container site (**overflow pathway**).

These include five different Scenarios in the full development pathway and three in the overflow pathway. Figure 2 introduces the eight different Scenarios considered. Scenarios B1, B2 and B2a are overflow pathway scenarios assuming that Port of Melbourne is used until demand reaches a certain capacity, while all additional demand will be accommodated at a second container port, either at Bay West or Hastings.

Scenarios 'Port of Melbourne with and w/o freight link', C2, C2a and C3 refer to full development pathway Scenarios where the majority of demand is assumed to be accommodated at one location (excluding Bass Strait trade which continues to be go through Port of Melbourne), these being either at the current site at Port of Melbourne, Bay West or Hastings. One variation of the full development Scenario of Port of Melbourne considers the construction of a Freight Link to enable further capacity extensions at Webb Dock. Two variations of the two Hastings Scenarios consider the possibility to develop Hastings excluding significant investments in rail infrastructure.

Figure 2: Options considered in the economic analysis

Deliberations between IV, GHD, Jacobs and Deloitte at the time of preparing this report concluded that a Freight Link will be required to increase the capacity of Webb Dock at Port of Melbourne when throughput reaches 4 million TEUs (this being considered as the upper limit). This will cost $3 billion. Other investments will also be required between 2028 and 2060, amounting to a total of $3.3 billion. At the same time, capacity at Swanson Dock may be limited as it cannot accommodate a significantly larger fleet compared with today (ship sizes exceeding 7,500 TEUs). Some investment will therefore be required to enable it to accommodate a larger fleet, and its footprint could be expanded to 4.5 million TEUs, and the cost of doing so will be modest in comparison to building the Freight Link. Furthermore, when Swanson Dock becomes constrained by fleet size, it may be relatively cheaper to expand capacity at Webb Dock instead of Swanson Dock to accommodate additional demand at Port of Melbourne. If no investments are made at Swanson Dock, its capacity in the future may be limited to 1.6 million TEU (due to ship size) in an extreme case Scenario.

Given that significant investment is needed at Webb Dock to expand its throughput beyond 4 million TEU, it was decided that an overflow pathway be constructed at a point where a second container site is built to accommodate container trade demand exceeding 5.6 million TEU (i.e. where Webb Dock cannot exceed 4 million TEU throughput and Swanson Dock is limited to 1.6 million TEU throughput). Two primary Scenarios were considered under this pathway, i.e. overflow to Bay West and Hastings.

A full development pathway instead recognises that throughput at Port of Melbourne can expand to 8.5 million TEU without a Freight Link and at least to 11.3 million with a Freight Link. In both situations, Swanson Dock could handle a throughput of 4.5 million, and there will be sufficient capacity at the port to meet demand to 2061 (expected to be 9.6 million TEUs). Other Scenarios considered in this pathway involve reducing Port of Melbourne to a size that is sufficient only to cater for Bass Strait trade (i.e. 0.6 million TEUs by 2061), and transferring all of the remaining container trade task (i.e. the remaining 9 million TEUs by 2061) to either Bay West or Hastings.

When considering the alternative port locations, it was concluded that significant investment will be needed in rail at Hastings (circa $6.9 billion) to operate a port which does not impose significant congestion and environmental impacts on the economy. Comparatively, providing a similar level of rail infrastructure at Bay

West is significantly cheaper at $331 million. In the interests of a fair and like for like comparison, a decision was made to consider Scenarios of moving to Hastings with minimum rail.[6]

Note that different Scenarios are used to respond to the two different questions, as follows:

- All Scenarios are used to respond to the first question, i.e. when to move
- All the overflow pathway Scenarios and three of the full development pathway Scenarios (i.e. C2 Hastings with rail, C3 Bay West and C2a Hastings with minimum rail) are used to respond to the second question, i.e., where to move.

3.2 Inputs to economic modelling

Inputs from various work-streams, including work completed by Deloitte, were used in this economics report to present our advice. In some cases, Deloitte had taken assumptions to adjust the input data provided as outlined below.

- Deloitte developed forecasts of:
  - Victorian container trade demand out to 2065 (shown in Figure 4)
  - Rail supply chain impacts (including the total rail freight kilometres travelled under the full development options and unit costs per kilometre).
- GHD provided:
  - Capital cost estimates (in 2017 dollar terms), associated expanded capacity estimates, and timing of expanding capacity at Port of Melbourne, as well as the costs of building new port terminals at Bay West and Hastings. Costs to build capacity at the alternative port location was provided in 3 million TEU tranches.
  - Operating and maintenance cost estimates (in 2017 dollar terms) at Hastings and Bay West. Deloitte prepared the forecasts for operating costs at Swanson and Webb Dock of Port of Melbourne based on a 2015 Hamburg Port Consulting GmbH study undertaken for the Port of Hastings Development Authority (Port of Hastings Development Authority 2015). This study shows notable operating costs differences between a straddle carrier (SC) option and an automated stacking cranes (ASC) system, estimating that a SC system is about 35 per cent more expensive per TEU. Assuming that the expansion of Swanson Dock would be SC operation, the operating costs of Swanson Dock is estimated to be 35 per cent higher compared with costs estimated for Bay West. The time profile of operating cost in all examined Scenarios is shown in Figure 13. A description of our approach to estimating operational cost forecasts at Port of Melbourne is presented in Appendix A.
  - Throughput estimates at Swanson Dock and Webb Dock considering fleet size growth over time and split between Asia and non-Asia trades (refer to Figure 21).
- Jacobs provided outputs of the Victoria Integrated Transport Model (VITM) for cars, light commercial vehicles and trucks, for the entire metropolitan network, for the years 2011 and 2046. These outputs comprise of:
  - Vehicle trips
  - Vehicle hours travelled
  - Vehicle kilometres travelled.

[6] The without rail Scenario excludes investment in the Hastings – Lyndhurst rail upgrade and the regional rail east (RRE) link. It is assumed that some containers would move to the port on the existing rail network via Frankston and the Stony Point line.

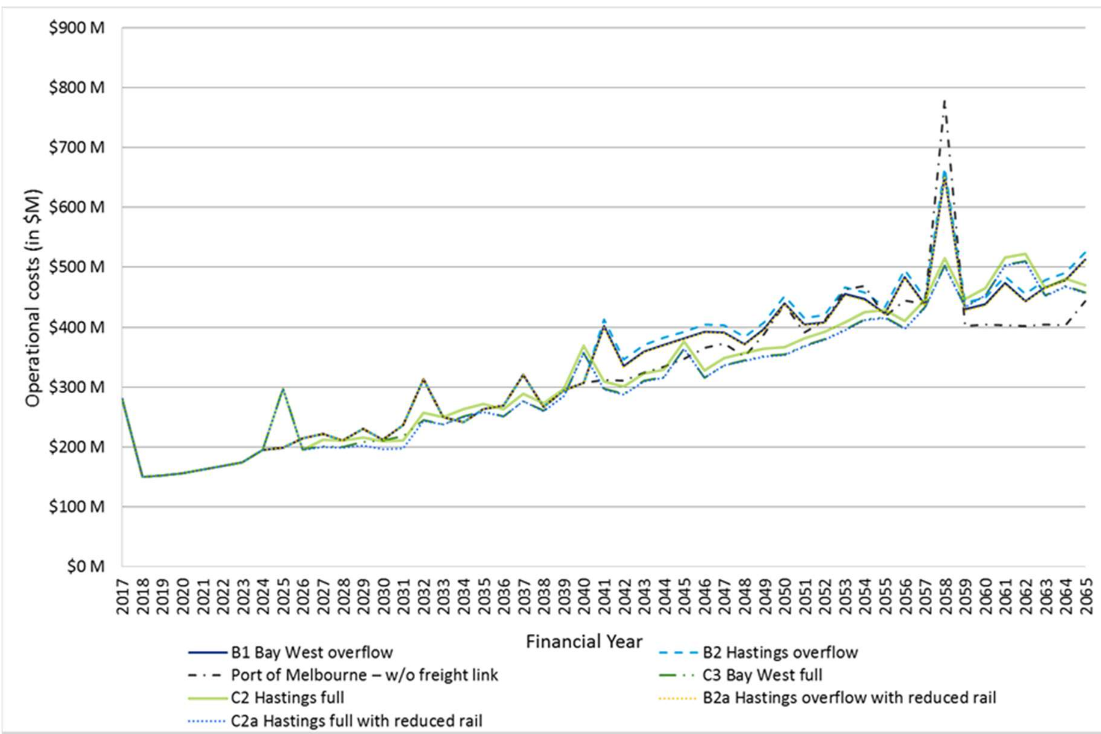
3.2.1 Traffic inputs

Summary outputs on vehicle kilometres travelled, vehicle hours travelled and number of trips of the VITM model are shown in Table 9 in Appendix A. These outputs were estimated for the eight Scenarios described in Figure 2. However, these outputs assume 2046 road conditions, the latest year for which the transport network is defined in the VITM model. The accompanying report "IV Ports Advice Infrastructure Victoria – Port Landside Transport Modelling" (Jacobs 2017) presents further details on the assumptions and inputs used in the modelling. Jacobs outputs were adjusted by Deloitte to reflect 2061 population conditions, the year when forecast container trade levels reflect the trade assumptions used in the Jacobs traffic Scenarios. A description of the method to interpolate outputs on impacts of congestion and externalities between 2017 and 2065 is shown in Appendix A. The method used by Deloitte to adjust VITM outputs to reflect 2061 population levels is also shown in this section.

3.2.2 Operational costs

Operational costs were estimated for each Scenario using GHD inputs on port operating costs at Hastings and Bay West and Deloitte assumptions for Port of Melbourne operating costs. Total annual operating costs for each Scenario are presented in Figure 3.

Figure 3: Operational costs at different port locations ($ million, 2016/17 values)



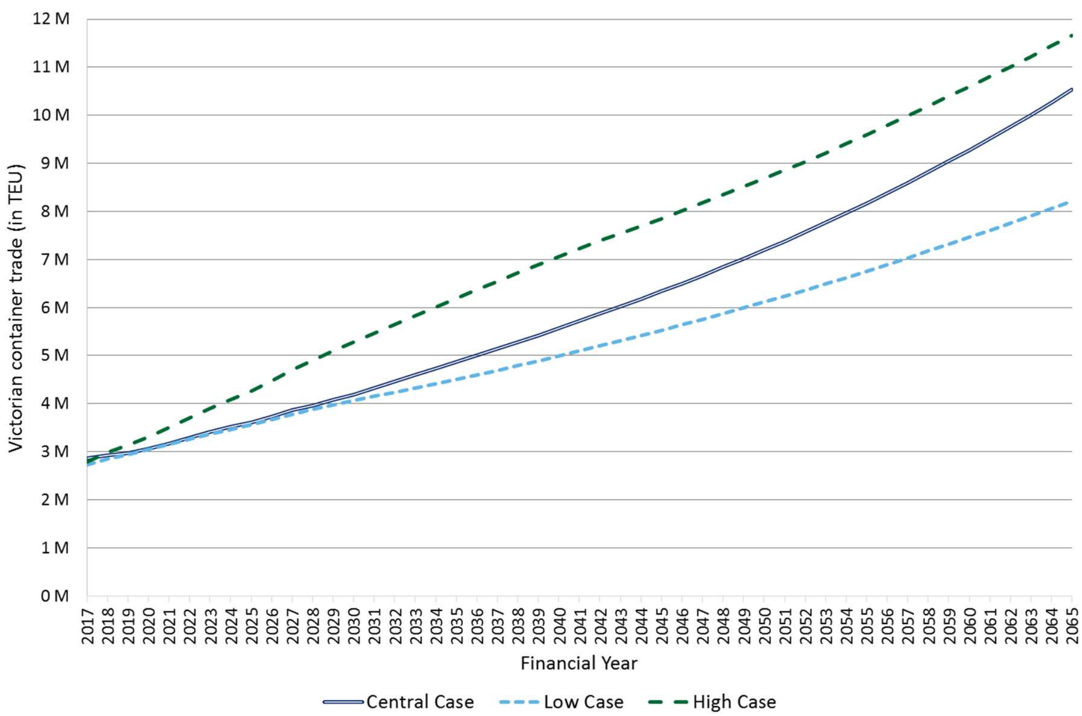
Source: GHD, Deloitte

Under scenarios B1, B2, B2a and Port of Melbourne expansion, there is a spike in operating costs in 2058. This is driven by operating costs at Port of Melbourne, reflecting cyclical terminal equipment maintenance and replacement costs at this location determined by the asset life of the equipment. Note that the throughput at Port of Melbourne under other scenarios is assumed to be minimal at 2058 and hence there is no spike in operating costs.

3.2.3 Container trade forecasts

For the purpose of preparing the analysis underpinning the advice on the timing (when) and location (where) of Victoria's second container port, Deloitte has estimated container trade forecasts for Victoria for a low, central and high case as presented in Figure 4.

Figure 4: Forecasts of total container trade: central, low and high cases (million TEU)



Source: Deloitte

Further details of Victorian historic and future container trade developments are discussed in the accompanying Deloitte report “IV Port Strategy – Container trade forecasts for Victoria” (Deloitte 2016).

3.3 Key assumptions

Key assumptions that were made to complete the economic modelling are outlined below.

- Overflow pathway:
  - The alternative port locations are built to a capacity of 6 million TEUs and are assumed to accommodate demand of nearly 5 million TEUs by 2065. By this time, total container demand is slightly above 9.5 million TEUs, of which 5.6 million TEU continues to be handled at Port of Melbourne. This assumption implies that a second container ports would be built to a higher capacity than required until the end of the project horizon in 2065. This assumption was taken based on GHD recommendation to construct a new port in stages of 3 million TEU capacity each. The means that the second container port will allow to accommodate demand beyond 2065.
  - Elements of operating costs at the alternative port locations – those pertaining to equipment capital – were curtailed at two thirds of the amount provided by GHD. GHD costs applied to a port working at a full capacity of 6 million, while the overflow Scenarios assume a maximum throughput of 5 million at the alternative locations.
  - Investment will be required at Port of Melbourne to increase its capacity from 4.4 million TEUs to 5.6 million TEUs shown in Figure 9.

- Full development pathway:
    - Capacity at the alternative port locations is staged in a manner so that they can accommodate container demand as quickly as possible, and operations at Port of Melbourne are wound down as a result.
    - Port of Melbourne continues to be used until such time that there is enough capacity at the alternative port locations to absorb the remainder of the demand. No investment is required at Port of Melbourne in this pathway because container demand does not exceed the current capacity of Port of Melbourne of 4.4 million TEUs until 2031, by which time an additional port location with 6 million TEU capacity would become available.
- Other assumptions affecting all pathways and Scenarios:
    - Capacity at different port locations can only be enhanced using infrastructure spending or upgrades. Such spending and upgrades can take several years. When there is insufficient capacity to meet demand, a port's ability to accommodate additional throughput is achieved only when spending on a particular investment stage or investment upgrades is fully completed. That is, no additional throughput is allowed during the implementation of a stage of capital works.
    - Costs are aggregated and discounted over the timeframe extending from 2017 to 2065, by when Victoria's container demand would have exceeded 9.5 million TEUs. Such a long-term horizon is selected as various capital expenditure costs of expanding capacity at the alternative port locations will continue to arise closer to 2060.
    - Some of the future port or landside capital development costs are attributed to this project even though the government might proceed to provide some of this infrastructure at a future date, regardless of the outcome of this project. In the case of Western Port Highway, costs attributed to this project include costs related to the southern section of the highway.

4 Findings: When should you move?

4.1 Discounted economic costs

As explained above, future costs are discounted to provide a systemic comparison of costs between various scenarios as these costs occur at different points of time.

Table 1 shows the discounted total economic costs of the various port development pathways and Scenarios, using a discount rate of 4 per cent. Table 2 and Table 3 show discounted results using a discounted rate of 7 and 10 per cent respectively.

Table 1: Economic costs to accommodate additional demand in different port development scenarios ($ billion, 2016-17 values, discounted using 4% discount rate)

	Full development, i.e. one port site meets all of Victoria's container trade					Overflow, i.e. a second container site is built to accommodate container trade exceeding 5.6 million TEU		
	Port of Melbourne without Freight Link	Port of Melbourne with Freight Link	C2 Hastings with rail	C3 Bay West	C2a Hastings (with minimum rail)	B1 Bay West overflow	B2 Hastings overflow (with rail)	B2a Hastings overflow (with minimum rail)
Total from 2017-65								
Capital expenditures	0.8 B	2.0 B	9.8 B	4.6 B	4.1 B	2.6 B	5.5 B	2.2 B
Operational expenditures	6.0 B	6.0 B	6.0 B	5.8 B	5.8 B	6.1 B	6.2 B	6.1 B
Total capital + operational expenditures	**6.8 B**	**8.0 B**	**15.7 B**	**10.4 B**	**9.9 B**	**8.7 B**	**11.7 B**	**8.3 B**
Annual average over 2017 and 2065								
Annual average cost of congestion and externalities*	34.2 B	34.2 B	34.4 B	34.3 B	34.5 B	34.2 B	34.3 B	34.3 B

*Note: * Annual average cost are derived by dividing total discounted cost over the period 2016-17 to 2064-65 by the number of years, i.e., 49 years.*

These results show that, in total over the period from 2017 to 2065, the combined capital and operational expenditures of staying at Port of Melbourne imposes the least cost out of all Scenarios. Developing Port of Melbourne to a capacity of 8.5 million TEUs entails a discounted capital and operational cost expenditure of $6.8 billion without a Freight Link, and $8 billion when developing it to a capacity of between 11.3 and 12.5 million TEUs with a Freight Link and extensions to Webb Dock East, West and South (and when using a discount rate of 4 per cent).

The underlying reason for relatively lower costs of developing Port of Melbourne including the construction of a the Freight Link is that costs of developing the Link and the Webb Dock extensions amounting to $5.9 billion in

undiscounted terms arise between 2056 and 2058, i.e. much later in the evaluation period. The present value of this investment is significantly less in today's discounted dollar terms. Other costs are involved to 2056 to upgrade capacity at both Swanson Dock and Webb Dock, however, these are relatively modest, and amount to $4.1 billion in undiscounted terms (refer Figure 6).

By comparison, the capital cost of developing alternative port locations at Bay West and Hastings in the full development pathway will arise much earlier as shown in Figure 7 and Figure 8 respectively, and amount to $6.1 billion and $12.8 billion respectively in undiscounted terms. This is because two of the three stages of capital investment to build the capacity of these ports to 6 million TEUs need to be implemented sequentially.

Consequently, the full development Scenarios at the proposed alternative port locations are quite expensive compared with staying at Port of Melbourne.

That said, an overflow pathway where part of the trade starts to overflow to an alternative port location (either at Bay West or Hastings) is only modestly more expensive compared with expanding Port of Melbourne.

When considering transport costs and externalities, expanding Port of Melbourne comes out cheaper, too, compared with all other examined Scenarios at $34.2 billion in annual average terms between 2017 and 2065 (in discounted values). This remains the case in Scenarios involving and excluding the Freight Link.

The high magnitude of average annual transport and externality costs under all Scenarios is driven by a large number of annual trips. For example, it is estimated that under the 'Port of Melbourne full development' Scenario, there will be 4.5 billion car and light vehicle trips and 199 million trucks trips in 2046 in the entire metropolitan network. Estimating total transport costs in 2046 at $89 billion (undiscounted), this is equivalent to an average cost of $1.64 per kilometre accounting costs associated with road damage, vehicle operating, travel time, crash costs and environmental externalities.

As shown in Table 1, Scenario B1 (Bay West overflow Scenario) entails a discounted capital and operational cost expenditure of $8.7 billion aggregated over 2017 and 2065, that is, some $700 million more expensive compared with expanding Port of Melbourne with the Freight Link. Scenario B2a Hastings overflow (with minimal rail) on the other hand entails a discounted capital and operational cost expenditure of $8.3 billion aggregated over 2017 and 2065, that is, $300 million more expensive compared with expanding Port of Melbourne with the Freight Link.

Hastings with minimal rail (Scenario B2a) entails lower costs when aggregating over capital and operational expenditures compared with an overflow to Bay West (Scenario B1). That said, it imposes more congestion on the network and therefore higher externality costs too. This is because there will be more truck movements in the overall network in this Scenario and more truck kilometres travelled compared with Scenario B1 (as shown in Table 9 in Appendix A). Because of provision for only minimal rail, time taken by private car users and trucks will also be significantly higher on an annual basis compared with Scenario B1.

Consequently, the lower capital and operational costs of Scenario B2a Hastings overflow (with minimal rail) compared with Scenario B1 Bay West overflow, are more than offset by the higher costs of congestion and externalities. On an annual basis, the former Scenario entails $100 million in additional costs towards congestion and externality impacts on a discounted basis compared with the latter (i.e. $34.3 billion compared with $34.2 billion).

When aggregated over the nearly 50 year period extending from 2017 to 2065, the total costs of congestion and externalities are nearly $5 billion more expensive in Scenario B2a Hastings overflow (with minimal rail) compared with Scenario B1 Bay West overflow. The difference in transport and externality costs between Hasting and Bay West is somewhat smaller when using higher discount rates of 7 per cent and 10 per cent. A higher discount factor reduces the impact of higher costs that arise later in time as can be seen in Table 2 and Table 3.

This finding further underscores the benefit of using a total economic approach. Given that port operations will impose not only capital and operational costs, but also impacts on congestion and externalities, a total economic approach is essential, rather than basing this decision on capital development and operational costs alone.

Importantly, developing a second container port will provide the government with a real option to de-risk reliance on one single port location that is worked too hard. Furthermore, relocating container port activities eventually to a location away from the central city, will pave the way for accommodating more population and employment close to a central city location in years to come.

It is also important to bear in mind that overflowing to Bay West after Port of Melbourne is developed to a capacity of 8.5 million TEUs will be cheaper in discounted terms compared with Scenario B1 Bay West overflow demonstrated here. This is because the Scenario modelled here assumes that Port of Melbourne is developed to a capacity of 5.6 million TEUs, and overflow to Bay West occurs thereafter. Consequently, the costs of developing Stages 1 and 2 of Bay West arise sooner. If instead, Port of Melbourne was developed further to 8.5 million, capital development costs for Bay West will be delayed and arise later. Moreover, developing Port of Melbourne further from a 5.6 million TEU capacity port to an 8.5 million TEU capacity port will be cheaper than investing in Bay West. As a result, the discounted value of a Scenario where Port of Melbourne is developed to 8.5 million TEUs will be lower than that shown here for Scenario B1 Bay West overflow. The upshot of this is that the Bay West overflow Scenario shown here appears more expensive than it might actually be in a real overflow situation.

Table 2: Economic costs to accommodate additional demand in different port development Scenarios ($ billion, 2016-17 values, total 2017-65, discounted using 7% discount rate)

	Full development, i.e. one port site meets all of Victoria's container trade					Overflow, i.e. a second container site is built to accommodate container trade exceeding 5.6 million TEU		
	Port of Melbourne without Freight Link	Port of Melbourne with Freight Link	C2 Hastings with rail	C3 Bay West	C2a Hastings (with minimum rail)	B1 Bay West overflow	B2 Hastings overflow (with rail)	B2a Hastings overflow (with minimum rail)
Aggregated over 2017-65								
Capital expenditures	0.5 B	0.9 B	8.2 B	3.8 B	3.3 B	1.5 B	3.1 B	1.2 B
Operational expenditures	3.5 B	3.6 B	3.5 B	3.5 B	3.5 B	3.6 B	3.6 B	3.6 B
Total capital + operational expenditures	**4.1 B**	**4.4 B**	**11.8 B**	**7.3 B**	**6.7 B**	**5.1 B**	**6.8 B**	**4.8 B**
Annual average over 2017 and 2065								
Annual average cost of congestion and externalities	21.2 B	21.2 B	21.4 B	21.3 B	21.4 B	21.3 B	21.3 B	21.3 B

Table 3: Economic costs to accommodate additional demand in different port development Scenarios ($ billion, 2016-17 values, total 2017-65, discounted using 10% discount rate)

	Full development, i.e. one port site meets all of Victoria's container trade					Overflow, i.e. a second container site is built to accommodate container trade exceeding 5.6 million TEU		
	Port of Melbourne without Freight Link	Port of Melbourne without Freight Link	C2 Hastings with rail	C3 Bay West	C2a Hastings (with minimum rail)	B1 Bay West overflow	B2 Hastings overflow (with rail)	B2a Hastings overflow (with minimum rail)
Aggregated over 2017-65								
Capital expenditures	0.3 B	0.4 B	7.1 B	3.2 B	2.7 B	0.9 B	1.9 B	0.7 B
Operational expenditures	2.4 B	2.4 B	2.4 B	2.4 B	2.4 B	2.4 B	2.5 B	2.4 B
Total capital + operational expenditures	**2.7 B**	**2.9 B**	**9.5 B**	**5.6 B**	**5.1 B**	**3.3 B**	**4.3 B**	**3.2 B**
Annual average over 2017 and 2065								
Annual average cost of congestion and externalities	14.9 B	14.9 B	15.0 B	15.0 B	15.1 B	15.0 B	15.0 B	15.0 B

4.2 Investment pathways

The following Figure 5 and Figure 6 illustrate the cash flows of capital investment required to expand Port of Melbourne including and excluding investment in the Freight Link, followed by Figure 7 to Figure 10 illustrating costs for the overflow and full development options at Hastings and Bay West.

Figure 5: Capital cost to expand capacity at Port of Melbourne without Freight Link (total capacity 8.5 million TEU) ($ million, 2016-17 values)

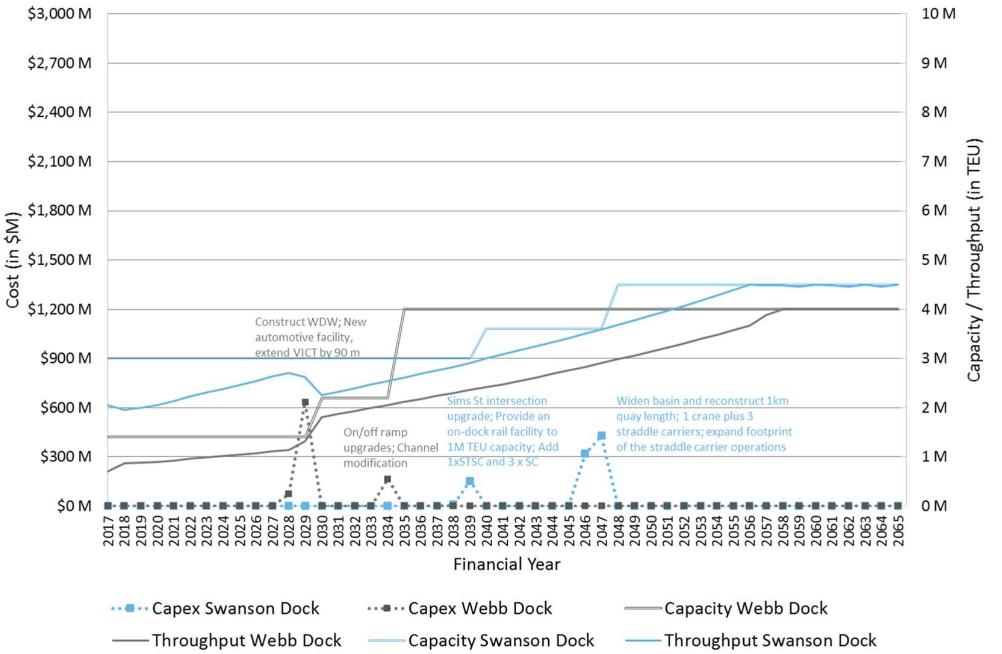
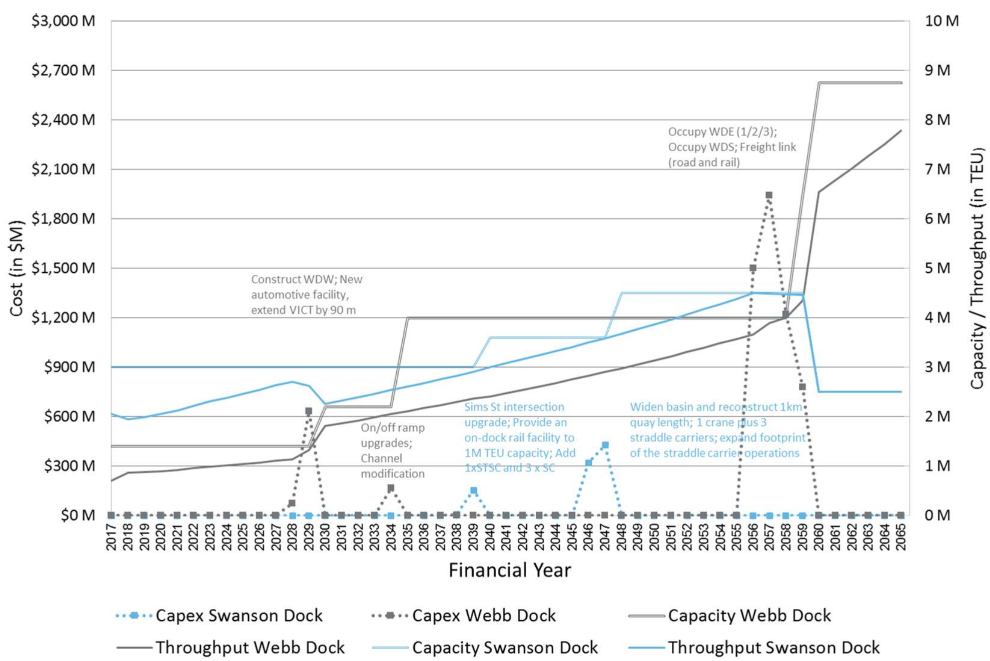


Figure 6: Capital cost to expand capacity at Port of Melbourne with Freight Link (total capacity 11.3 million TEU) ($ million, 2016-17 values)



The following Figure 7 and Figure 8 present capital costs associated with scenarios C2 and C3. Table 7 and Table 8 in Appendix A: provides a summary of the main cost components included.

Figure 7: Capital cost to expand capacity at Bay West (in a full development Scenario) (total capacity 9.6 million TEU) ($ million, 2016-17 values)

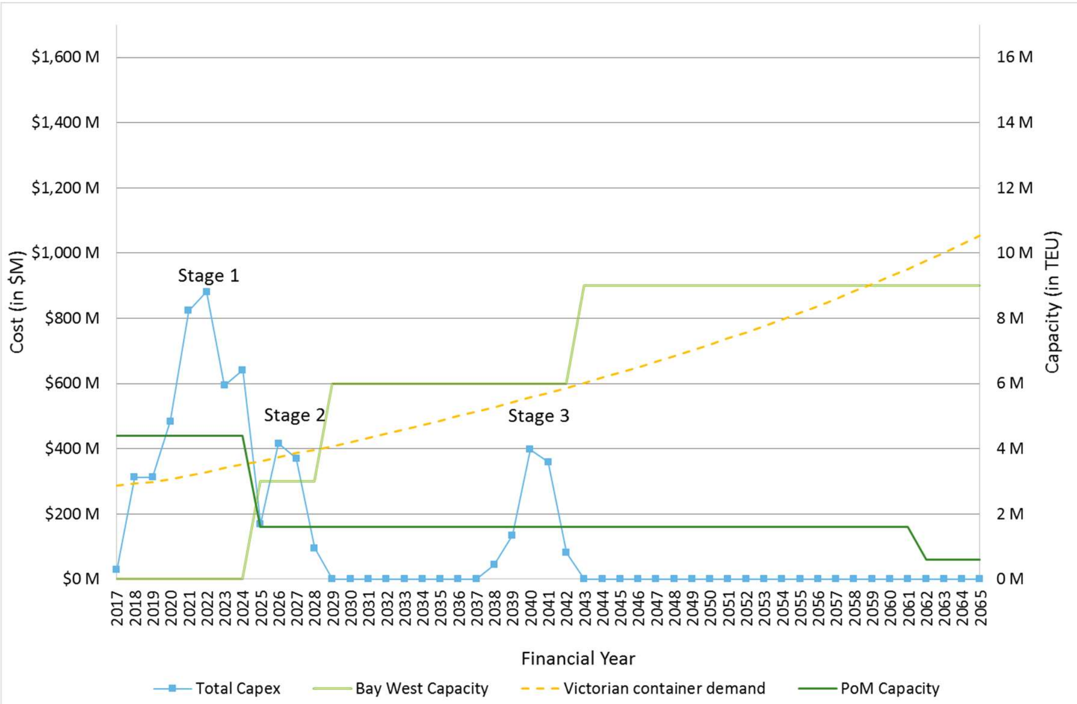


Figure 8: Capital cost to expand capacity at Hastings (in a full development Scenario, with and without rail) (total capacity 9.6 million TEU) ($ million, 2016-17 values)

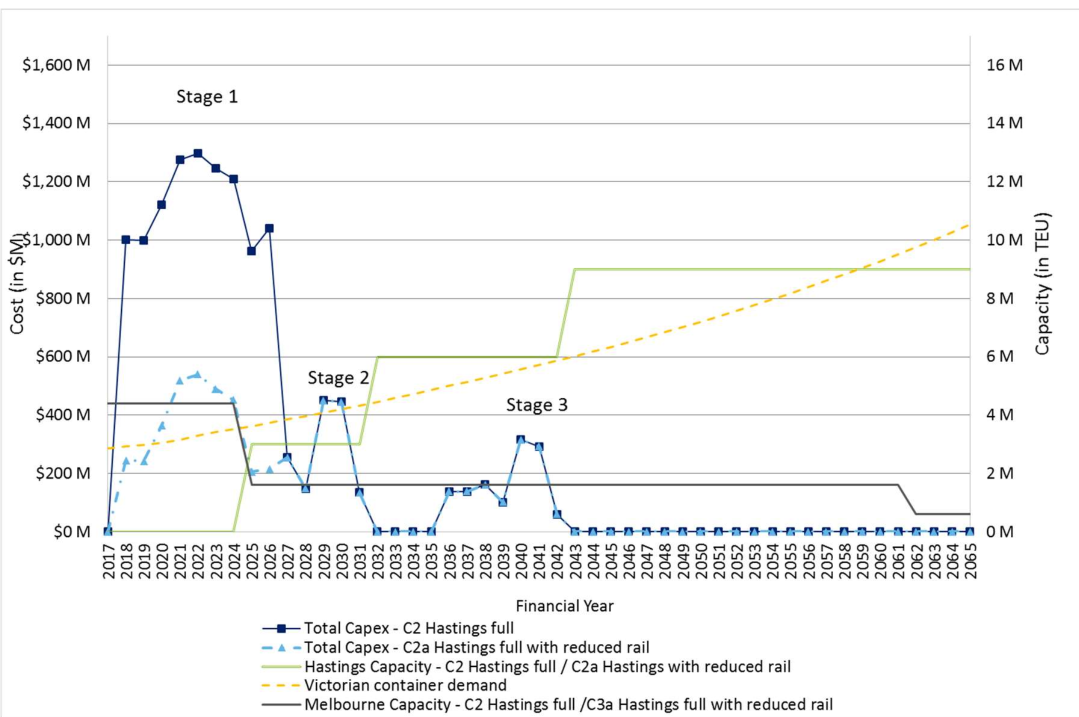


Figure 9: Capital cost to expand capacity at Bay West (in an overflow Scenario) (total capacity of 11.6 million TEU) ($ million, 2016-17 values)

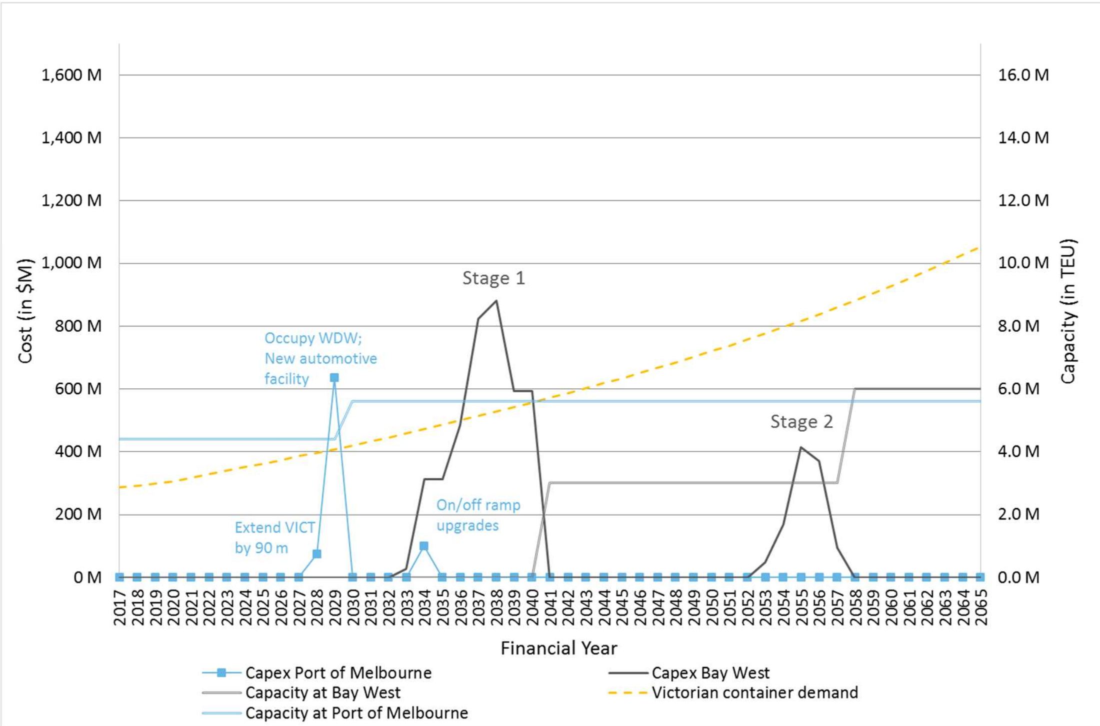
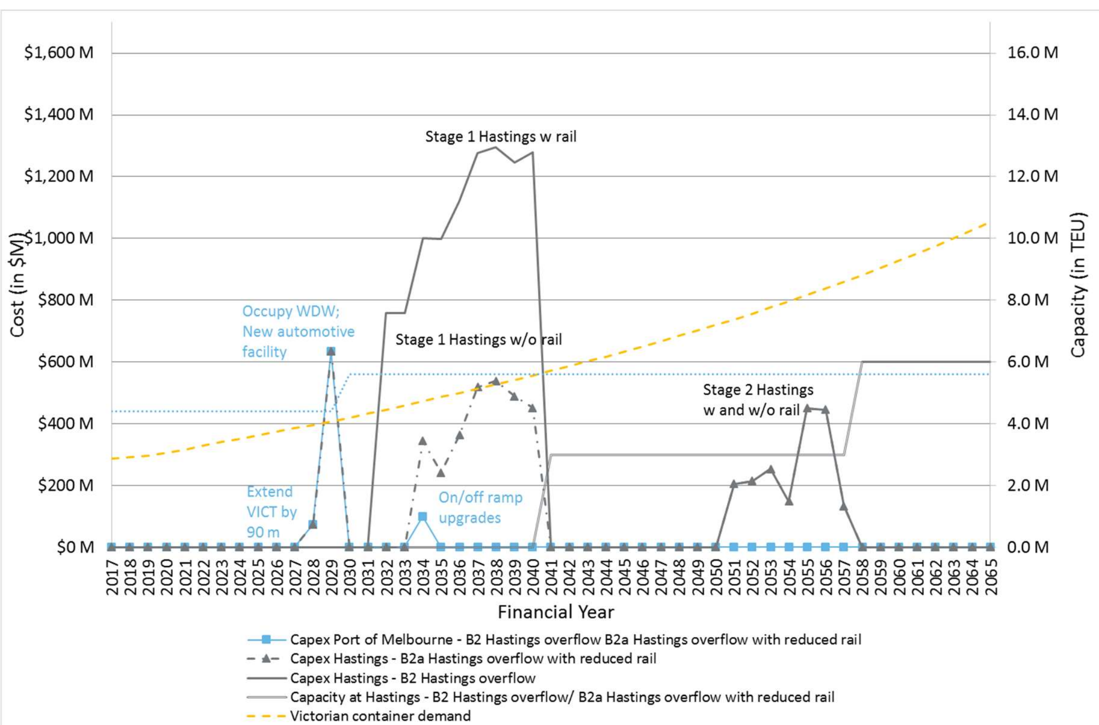


Figure 10: Capital cost to expand capacity at Hastings (in an overflow Scenario, with and without rail) (total capacity 11.6 million TEU) ($ million, 2016-17 values)



4.3 Costs of accommodating additional demand

Based on the above discussion, the choice is between staying at Port of Melbourne, or developing a second container port terminal at Bay West using an overflow pathway.

When might be a good time to move if indeed the overflow pathway is explored? To respond to this, we examine the magnitude of capital investment required to accommodate 3 million additional TEUs of container trade at these two alternative locations (i.e., Port of Melbourne and Bay West).

Table 4: Capital costs to accommodate additional demand at different port locations ($ billion, 2016-17 values)

Scenario	0-3 M TEU	3-6 M TEU	6-8.5 M TEU	Beyond 8.5 M TEU
Port of Melbourne without Freight Link	-	0.88 B	0.91 B	Not possible w/o Freight Link
Port of Melbourne with Freight Link	-	0.88 B	0.91 B	5.9 B (including extensions at Webb Dock East, West and South)
Bay West	4.03 B	1.10 B	1.02 B	Accommodated in the same budget of $1 B needed to develop capacity to 8 M TEU
Hastings	9.73 B	1.85 B	1.21 B	Accommodated in the same budget of $1 B needed to develop capacity to 8 M TEU

The current capacity at Port of Melbourne is 4.4 million TEUs. Going forward, meeting demand of 6 million at Port of Melbourne will entail a capital cost of $0.88 billion and another $0.91 billion to increase capacity further to 8.5 million TEUs. That is, unlocking 8.5 million TEUs capacity at Port of Melbourne will entail a capital cost of $1.79 billion.

Accommodating demand beyond 8.5 million TEUs at Port of Melbourne will involve building the Freight Link and creating Webb Dock East and Webb Dock West at a combined total cost of $5.9 billion thereby providing capacity of between 11.3 and 12.5 M TEU.

That is, once demand exceeds 8.5 million TEUs, accommodating an additional TEU throughput at Port of Melbourne ($5.9 billion) will cost substantially more than providing the capacity at an alternative location at Bay West (with a cost of $4 billion).

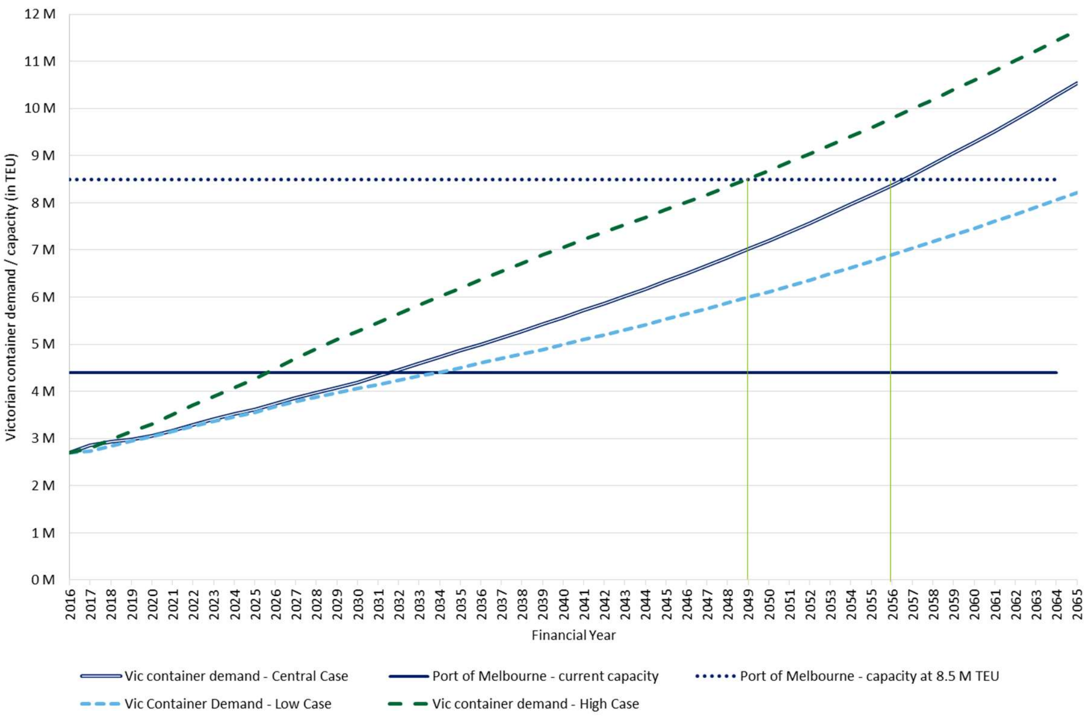
4.4 Findings

In order to determine the exact time period in which trade should move, we examined the demand profile of container trade against the capacity of Port of Melbourne. The objective was to understand when demand might exceed 8.5 million TEUs.

Assuming the central demand forecasts hold, the need to move will arise in 2056, i.e. when Port of Melbourne has a capacity of 8.5 million TEUs. Beyond this year, further capacity will need to be made available in Victoria to accommodate demand exceeding 8.5 million TEUs. However, this capacity can be reached as early as 2049, as per the high demand forecasts.

The case for moving the port away from a central city location sooner rather than later could be stronger if population and employment growth exceeds current expectations. Consequently, the opportunity cost of land at Port of Melbourne will rise faster than currently expected.

Figure 11: Capacity exceeded at Port of Melbourne



5 Findings: Where should you move?

Comparing the two alternative port locations – Bay West and Hastings - Table 5 shows the discounted total economic costs of the two alternative port locations in both development pathways, i.e., full development and overflow, using a discount rate of 4 per cent.

Table 5: Economic costs to accommodate additional demand in different port development scenarios ($ billion, 2016-17 values, discounted using 4% discount rate)

	Full development, i.e. one port site meets all of Victoria's container trade			Overflow, i.e. a second container site is built to accommodate container trade exceeding 5.6 million TEU		
	C2 Hastings with rail	C3 Bay West	C2a Hastings (with minimum rail)	B1 Bay West overflow	B2 Hastings overflow (with rail)	B2a Hastings overflow (with minimum rail)
Total from 2017-65						
Capital expenditures	9.8 B	4.6 B	4.1 B	2.6 B	5.5 B	2.2 B
Operational expenditures	6.0 B	5.8 B	5.8 B	6.1 B	6.2 B	6.1 B
Total capital + operational expenditures	**15.7 B**	**10.4 B**	**9.9 B**	**8.7 B**	**11.7 B**	**8.3 B**
Annual average over 2017 and 2065						
Annual average cost of congestion and externalities	34.4 B	34.3 B	34.5 B	34.2 B	34.3 B	34.3 B

These results show that Hastings with rail is the most expensive of all Scenarios, regardless of the pathway chosen. Meanwhile, Hastings with minimal rail is the cheapest when aggregating over capital and operational cost expenditures.

That said, Hastings with minimal rail imposes more congestion on the network and therefore higher externality costs too. This is because there will be more truck movements in the overall network in this Scenario and more truck kilometres travelled compared with development at Bay West (as shown in Table 9). Because of provision for only minimal rail, time taken by private car users and trucks will be significantly higher on an annual basis compared with Bay West (Scenario B1).

Consequently, the lower capital and operational costs of Hastings (with minimal rail) compared with Bay West, are more than offset by the higher costs of congestion and externalities. On an annual basis, Hastings in an overflow Scenario (Scenario B2a) entails $100 million in additional costs for congestion and externality impacts on a discounted basis compared with Bay West overflow (Scenario B1) (i.e. $34.3 billion compared with $34.2 billion).

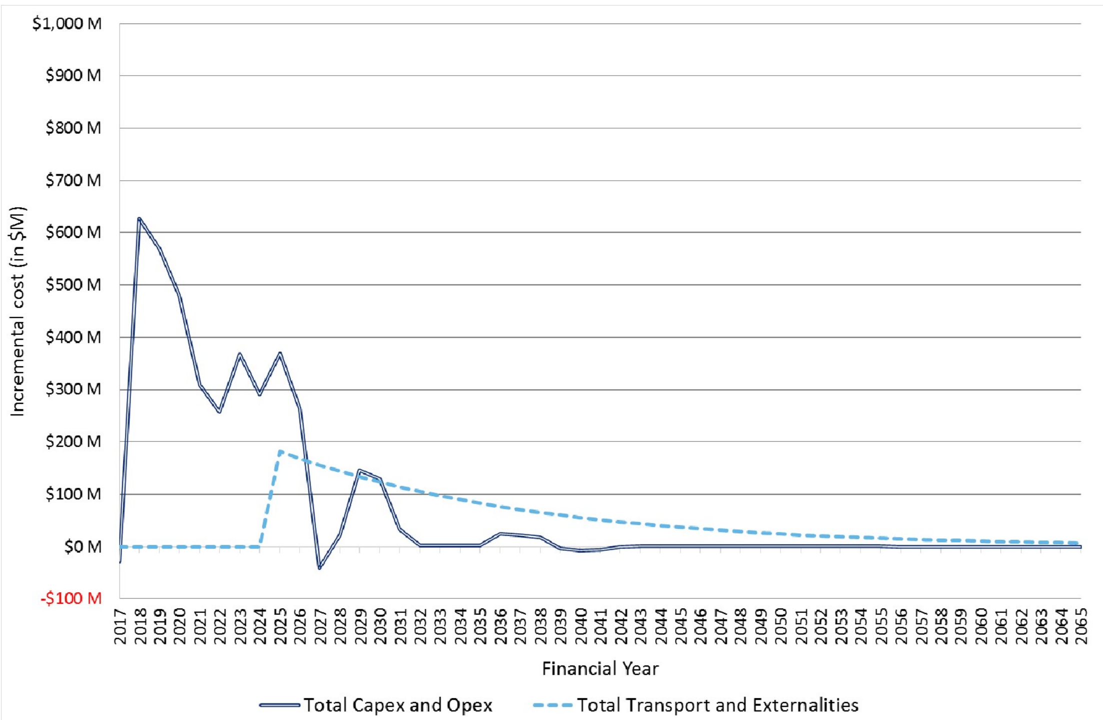
In a full development pathway, additional costs of Hastings with minimal rail (Scenario C2a) are $200 million higher on an annual basis for congestion and externalities when compared with Bay West (Scenario C3).

When aggregated over the nearly 50 year period extending from 2017 to 2065, total economic costs of Hastings are higher compared with Bay West, regardless of the development pathway.

The difference in congestion and externality costs between Hasting and Bay West is smaller when using higher discount rates of 7 per cent and 10 cent. A higher discount factor reduces the impact of costs that arise later in time (refer to Table 2 and Table 3).

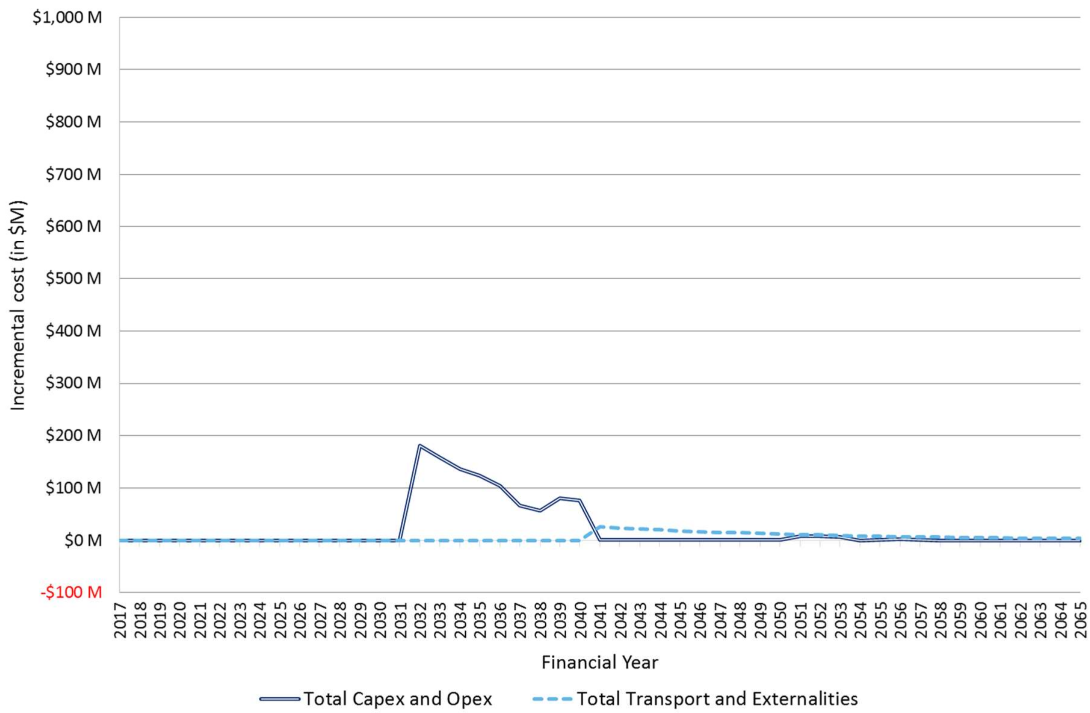
For most years over the project horizon, costs to develop and operate a container port in Hastings are higher compared to Bay West as can be seen in Figure 12.

Figure 12: Additional costs to develop and operate Hastings (compared with Bay West development) ($ billion, 2016-17 values)



Costs to develop and operate a container port in Hastings are also high compared to Bay West under the overflow scenario as can be seen in Figure 13.

Figure 13: Additional costs to develop and operate Hastings (in an overflow scenario compared with Bay West) ($ million, 2016-17 values)



6 Economic impact results

6.1 Overview

This section presents the economy-wide impacts of developing the port at Hastings and Bay West in a full development pathway (i.e. C2 and C3). The two scenarios are modelled incrementally relative to the scenario of continuing with Port of Melbourne without Freight Link, i.e. Port of Melbourne developed to an 8.5 million TEU capacity.

Economic impacts are measured using **full-time equivalent workers** and **gross state product (GSP) / gross regional product** (GRP)[7] induced in the selected regions.[8] These headline economic findings are supported by an analysis of the industries that will likely benefit most from having a new port terminal in the region.

Economic impacts are estimated on the two following regions:

- The regional economies where the ports will be located (i.e. regional economy of Bay West includes the local government areas of Wyndham, Hobsons Bay, Melton and City of Greater Geelong whereas the regional economy for Hastings includes the local government areas of Mornington Peninsula, Frankston, Casey and Greater Dandenong).
- The state-wide economy.

Estimated economic impacts are disaggregated into **direct impacts** – economic activity generated by terminal construction, operations and the broader impacts of vehicular flows of business users, as well as the economic **flow-on impacts**. Flow-on impacts include impacts to other industries not directly affected by the project would not have been generated without the proposed investment in the terminal.

A summary of the economic methodology (DAE RGEM) used to estimate the economic impacts is discussed in Appendix B.

6.2 Inputs to modelling

The incremental differences in costs (aggregated from 2016-17 to 2064-65) for each of these two alternatives relative to continuing with Port of Melbourne are presented in Figure 14. Annual incremental costs are shown in Figure 23 to Figure 27 in Appendix A.

Incremental costs are shown as positive, whereas cost savings represent an efficiency gain, and shown as negative for the purposes of this analysis. Capital expenditures of building the Port at the alternative locations induces new economic activity in the local region and state-wide. Given that the new port locations will be more efficient to operate compared with Swanson Dock, there will be savings from operations that represent cost savings and are shown as negative. By contrast, the alternative locations will induce additional travel in the metropolitan network, and therefore, induce an efficiency loss.

[7] Gross State Product (GSP) is the measure of Victoria's overall economic output. It is the sum of the market value of all final goods produced by industries within Victoria (e.g. manufacturing, construction). Gross Regional Product refers to the same notion, but measured at a regional level.

[8] Gross regional (state) product is the total market value of goods and services produced by a region within a given period after deducting the cost of goods and services used up in the process of production but excluding consumption of fixed capital (Source ABS Cat.no 5206.0). In other words, it is the sum of all outputs less intermediate inputs used in the production process.

Figure 14: Incremental costs relative to the Port of Melbourne expansion scenario ($ million, $2016-17, undiscounted)

	Scenario C2 (Hastings with rail)	Scenario C3 (Bay West)
Total capital expenditure	12,701 M	6,051 M
Total operational expenditure (efficiency gain)	-1,350 M	-1,781 M
Travel time costs (efficiency loss)	10,149 M	299 M
Vehicle operating costs (efficiency loss)	10,686 M	4,678 M

Source: Deloitte Access Economics

6.3 Estimated impacts

Table 6 highlights the sectoral impacts of each evaluated scenario at the regional and state level, showing the deviation against the scenario in which operations continue at Port of Melbourne without the Freight Link. Results are shown for real gross regional product (GRP), employment (FTE) and real gross value added by industry sector.

The following observations can be made from these results:

- The state-wide impact of having a port at Bay West is better compared with having a port at Hastings, relative to continuing with Port of Melbourne. The GSP impact aggregated over the period from 2017 to 2065 is $3.48 billion when the port is built at Bay West, compared with $3.39 billion when it is built at Hastings.
- In fact, the return on investment – measured by the ratio of state-wide GSP impacts against this incremental capital expenditures to build the port at these locations – is significantly higher at Bay West compared with Hastings. This is the case regardless of whether observing results at the regional or state-wide level.
- Port development at Hastings will have a higher impact on the regional economy. This is because it involves a higher magnitude of capital expenditure.
- Impacts on the state (measured by real GSP) are lower than the impacts on the grouping of LGAs (measured by GRP) in both scenarios. The main reason for this is that the alternative port locations induce higher direct travel costs (i.e. increased business travel time and vehicle operating costs). Although there are some operational efficiencies associated with the development at Bay West or Hastings, these are outweighed by the productivity detractions. The additional costs are largely experienced in the Greater Melbourne area leading to a productivity detraction for the transport sector.
- In fact, when considering employment outcomes at the state, scenario C2 (Hastings without rail) results in lower aggregate employment relative to the scenario of continuing with Port of Melbourne9.
- Across both scenarios, the transport sector experiences higher growth relative to the scenario of continuing with Port of Melbourne at the regional level owing to large capital expenditures in that sector and improved efficiency. However, at the state level, the transport sector in Victoria experiences lower growth relative to this base scenario due to the high costs in Greater Melbourne.

[9] Aggregate employment grows but at a lower rate compared with the scenario of continuing with Port of Melbourne.

Table 6: Sectoral impacts ($ million, 2016-17 values, 2016-17 to 2069-70)

	Scenario C2		Scenario C3	
	Hastings regional economy***	Victoria	Bay West regional economy***	Victoria
Real GRP / GSP deviation ($ million NPV)	9.24 B	3.39 B	4.3 B	3.48 B
Incremental capital expenditure ($ billion, PV)*	7.73 B		3.30 B	
Impact on GRP / GSP relative to investment required**	1.20	0.44	1.30	1.06
Employment (FTE, annual average)	840	-472	391	152
Sectoral gross value added ($ million NPV)				
Agriculture	85 M	95 M	29 M	57 M
Mining	87 M	66 M	38 M	39 M
Manufacturing	2,240 M	1,105 M	1,059 M	766 M
Transport	255 M	-1,519 M	173 M	-234 M
Construction	1,969 M	1,704 M	912 M	921 M
Electricity, gas and water	180 M	106 M	86 M	85 M
Finance, insurance and business	1,317 M	1,278 M	642 M	965 M
Other services	3,081 M	524 M	1,350 M	851 M

Source: Deloitte Access Economics

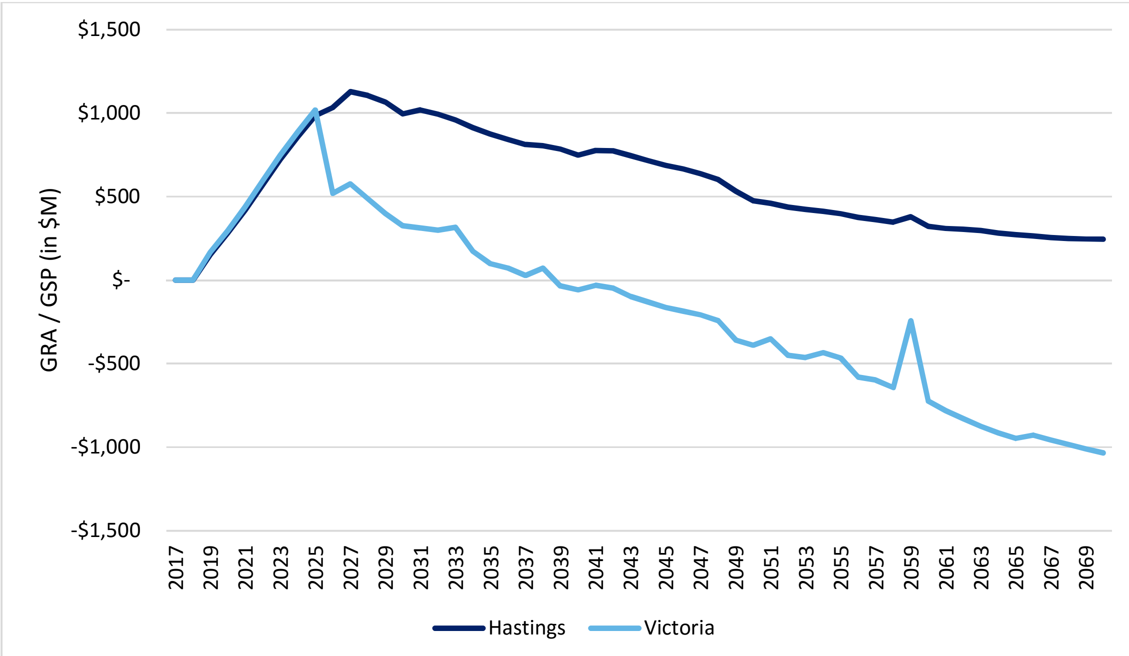
*Notes: *Capital expenditure that is incremental to the Base Case of continuing with Port of Melbourne without Freight Link, i.e. Port with 8.5 M TEU capacity. **Impact is measured as a ratio, i.e. the ratio of the impact on the state's GSP / regional GRP relative to the incremental capital expenditure at each port. A ratio above 1 indicates a positive impact against the benchmarked scenario. *** Regional economy of Bay West includes the local government areas of Wyndham, Hobsons Bay, Melton and City of Greater Geelong whereas the regional economy for Hastings includes the local government areas of Mornington Peninsula, Frankston, Casey and Greater Dandenong). ^ Other services includes information media and telecommunication services, government services and other transport services.*

6.4 Detailed results – Scenario C2 (Hastings with rail)

The development in Hastings is estimated to increase GRP by about $9.2 billion over the period 2017 to 2070 relative to the base scenario in net present value terms (using a 7 per cent discount rate). Over the same period at the state level, GSP is estimated to increase by about $3.4 billion.

Figure 15 traces the time path of GRP for the Hastings regional economy and Victoria. Additional capital expenditure over the construction phase increases GRP at the regional and state level. As before, deteriorating productivity in the transport sector constrains GRP, particularly at the state level which experiences the greatest decreases in productivity (stemming from Greater Melbourne).

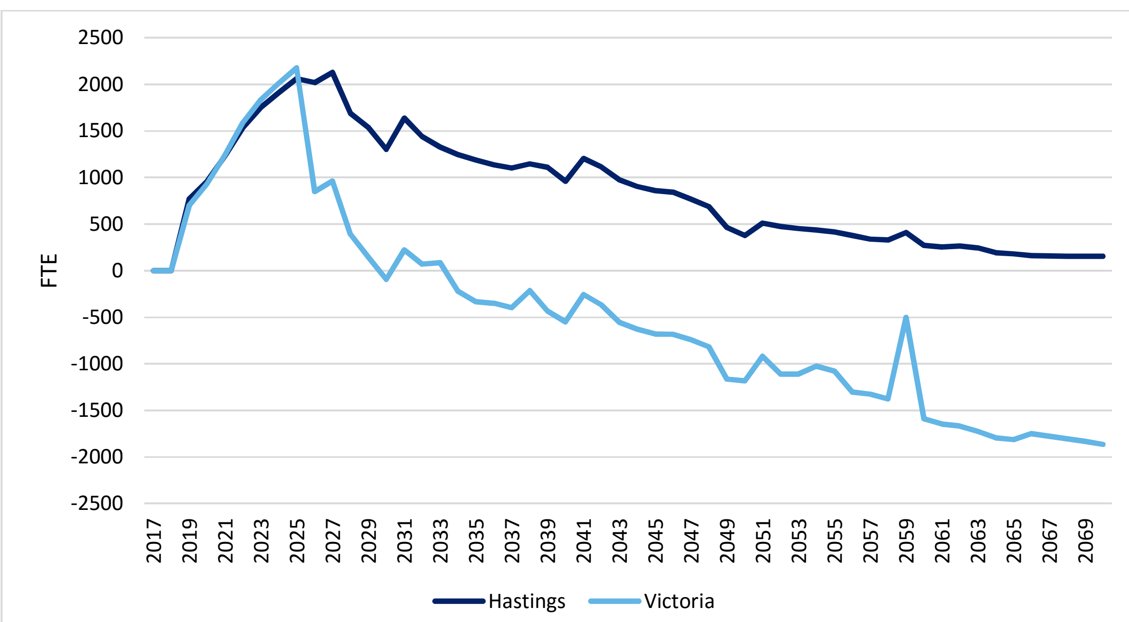
Figure 15: Impact of Scenario C2 on Hastings regional economy GRP and Victoria GSP ($ million, 2016-17 values, 2016-17 to 2069-70)



Source: Deloitte Access Economics

The results indicate that the expansion in Hastings could result in an additional 840 FTE jobs, each year on average over the period 2017 to 2070. Figure 16 highlights an increase in FTE's of 153 relative to the base scenario by 2070 in the Hastings regional economy.

Figure 16: Impact of Scenario C3 on Hastings regional economy and Victoria employment (FTE)



Source: Deloitte Access Economics

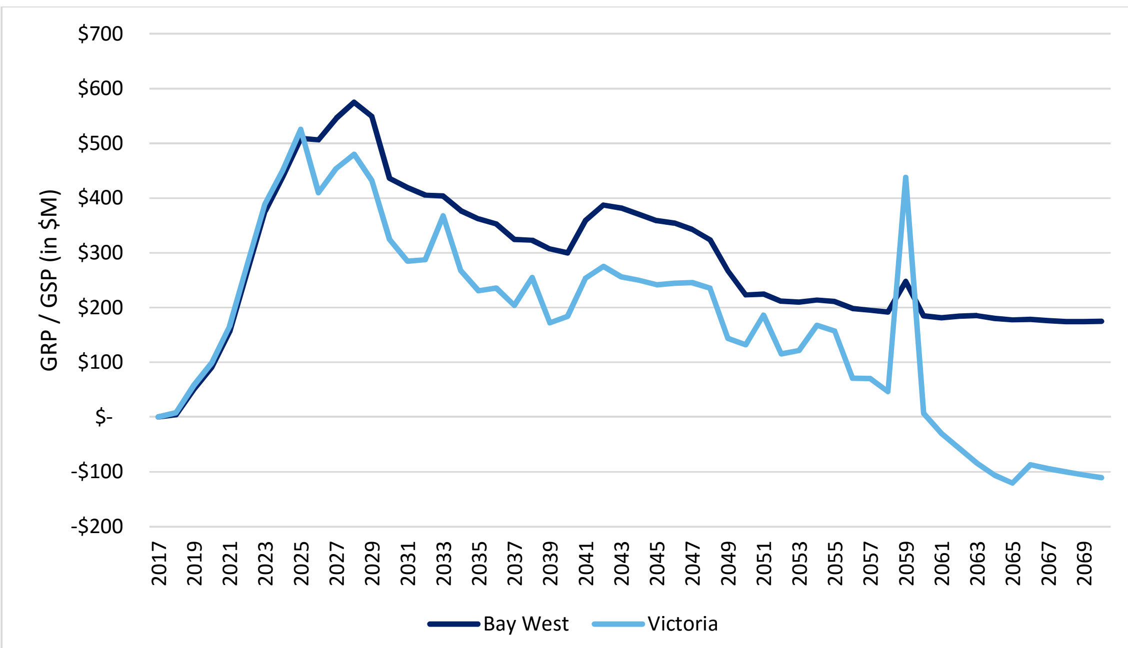
6.5 Detailed results – Scenario C3 (Bay West)

The expansion at Bay West is estimated to increase GRP by about $4.3 billion over the period 2016-2017 to 2069-70 relative to the base in net present value terms (using a 7 percent discount rate in $2016-17). Over the same period at the state level, real GSP is estimated to increase by about $3.5 billion.

Figure 17 traces the time path of real GRP in the Bay West regional economy and Victoria. In the Bay West regional economy, real GRP is stimulated over the construction phase due to additional capital investment in the region. Over time, this effect tapers off as increased travel time and operating costs effectively decrease the productivity in the transport sector across the region and Greater Melbourne. By 2070, GRP in the Bay West region is $175 million higher relative to the base scenario. The higher costs are more pronounced in Greater Melbourne which is also reflected in Victoria's GSP, ending below base by 2070.

Furthermore, the expansion at Bay West could result in 391 full-time equivalent (FTE) jobs for the Bay West regional economy, each year on average over the period 2017 to 2065 (compared to the base scenario). Figure 18 highlights an increase in FTE's over the construction phase (which is relatively more labour intensive), before finally levelling off to remain at 164 FTE's above the base scenario by 2070.

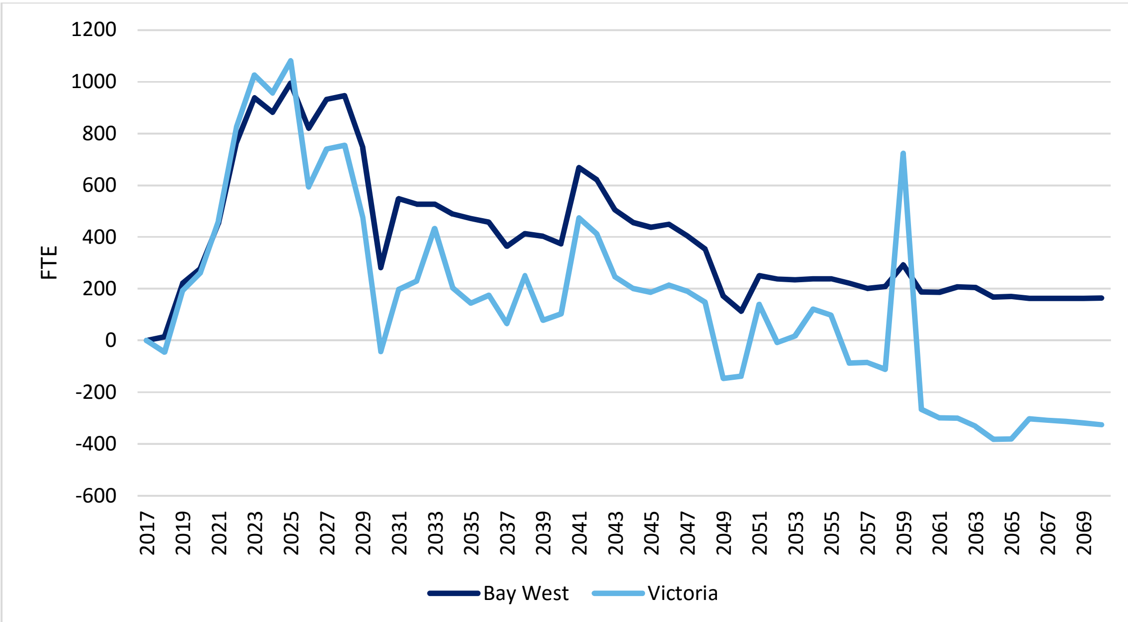
Figure 17: Impact of Scenario C3 on Bay West regional economy GRP and Victoria GSP ($ million, 2016-17 values, 2016-17 to 2069-70)



Source: Deloitte Access Economics

Notes: The large spike in 2059 is caused by a temporary increase in the base cases' operating expenditure driven by operating costs at Port of Melbourne reflecting cyclical terminal equipment maintenance and replacement costs, resulting in a large operating efficiency for the region relative to the base in that particular year.

Figure 18: Impact of Scenario C3 on Bay West regional economy and Victoria employment (FTE)



Source: Deloitte Access Economics

Notes: The large spike in 2059 is caused by a temporary increase in the base cases' operating expenditure driven by operating costs at Port of Melbourne reflecting cyclical terminal equipment maintenance and replacement costs, resulting in a large operating efficiency for the region relative to the base in that particular year.

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Appendix A: Assumptions and key inputs for economic modelling

A.1 Capital costs at Hastings and Bay West

Table 7 and Table 8 show capital costs to develop a new port in Hastings and Bay West. Costs were provided by GHD. Further details can be found in the accompanying reports prepared by GHD "Ports Advice - Engineering, Dredging and Reclamation Concept Designs and Costings - Bay West and Hastings" and "Second Container Terminal Port Advice Estimated Capacity of the Port of Melbourne".

Table 7: Capital costs at Bay West full development scenario ($ million, 2016-17 values)

Item	Stage 1	Stage 2	Stage 3	Total
Port capital costs				
Demolition and relocation	0 M	0 M	0 M	0 M
Dredging and reclamation	1,077 M	0 M	0 M	1,077 M
Earthworks / groundworks	86 M	104 M	70 M	261 M
Wharf / terminal	591 M	525 M	525 M	1,641 M
Bridge construction	332 M	0 M	0 M	332 M
Rail / road linkages in port precinct	434 M	14 M	9 M	456 M
Infrastructure development	62 M	24 M	23 M	109 M
Total port capex	**2,582 M**	**667 M**	**627 M**	**3,876 M**
Landside capital costs				
Landside rail infrastructure capital costs	290 M	0 M	0 M	290 M
Landside road infrastructure capital costs	0 M	0 M	0 M	0 M
Total landside capex	**290 M**	**0 M**	**0 M**	**290 M**
Other project costs				
Contractor overheads	439 M	207 M	182 M	828 M
Design, planning, investigations	217 M	89 M	81 M	388 M
Land acquisition costs	0 M	0 M	0 M	0 M
Total other project cost	**656 M**	**296 M**	**264 M**	**1,216 M**
Base Estimate	**3,528 M**	**963 M**	**891 M**	**5,382 M**
Contingency (14.2 per cent)	**499 M**	**136 M**	**126 M**	**762 M**
Total Capex	**4,027 M**	**1,100 M**	**1,017 M**	**6,144 M**

Source: GHD

Table 8: Capital costs at Hastings full development scenario ($ million, 2016-17 values)

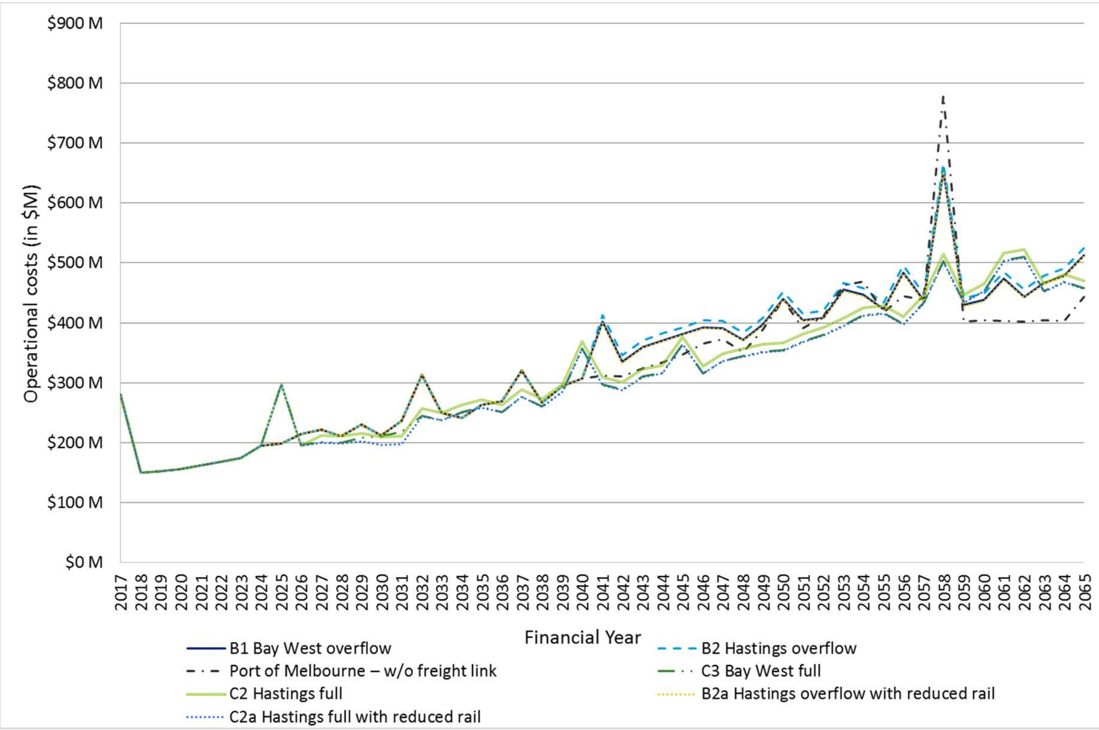
Item	Stage 1	Stage 2	Stage 3	Total
Port capital costs				
Demolition and relocation	2 M	5 M	0 M	7 M
Dredging and reclamation	493 M	580 M	377 M	1,451 M
Earthworks / groundworks	97 M	59 M	46 M	202 M
Wharf / terminal	575 M	660 M	457 M	1,691 M
Bridge construction	177 M	0 M	0 M	177 M
Rail / road linkages in port precinct	396 M	25 M	0 M	421 M
Infrastructure development	59 M	40 M	35 M	134 M
Total port capex	**1,799 M**	**1,369 M**	**915 M**	**4,083 M**
Landside capital costs				
Landside rail infrastructure capital costs	6,500 M	0 M	0 M	6,500 M
Landside road infrastructure capital costs	306 M	44 M	0 M	350 M
Total landside capex	**6,806 M**	**44 M**	**0 M**	**6,850 M**
Other project costs				
Contractor overheads	390 M	234 M	156 M	779 M
Design, planning, investigations	194 M	103 M	70 M	366 M
Land acquisition costs	0 M	0 M	0 M	0 M
Total other project cost	**584 M**	**336 M**	**225 M**	**1,145 M**
Base Estimate	**9,188 M**	**1,749 M**	**1,140 M**	**12,078 M**
Contingency (5.9 per cent)	**545 M**	**104 M**	**68 M**	**716 M**
Total Capex	**9,733 M**	**1,852 M**	**1,208 M**	**12,794 M**

Source: GHD

A.2 Operating costs

The following Figure 19 provides total annual operating costs under the Scenarios considered in the economic analysis. Operating costs for Hastings and Bay West were estimated by GHD.

Figure 19: Operational costs at different port locations ($ million, 2016-17 values)



Source: GHD, Deloitte assumptions

Operating cost assumptions: Bay West and Hastings

Operating costs were provided by GHD for the purpose of the economic analysis and include three main components:

- Recurrent costs related to labour, maintenance and energy for terminal operations
- Equipment capex
- Civil engineering maintenance costs.

Terminal operating costs are directly driven by the volume handled at a port assuming decreasing marginal costs. For example, unit costs are assumed to be $67 per TEU assuming an annual throughput of 1 M TEU, and $43 at an annual throughput at 2 M TEU.

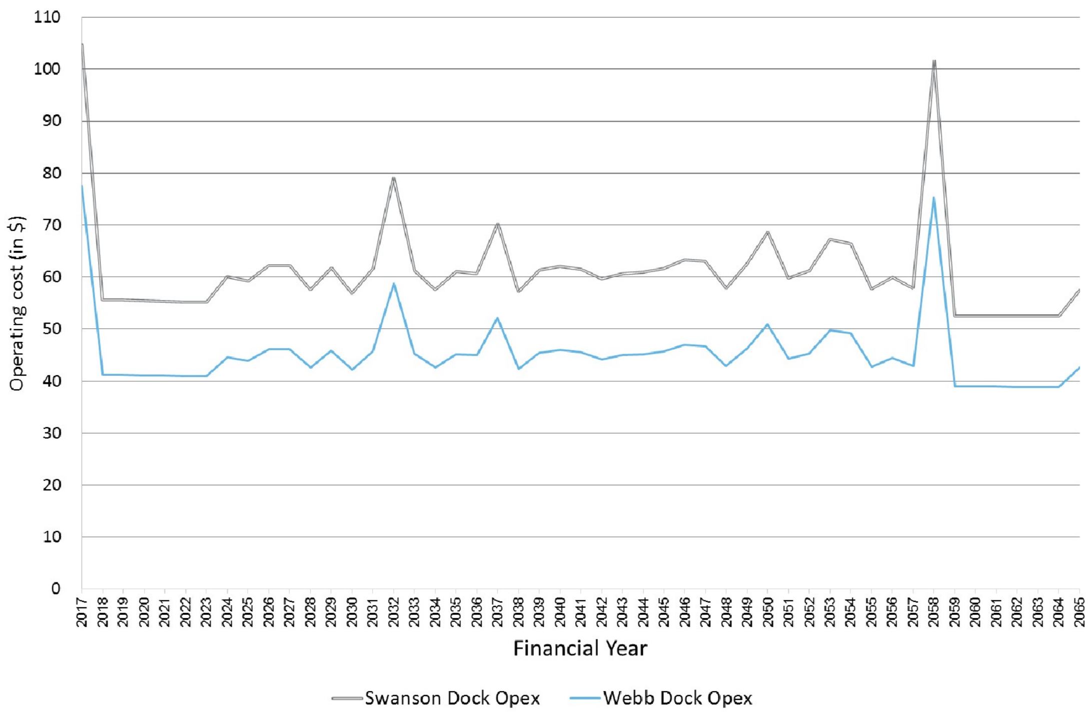
Equipment capex capture maintenance and replacement costs of Ship to Shore Cranes (STSCs), Automated Stacking Cranes and other equipment and is calculated based on the number of equipment required and their asset life. It is assumed that annual equipment capex maintenance costs are the same for Bay West and Hastings.

Civil engineering maintenance costs are assumed to be 0.2 per cent of cumulative capital expenditure for developing Hastings and Bay West, respectively. Cumulative capital expenditure include port construction and landside infrastructure capex, excluding contingency and other project costs.

Operating cost assumptions: Port of Melbourne

Operating costs at the Port of Melbourne were estimated separately for Webb Dock and Swanson Dock. Unit cost ($ per TEU throughput) over time are shown in Figure 20.

Figure 20: Opex unit cost at Swanson and Webb Dock ($ per TEU, 2016-17 values)



Source: Deloitte, GHD

Unit costs used for Port of Melbourne were based on operating costs at Bay West and Hastings provided by GHD. The recurrent cost component related to labour, maintenance and energy for terminal operations at Webb Dock are based on the same unit costs assumed for Bay West and Hastings, while a 35 per cent mark-up was assumed for Swanson Dock.[10] Annual equipment capex and civil engineering maintenance costs for Bay West was divided by total throughput at this location to derive a unit costs per TEU throughput. These unit costs were used for Webb Dock, while a 35 per cent mark-up was added to derive unit costs for Swanson Dock.

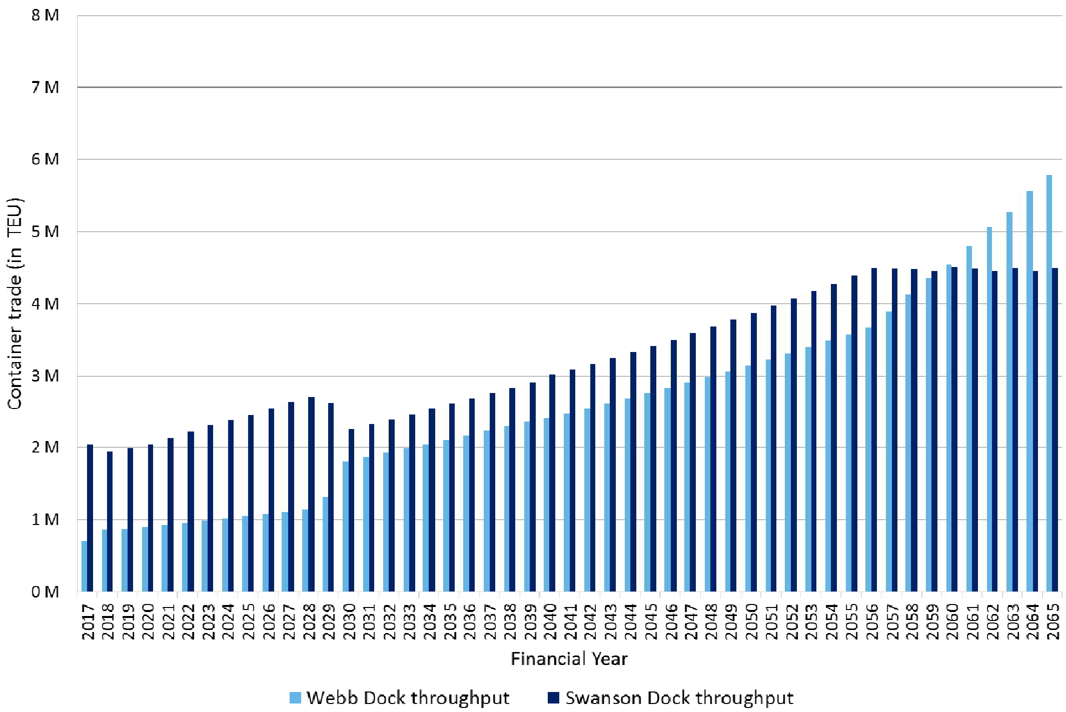
To estimate opex related to equipment capex and civil engineering maintenance costs, unit cost per TEU throughput were derived based on the C3 Bay West full Scenario. These unit costs were used for Webb Dock, while a 35 per cent mark-up was added to derive unit costs for Swanson Dock.

A.3 Throughput forecasts at Swanson Dock and Webb Dock

The following figures show forecasts of container trade at Swanson Dock and Webb Dock at Port of Melbourne. These forecasts were provided by GHD. Figure 21 shows the forecast container trade under the 'Port of Melbourne without freight link Scenario'.

[10] The mark-up is based on a 2015 Hamburg Port Consulting GmbH study undertaken for the Port of Hastings Development Authority (Port of Hastings Development Authority 2015). This study shows notable operating costs differences between a straddle carrier (SC) option and an automated stacking cranes (ASC) system, estimating that a SC system is about 35 per cent more expensive per TEU. Hence, assuming that the expansion of Swanson Dock would be SC operation, the operating costs of Swanson Dock is estimated to be 35 per cent higher compared with costs estimated for Bay West.

Figure 21: Throughput at Swanson Dock and Webb Dock at Port of Melbourne without Freight Link (million TEU)

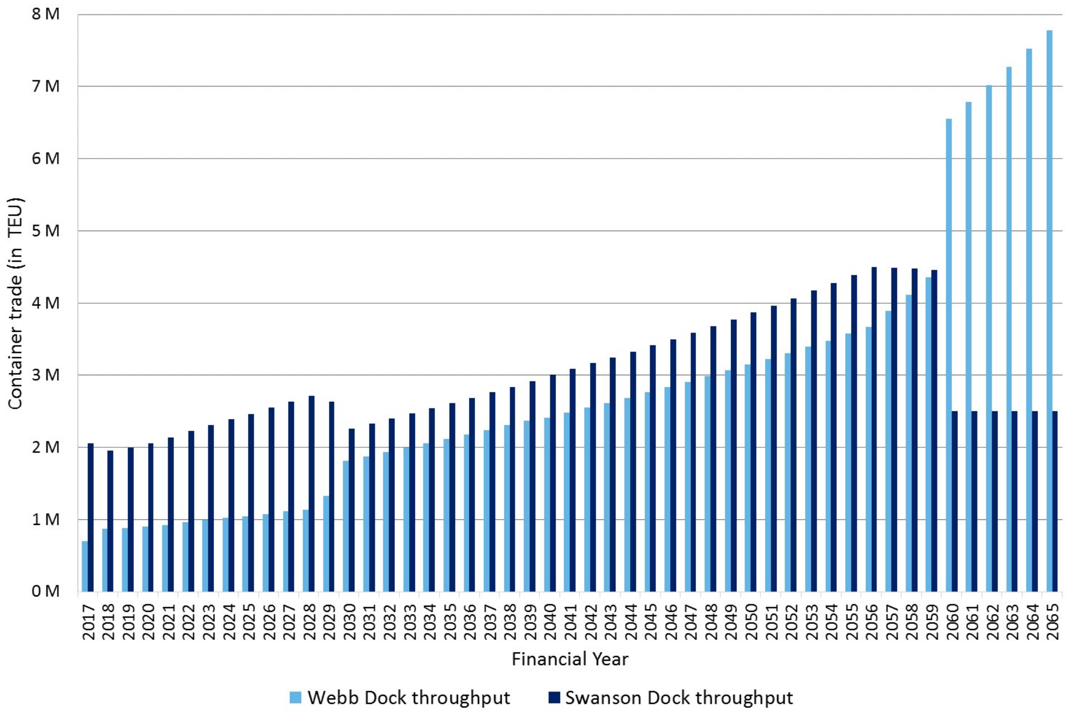


Source: GHD

According to GHD estimates, a decrease of trade at Webb Dock will occur at around 1.4 M TEU throughput (i.e., in 2029) following the relocation of Bass Strait trade to Swanson Dock with the intention to free up additional berth capacity for international trade. It is estimated that between 2057 and 2065, further growth in demand will only be accommodated at Webb Dock, due to ship size constraints restricting further growth in trade at Swanson Dock.

Figure 22 shows forecast container trade under the 'Port of Melbourne with freight link' Scenario. In contrast to the 'Port of Melbourne without freight link' Scenario, total trade at Swanson Dock is assumed to be restricted at 2.5 M TEU per annum starting from 2060, following the opening of the freight link and significant investment at Webb Dock to increase capacity to 8.8 M TEU per annum.

Figure 22: Throughput at Swanson Dock and Webb Dock Port of Melbourne with Freight Link (million)



Source: GHD, Deloitte assumptions

A.4 Traffic modelling outputs (Jacobs)

Traffic modelling was undertaken by Jacobs. The main results summarising vehicle kilometres travelled, vehicle hours travelled and number of trips by vehicle type (car and light vehicles and trucks) are summarised in Table 9.

Table 9: VITM model outputs at 2046 (billion)

	2011	Port of Melbourne without Freight Link	Port of Melbourne with Freight Link	C2 Hastings with rail	C3 Bay West	C2a Hastings (with minimum rail)	B1 Bay West overflow	B2 Hastings overflow (with rail)	B2a Hastings overflow (with minimum rail)
Vehicle-kilometres travelled									
Cars / LCVs	28.3 B	48.0 B	48.0 B	48.0 B	48.0 B	47.9 B	48.0 B	48.0 B	48.0 B
Trucks	2.7 B	6.7 B	6.7 B	7.0 B	6.8 B	7.1 B	6.8 B	6.8 B	6.9 B
Vehicle-hours travelled									
Cars / LCVs	0.633 B	1.181 B	1.180 B	1.182 B	1.181 B	1.184 B	1.181 B	1.181 B	1.182 B
Cars / LCVs	50 M	145 M	145 M	149 M	145 M	152 M	145 M	147 M	148 M
Trips									
Cars / LCVs	n/a	4.541 B	4.541 B	4.541 B	4.543 B	4.540 B	4.542 B	4.541 B	4.541 B
Cars / LCVs	n/a	199 M	199 M	200 M	200 M	203 M	200 M	200 M	201 M

Source: Jacobs

Outputs from the VITM model in the form of vehicle-kilometres travelled, passenger-kilometres travelled, number of trips and load factors of freight vehicles are major inputs into the economic analysis. These outputs were only available for two years, 2011 and 2046. Economic costs including vehicle operating costs, travel time costs, externalities and crash costs were estimated for these two years. To estimate economic costs in other years, 2011 costs were applied to years prior to the implementation of the project, while 2046 costs were applied thereafter. For every year, these costs were adjusted to reflect changes in the population using ABS (2013) Greater Melbourne Population Forecast (ABS 2013).

A.5 Parameter values used to monetise costs

Parameter values used in the economic appraisal were sourced from ATAP (2016) guidelines and indexed to reflect 2016/17 prices. The main parameter values are presented in the following tables.

Table 10: Parameter values for travel time costs (2016-17 values, $/occupant and $/vehicle-hour)

	Value per occupant	Value per vehicle-hour	Total VTTS per hour
Car and LCV - Private	16.9	-	16.9
Car - Business	54.7	-	54.7
LCV - Business	28.6	-	28.6
Rigid	29.0	6.9	35.9
Articulated	30.2	38.7	68.9
B-Double	30.6	67.5	98.1

Source: ATAP (2016)

Table 11: Parameter values for environmental externalities (2016-17 values, $/vehicle-kilometre, $/tonne-kilometre)

	Cars ($/ vkt)	LCV ($/ tkm)	Heavy vehicles ($/ tkm)
Air pollution	0.03	0.20	0.03
Greenhouse	0.03	0.06	0.01
Noise	0.01	0.03	0.00
Water	0.00	0.03	0.00
Nature & landscape	0.00	0.02	0.00
Urban separation	0.01	0.03	0.00
Upstream and downstream costs	0.04	0.21	0.02
Total	**0.13**	**0.60**	**0.07**

Source: ATAP (2016)

Table 12: Parameter values for vehicle operating costs (2016-17 values, $/vehicle kilometre)

	B1	B2	Port of Melbourne with and w/o freight link	C2	C3	C2	B2a	C2a
Freeway								
AM	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
IP	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
PM	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
OP	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Arterial								
AM	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
IP	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
PM	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
OP	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Local								
AM	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
IP	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
PM	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
OP	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
HCV								
Freeway								
AM	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8
IP	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
PM	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
OP	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Arterial								
AM	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.7
IP	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
PM	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
OP	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Local								
AM	1.8	1.9	1.9	1.8	1.9	1.8	1.9	1.9
IP	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
PM	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
OP	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

Source: ATAP (2016), Jacobs, Deloitte

Table 13: Parameter values for crash costs (2016-17 values, $/vehicle kilometre travelled)

	Fatal crash	Other injury crash	Serious injury crash
Crash cost rate	0.04	0.01	0.05

Source: ATAP (2016), https://www.data.vic.gov.au/data/dataset/crashes-last-five-years, Austroads (2010), AP-T152/10.

Table 14: Parameter values for road damage costs ($/vehicle kilometre travelled, 2016/17 prices)

	Value
Cars	0.04
Rigid	0.06
Articulated	0.19
B-Double	0.26

Source: Transport for NSW (2016)

Table 15: Parameter values and assumptions for rail operating costs (2016-17 values)

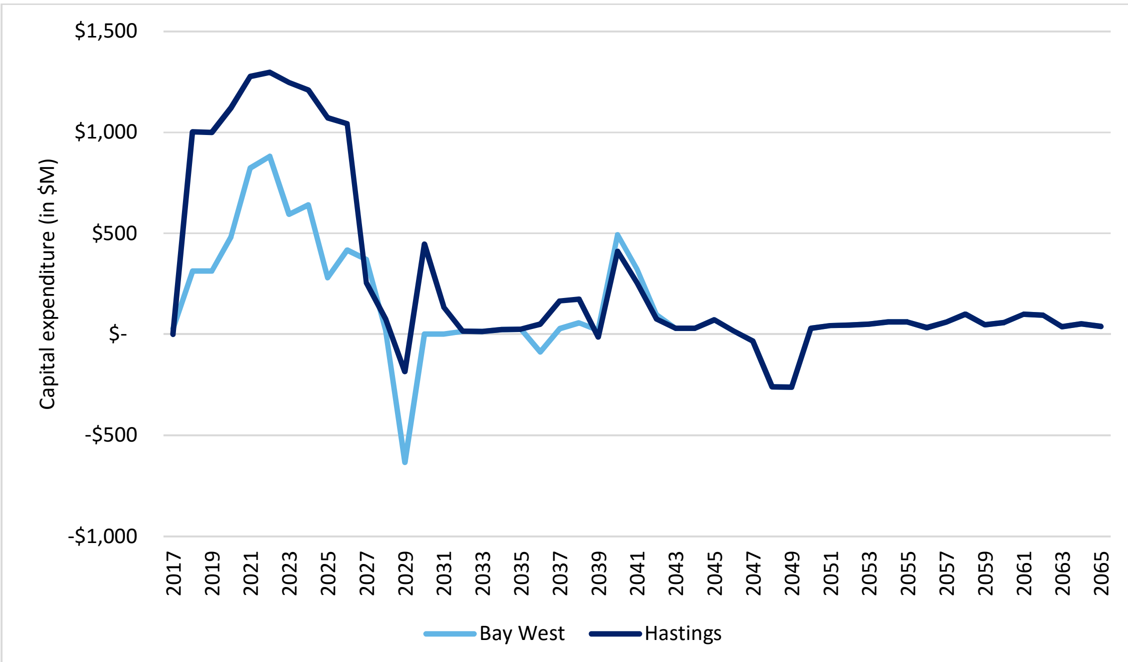
	Port of Melbourne	C3	C2	B1	B2	B2a	C2a	A1	2011
Rail kilometres travelled									
Regional Exports	0.3 M	0.3 M	0.2 M	0.4 M	0.5 M	0.2 M	0.0 M	0.2 M	0.3 M
Metropolitan Imports	1.2 M	0.9 M	0.7 M	1.4 M	1.6 M	0.7 M	0.1 M	0.4 M	1.2 M
TEU/train									
Regional Exports (carry capacity)	88	88	88	88	88	88	88	88	88
Metropolitan Imports (carry capacity)	68	68	68	68	68	68	68	68	68
Average trip distance per train or total distance (train km travelled)									
Regional Exports	30	30	40	30	34	34	34	30	30
Metropolitan Imports	20	59	76	36	43	43	43	20	20
$ per TEU-km									
Regional Exports	0.81	0.80	0.47	0.80	0.67	0.80	0.80	0.81	0.81
Metropolitan Imports	2.00	1.21	0.76	1.68	1.49	1.65	1.65	2.00	2.00

Source: Deloitte supply chain model

A.6 Inputs to CGE modelling

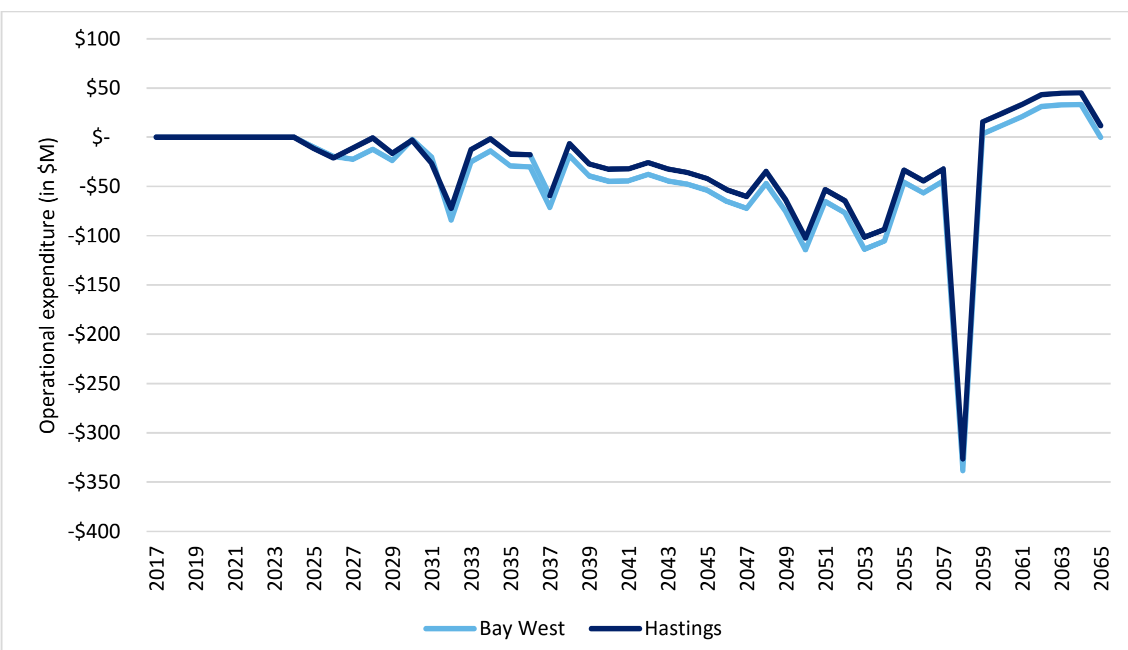
The following Figure 23 to Figure 27 present the input data used to inform the CGE modelling.

Figure 23: Total capital expenditure – direct data used in CGE model (expressed incrementally to Port of Melbourne without Freight Link) ($ million, 2016-17 values)



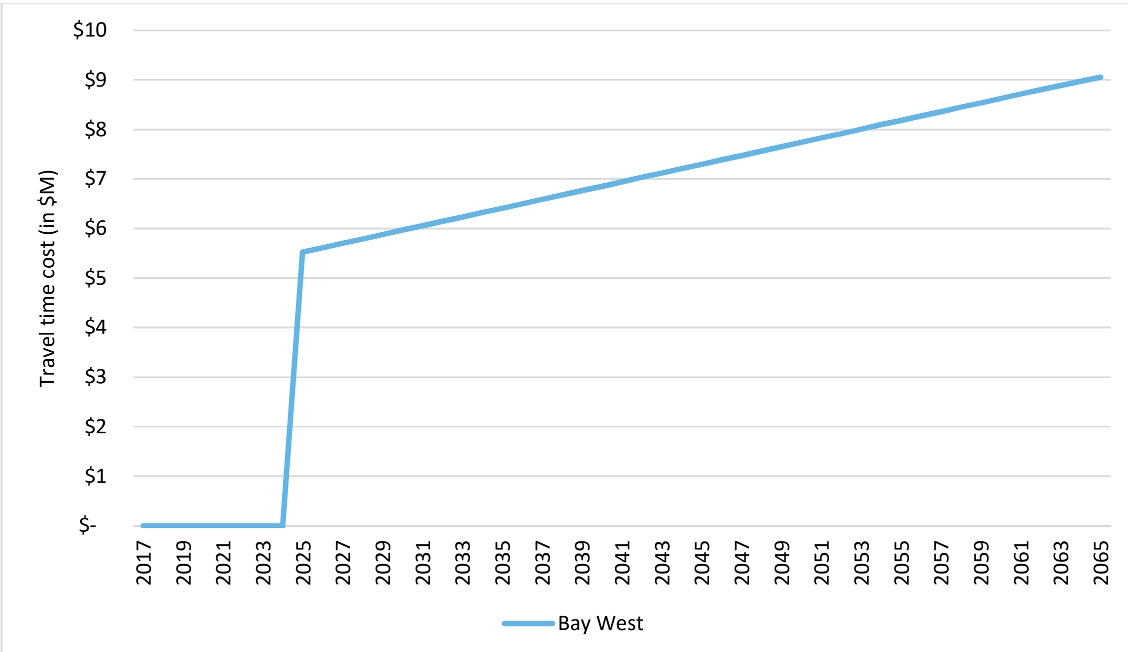
Source: GHD

Figure 24: Total operational expenditure – direct data used in CGE model (expressed incrementally to Port of Melbourne without Freight Link) ($ million, 2016-17 values)



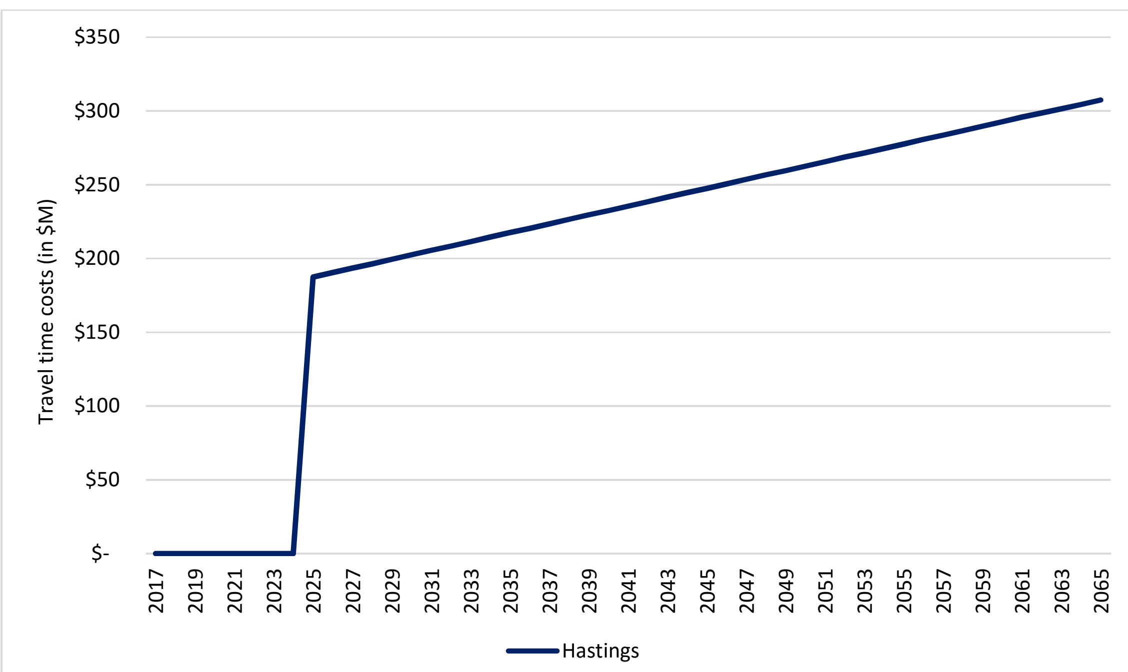
Source: GHD, Deloitte assumptions

Figure 25: Travel time costs for Bay West – direct data used in CGE model (expressed incrementally to Port of Melbourne without Freight Link) ($ million, 2016-17 values)



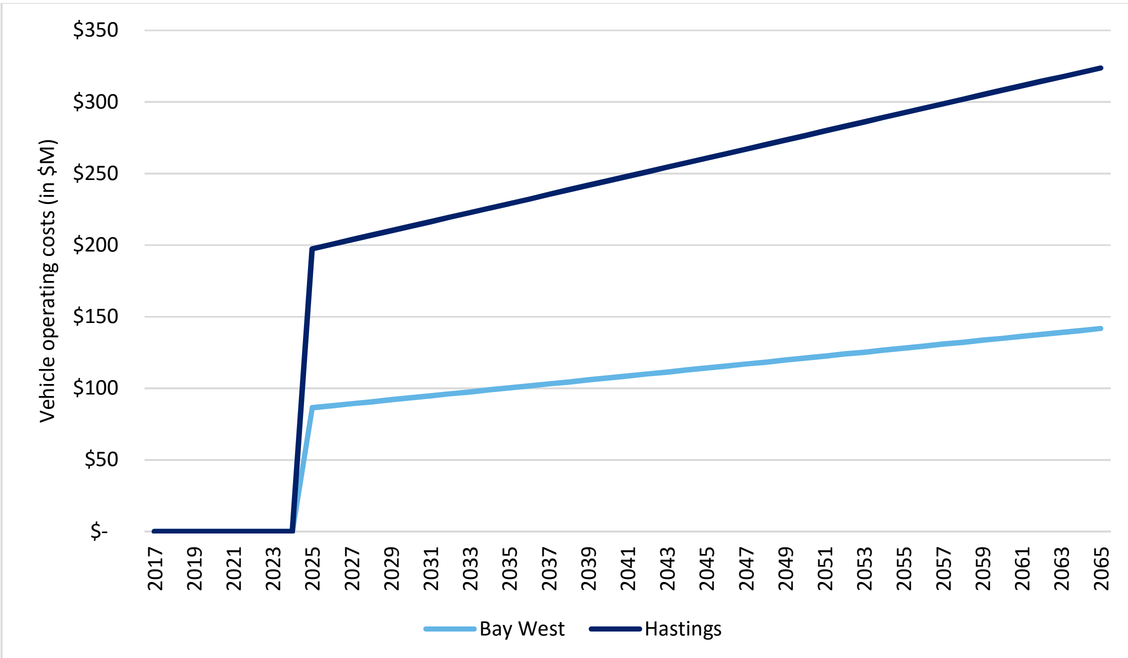
Source: Deloitte

Figure 26: Travel time costs for Hastings – direct data used in CGE model (expressed incrementally to Port of Melbourne without Freight Link) ($ million, 2016-17 values)



Source: Deloitte

Figure 27: Vehicle operating costs – direct data used in CGE model (expressed incrementally to Port of Melbourne without Freight Link) ($ million, 2016-17 values)



Source: Deloitte

Appendix B: Economic impact methodology

The Deloitte Access Economics – Regional General Equilibrium Model (DAE-RGEM) is a large scale, dynamic, multi-region, multi-commodity computable general equilibrium model of the world economy with bottom-up modelling of Australian regions. The model allows policy analysis in a single, robust, integrated economic framework. This model projects changes in macroeconomic aggregates such as GDP, employment, export volumes, investment and private consumption. At the sectoral level, detailed results such as output, exports, imports and employment are also produced.

The model is based upon a set of key underlying relationships between the various components of the model, each which represent a different group of agents in the economy. These relationships are solved simultaneously, and so there is no logical start or end point for describing how the model actually works. However, they can be viewed as a system of interconnected markets with appropriate specifications of demand, supply and the market clearing conditions that determine the equilibrium prices and quantity produced, consumed and traded.

DAE-RGEM is based on a substantial body of accepted microeconomic theory. Key assumptions underpinning the model are:

- The model contains a 'regional consumer' that receives all income from factor payments (labour, capital, land and natural resources), taxes and net foreign income from borrowing (lending).
- Income is allocated across household consumption, government consumption and savings so as to maximise a Cobb-Douglas (C-D) utility function.
- Household consumption for composite goods is determined by minimising expenditure via a CDE (Constant Differences of Elasticities) expenditure function. For most regions, households can source consumption goods only from domestic and imported sources. In the Australian regions, households can also source goods from interstate. In all cases, the choice of commodities by source is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption for composite goods, and goods from different sources (domestic, imported and interstate), is determined by maximising utility via a C-D utility function.
- All savings generated in each region are used to purchase bonds whose price movements reflect movements in the price of creating capital.
- Producers supply goods by combining aggregate intermediate inputs and primary factors in fixed proportions (the Leontief assumption). Composite intermediate inputs are also combined in fixed proportions, whereas individual primary factors are combined using a CES production function.
- Producers are cost minimisers, and in doing so, choose between domestic, imported and interstate intermediate inputs via a CRESH production function.
- The supply of labour is positively influenced by movements in the real wage rate governed by an elasticity of supply.
- Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. A global investor ranks countries as investment destinations based on two factors: global investment and rates of return in a given region compared with global rates of return. Once the aggregate investment has been determined for Australia, aggregate investment in each Australian sub-region is determined by an

Australian investor based on: Australian investment and rates of return in a given sub-region compared with the national rate of return.

- Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interstate sources for these goods via a CRESH production function.
- Prices are determined via market-clearing conditions that require sectoral output (supply) to equal the amount sold (demand) to final users (households and government), intermediate users (firms and investors), foreigners (international exports), and other Australian regions (interstate exports).
- For internationally-traded goods (imports and exports), the Armington assumption is applied whereby the same goods produced in different countries are treated as imperfect substitutes. But, in relative terms, imported goods from different regions are treated as closer substitutes than domestically-produced goods and imported composites. Goods traded interstate within the Australian regions are assumed to be closer substitutes again.
- The model accounts for greenhouse gas emissions from fossil fuel combustion. Taxes can be applied to emissions, which are converted to good-specific sales taxes that impact on demand. Emission quotas can be set by region and these can be traded, at a value equal to the carbon tax avoided, where a region’s emissions fall below or exceed their quota.

Below is a description of each component of the model and key linkages between components

Households

Each region in the model has a so-called representative household that receives and spends all income. The representative household allocates income across three different expenditure areas: private household consumption; government consumption; and savings.

The representative household interacts with producers in two ways. First, in allocating expenditure across household and government consumption, this sustains demand for production. Second, the representative household owns and receives all income from factor payments (labour, capital, land and natural resources) as well as net taxes. Factors of production are used by producers as inputs into production along with intermediate inputs. The level of production, as well as supply of factors, determines the amount of income generated in each region.

The representative household’s relationship with investors is through the supply of investable funds – savings. The relationship between the representative household and the international sector is twofold. First, importers compete with domestic producers in consumption markets. Second, other regions in the model can lend (borrow) money from each other.

- The representative household allocates income across three different expenditure areas – private household consumption; government consumption; and savings – to maximise a Cobb-Douglas utility function.
- Private household consumption on composite goods is determined by minimising a CDE (Constant Differences of Elasticities) expenditure function. Private household consumption on composite goods from different sources is determined is determined by a CRESH (Constant Ratios of Elasticities Substitution, Homothetic) utility function.
- Government consumption on composite goods, and composite goods from different sources, is determined by maximising a Cobb-Douglas utility function.
- All savings generated in each region is used to purchase bonds whose price movements reflect movements in the price of generating capital.

Producers

Apart from selling goods and services to households and government, producers sell products to each other (intermediate usage) and to investors. Intermediate usage is where one producer supplies inputs to another's production. For example, coal producers supply inputs to the electricity sector.

Capital is an input into production. Investors react to the conditions facing producers in a region to determine the amount of investment. Generally, increases in production are accompanied by increased investment. In addition, the production of machinery, construction of buildings and the like that forms the basis of a region's capital stock, is undertaken by producers. In other words, investment demand adds to household and government expenditure from the representative household, to determine the demand for goods and services in a region.

Producers interact with international markets in two main ways. First, they compete with producers in overseas regions for export markets, as well as in their own region. Second, they use inputs from overseas in their production.

- Sectoral output equals the amount demanded by consumers (households and government) and intermediate users (firms and investors) as well as exports.
- Intermediate inputs are assumed to be combined in fixed proportions at the composite level. As mentioned above, the exception to this is the electricity sector that is able to substitute different technologies (brown coal, black coal, oil, gas, hydropower and other renewables) using the 'technology bundle' approach developed by ABARE (1996).
- To minimise costs, producers substitute between domestic and imported intermediate inputs is governed by the Armington assumption as well as between primary factors of production (through a CES aggregator). Substitution between skilled and unskilled labour is also allowed (again via a CES function).
- The supply of labour is positively influenced by movements in the wage rate governed by an elasticity of supply is (assumed to be 0.2). This implies that changes influencing the demand for labour, positively or negatively, will impact both the level of employment and the wage rate. This is a typical labour market specification for a dynamic model such as DAE-RGEM. There are other labour market 'settings' that can be used. First, the labour market could take on long-run characteristics with aggregate employment being fixed and any changes to labour demand changes being absorbed through movements in the wage rate. Second, the labour market could take on short-run characteristics with fixed wages and flexible employment levels.

Investors

Investment takes place in a global market and allows for different regions to have different rates of return that reflect different risk profiles and policy impediments to investment. The global investor ranks countries as investment destination based on two factors: current economic growth and rates of return in a given region compared with global rates of return. Once aggregate investment is determined in each region, the regional investor constructs capital goods by combining composite investment goods in fixed proportions, and minimises costs by choosing between domestic, imported and interstate sources for these goods via a CRESH production function.

International

Each of the components outlined above operate, simultaneously, in each region of the model. That is, for any simulation the model forecasts changes to trade and investment flows within, and between, regions subject to optimising behaviour by producers, consumers and investors. Of course, this implies some global conditions that must be met, such as global exports and global imports, are the same and that global debt repayment equals global debt receipts each year.

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