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## B Analysing transport safety outcomes and heavy vehicle productivity

The Commission used qualitative and quantitative evidence to assess the effects of the national transport reforms on safety and productivity. Transport industry representatives, regulators and other government agencies provided evidence through their submissions to the inquiry and through consultations. The Commission is grateful to the following organisations for their assistance in accessing and understanding various data holdings, and in providing permission to publish analysis using unpublished data:

- the Bureau of Infrastructure, Transport and Regional Economics (BITRE)
- State and Territory road safety authorities
- the National Heavy Vehicle Regulator (NHVR)
- the Office of the National Rail Safety Regulator (ONRSR)
- the Australian Maritime Safety Authority (AMSA)
- Transport Certification Australia (TCA).

The best available data have been accessed to provide evidence about safety and productivity. However, assembling the data has taken time and the data are often incomplete, inconsistent, or unavailable. Further, isolating the impact of regulatory reform when many factors are at work is contentious.

The analysis of transport safety is set out in sections B.1 and B.2 and analysis of heavy vehicle productivity is set out in section B.3.

### B.1 Transport safety data

Chapter 5 sets out the assessment of safety outcomes based on published and unpublished data. Published sources of data include:

- fatalities data published by the ABS (2019a)
- heavy vehicle crash data published by Transport for New South Wales (2019)
- rail safety data published by ONRSR (2018).

The sources of unpublished data are detailed in table B.1 and described below.

**Table B.1 Unpublished sources of transport safety data**

<i>Dataset</i>	<i>Source</i>	<i>Description</i>
National Crash Database (NCD)	Bureau of Infrastructure, Transport and Regional Economics (BITRE)	<p>BITRE developed the NCD in 2010 to support the annual reporting of progress against the <i>National Road Safety Strategy 2011–2020</i> targets. State and Territory governments supply fatality and injury crash data, which BITRE combines into the NCD. As part of this reporting function, BITRE has worked with jurisdictions to develop new indicators and a set of standardised national variables (including an indicator for crash severity, and the number and type of vehicles involved). However, there remain some differences in the definitions of a ‘crash involving injury’ across jurisdictions.</p> <p>State and Territory governments (other than the ACT) provided the Commission with written agreement to access unit record data and publish data and analysis from the NCD. Data were provided for the period 2008–2017.</p>
Rail safety	Office of the National Rail Safety Regulator (ONRSR)	<p>ONRSR has published annual rail safety reports since 2012–13. In most instances data are published only for States and Territories that signed up to the Rail Safety National Law, and for the time period since their enrolment. Data are not available for Victoria, Queensland, Western Australia and the ACT over the full time period as they signed up after 2013.</p> <p>ONRSR provided additional (unpublished) data on fatalities, level crossing collisions, running line derailments, running line collisions, train kilometres travelled and track kilometres managed for the period 2013–14 to 2018–19. Data for Victoria, Queensland and Western Australia are from 1 July 2014 only, while data for other jurisdictions cover the full period. Some of these data were collected by state regulators for periods that pre-dated ONRSR’s regulatory oversight in those states.</p> <p>Both published and unpublished data from ONRSR exclude Victorian operators regulated under state legislation for the whole reporting period.</p>
Maritime incidents	Australian Maritime Safety Authority (AMSA)	<p>AMSA provided maritime incident data, detailing both incidents that involved casualties and no casualties, for the period 1992–2019. Much of this was inherited from state agencies as part of the transition to the national regulator and for that reason AMSA noted it could not guarantee the completeness or quality of earlier data. Data were provided in three datasets (A, B and C).</p> <p>Dataset A contains information on maritime incidents for March 1992–November 2017 collated through the pre-existing National Marine Safety Committee (NMSC) reporting process. Data prior to 2001 were for Western Australia and Queensland only. South Australia, Tasmania and the Northern Territory were included from 2001. Data for Victoria and New South Wales were not included for the whole reporting period. The dataset includes unit level indicators for: jurisdiction, date, vessel type, weather, wind, visibility and accident type (for example collision, grounding, capsizing).</p> <p>Dataset B contains information on maritime incidents over the period July 2013–December 2017, since AMSA became the national regulator. Maritime incidents were collated by AMSA using their own reporting process with the NMSC approach as a base. Indicators are similar to dataset A, but include a variable for incident severity (fatal, serious or minor) and a free-text field that provides additional context for each incident.</p> <p>Dataset C contains information on maritime incidents reported directly to AMSA, using an updated approach to that used for dataset B, over the period September 2017–August 2019.</p> <p>There are inconsistencies in the data within and across the datasets, and in some instances duplication of data for maritime incidents.</p>

The National Crash Database (NCD) was used to examine the impact of the Heavy Vehicle National Law (HVNL) on safety. The method used to assess the impact of the HVNL on safety is discussed in section B.2.

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National rail safety data were sourced from annual safety reports prepared by ONRSR and unpublished data provided by ONRSR. A causal impact of the introduction of the Rail Safety National Law (RSNL) on safety outcomes could not be investigated due to the lack of pre-reform data and the staggered sign-up of Australian States and Territories (henceforth, jurisdictions) to the RSNL.

AMSA provided maritime incident data, detailing both incidents that involved casualties and no casualties, in three separate datasets (table B.1). The Commission attempted to standardise and merge these datasets, but the task is complicated by inconsistent reporting on variables both within and across datasets. Causal analysis to link the impact of the Maritime Safety National Law (MSNL) to maritime safety outcomes was not undertaken because of data inconsistencies, the lack of a valid counterfactual and the fact that the total number of maritime fatalities is relatively small, making it difficult to attribute any small changes to the reform. Further, unlike in the heavy vehicle and rail sectors, there is a lack of data to control for changes in the level of maritime activity, such as a measure of total nautical miles travelled over time.

## **B.2 Heavy vehicle safety**

A principal focus of the HVNL and the NHVR has been to improve the safety of the heavy vehicle sector. Heavy vehicle safety has improved, with the number of heavy vehicle crashes involving injury or death per kilometre travelled decreasing by about 40 per cent between 2008 and 2018 (chapter 5).

The task has been to examine whether there is evidence supporting the role of the national reforms in explaining the patterns observed in the raw data. That is, to determine the extent to which the changes in heavy vehicle crash rates occurring in the post-reform period can be attributed to the HVNL, as opposed to other factors (such as ongoing improvements in vehicle design and safety features).

This is a challenging task because there is no way to know the trends in heavy vehicle crash rates that would have prevailed in the absence of the national transport reforms. However, there are two comparisons that can provide possible counterfactual scenarios:

- heavy vehicles in Western Australia and the Northern Territory — the two jurisdictions that did not sign up to the HVNL
- non-heavy vehicles (such as light commercial vehicles and cars) in HVNL jurisdictions. These operated under similar conditions to heavy vehicles (in terms of road infrastructure, maintenance and road safety awareness campaigns, for example) but were not subject to the heavy vehicle reforms.

Heavy vehicle crash rates in jurisdictions that have implemented the HVNL were compared with crash rates for these two control groups by examining trends over time in charts and through statistical techniques.

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## Statistical methodology

An analytical technique called difference-in-differences was used to estimate the effect of the HVNL on heavy vehicle safety outcomes (box B.1). This approach is appropriate due to the existence of control groups and data on pre-reform safety outcomes.

### Box B.1      **The difference-in-differences method**

Difference-in-differences is a statistical technique that makes use of longitudinal data to estimate the effect of a specific intervention or treatment (such as a passage of law or enactment of policy). The technique compares changes in the variable of interest among a population that is subject to the treatment (the treated group) and a population that is not (the control group) (Angrist and Pischke 2009). This technique has been used to examine a range of policy issues — such as the relationship between minimum wages and employment (Card and Krueger 1994), trade liberalisation and per capita income (Slaughter 2001) and medical marijuana laws and traffic fatalities (Anderson, Hansen and Rees 2013).

In order to estimate a causal effect using a difference-in-differences method, a number of assumptions must be satisfied. Most notably, this approach requires that in the absence of the treatment, the difference between the ‘treated’ and ‘control’ group is constant over time (common trend assumption). However, additional control variables can be added to the specification to account for time-varying factors that might affect the difference between the two groups over time. Other assumptions are that the treatment is unrelated to outcomes before the treatment, and that the composition of treated and control groups is stable over time.

This statistical technique was used to compare changes in heavy vehicle crash rates in HVNL jurisdictions and the two control groups before and after the national reforms. Two models were estimated. First, a difference-in-differences estimation was performed comparing heavy vehicle crash rates in HVNL and non-HVNL jurisdictions (model 1). Using the same model, additional estimations were performed on different types of crashes (such as crashes that involved articulated heavy vehicles only). Second, as an additional robustness check, an alternative model was estimated by comparing heavy and non-heavy vehicle crash rates in HVNL jurisdictions (model 2).

By including jurisdiction-level fixed effects in the models, this approach controls for time-invariant differences between jurisdictions that affect crash rates. For example, in the case of model 1, this approach controls for differences in geography and road geometry (such as the remoteness of the landscape and degree of curvature on major freight routes) between HVNL and non-HVNL jurisdictions. The approach also includes time fixed effects. This controls for trends in factors that affect crash rates that are common to all jurisdictions, such as the increasing prevalence of mobile phone usage while driving, or improvements in road safety technology.

## Heavy vehicle crashes in HVNL and non-HVNL jurisdictions

### Model specification

Using model 1, the following difference-in-differences model for jurisdiction  $i$ , in year-quarter  $t$  was estimated using ordinary least squares, where  $Crash\ rate_{it}$  is the number of heavy vehicle crashes per billion heavy vehicle kilometres travelled.

$$Crash\ rate_{it} = \beta_0 + \gamma_i + \lambda_t + \beta_1 D_{it} + \beta_s state_{it} + \beta' X_{it} + \varepsilon_{it}$$

Descriptions of the variables and parameters used in model 1 are detailed in table B.2.

Three empirical specifications were used:

- specification 1 — baseline specification with time fixed effects and jurisdiction fixed effects
- specification 2 — the baseline specification with the addition of jurisdiction-specific linear time trends
- specification 3 — the baseline specification with the addition of jurisdiction-specific linear time trends and control variables.

Specification 3 is preferred because it includes the most control variables for factors that could affect crash rates, allowing it to better isolate the effect of the HVNL.

**Table B.2 Model 1 variables and parameters**

Variable/ parameter	Variable or parameter descriptions	Included in specification:		
		(1)	(2)	(3)
$\beta_0$	Intercept	✓	✓	✓
$\gamma_i$	Jurisdiction fixed effects	✓	✓	✓
$\lambda_t$	Time (year-quarter) fixed effects	✓	✓	✓
$D_{it}$	Dummy variable indicating 1 for when the HVNL applies for HVNL jurisdictions	✓	✓	✓
$\beta_1$	Effect of the HVNL (treatment effect)	✓	✓	✓
$state_{it}$	Jurisdiction-specific linear time trends <sup>a</sup>		✓	✓
$\beta_s$	Vector of coefficients corresponding to each respective jurisdiction-year-quarter interaction		✓	✓
$X_{it}$	Vector of control variables to account for changes in jurisdiction-level vehicle kilometres travelled (of both heavy and non-heavy vehicles) and jurisdiction populations over time			✓
$\beta'$	Vector of coefficients corresponding to each respective control variable			✓

<sup>a</sup> Jurisdiction-specific linear time trends are incorporated through an interaction term between jurisdiction indicator variables and a variable indicating the period of time since 2008 (the first data point in the NCD). This controls for unobserved factors (such as attitudes towards road safety and road management) that trend smoothly in each jurisdiction.

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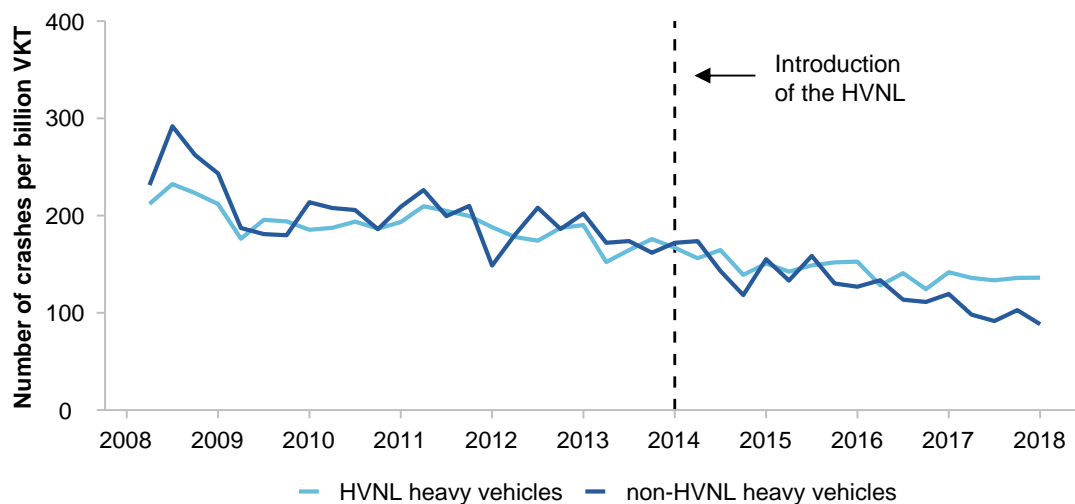
## Pre- and post-reform trends

Pre- and post-reform trends in crashes for heavy vehicles in HVNL and non-HVNL jurisdictions are depicted in figure B.1. Crash rates are expressed per billion heavy vehicle kilometres travelled to account for the different levels of vehicle activity across jurisdictions. In examining whether the common trend assumption (box B.1) is satisfied, a slightly steeper downward trend is observed in heavy vehicle crash rates in non-HVNL jurisdictions compared to HVNL jurisdictions.<sup>1</sup> In examining the figure, these trends appear to be relatively constant across both the pre- and post-reform periods. This difference in trend is accounted for via the inclusion of jurisdiction-specific linear time trends (included in specifications two and three of the difference-in-differences model). There does not appear to be a substantial deviation from the pre-reform trends in either HVNL or non-HVNL jurisdictions in the post-reform period. This observation does not suggest that the HVNL has had an impact one way or the other on heavy vehicle safety. The following section examines whether there is evidence supporting the role of the national reforms in explaining the observed improvement in safety outcomes after controlling for a variety of factors (as outlined above).

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**Figure B.1 Pre- and post-reform trends in heavy vehicle crash rates in HVNL and non-HVNL jurisdictions<sup>a,b</sup>**

Heavy vehicle crashes involving injury or death per billion heavy vehicle kilometres travelled (VKT)



<sup>a</sup> Crashes (fatal and non-fatal) are expressed as crashes per billion heavy vehicle kilometres travelled. Data for ACT not included. The Commission is aware that a quality assurance process is underway for WA crash statistics before 2012. <sup>b</sup> The HVNL commenced on 10 February 2014 in all jurisdictions except for Western Australia and the Northern Territory.

Source: Commission estimates based on National Crash Database (BITRE, unpublished).

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<sup>1</sup> The other two difference-in-differences assumptions discussed in box B.1 appear to be satisfied.

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## Regression results

The estimates for model 1 are presented in table B.3. If the HVNL had improved heavy vehicle safety, the treatment effect would be expected to be significant and negative (reducing the crash rate). However, across all specifications, there is insufficient evidence to suggest that the HVNL had a statistically significant impact on heavy vehicle safety.<sup>2</sup>

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**Table B.3 Heavy vehicle crashes in HVNL and non-HVNL jurisdictions<sup>a</sup>**  
Difference-in-differences results

	<i>Specification 1</i> <i>Baseline with fixed effects</i>	<i>Specification 2</i> <i>Baseline with fixed effects and jurisdiction-specific time trends</i>	<i>Specification 3</i> <i>Baseline with fixed effects, jurisdiction-specific time trends and control variables</i>
Effect of HVNL	1.56	-10.53	-8.87
Standard error	(10.47)	(20.47)	(20.94)
R-squared	0.68	0.74	0.74
Observations	279	279	279

<sup>a</sup> Results using quarterly data from January 2008 to December 2017. The HVNL was assumed to apply for relevant jurisdictions from the first quarter of 2014. The dependent variable is the number of heavy vehicle crashes (involving injury or death) per billion heavy vehicle kilometres. Standard errors have been corrected for clustering at the jurisdiction level. \* p<0.10, \*\* p<0.05, \*\*\* p<0.01.

Source: Commission estimates based on National Crash Database (BITRE, unpublished).

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A caveat to this finding is that, after the HVNL was enacted, there have been regulatory changes in Western Australia and the Northern Territory that may have affected heavy vehicle safety outcomes — such as the introduction of chain of responsibility laws and changes to heavy vehicle road transport compliance requirements (Main Roads Western Australia 2015). Adopting the HVNL could have affected heavy vehicle safety but parallel regulatory changes in non-HVNL jurisdictions may have had similar effects, masking the impact of the HVNL. As such, this analysis does not identify a ‘pure’ treatment effect of the HVNL. It also captures other differences between HVNL and non-HVNL jurisdictions that occurred during the HVNL period. Analysis in the following section (using model 2) examines differences between heavy and non-heavy vehicles in HVNL jurisdictions only, to overcome the potential for parallel regulatory changes in non-HVNL jurisdictions to bias results.

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<sup>2</sup> In the preferred specification (specification 3), states that signed up to the HVNL are associated with 8.87 fewer quarterly heavy vehicle crashes per billion kilometres travelled in the post-reform period on average — an approximate 5 per cent decrease relative to the average. However, this result is not statistically significant.

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## Robustness checks

To examine whether the results in model 1 were robust across different types of crashes, the Commission examined:

- crashes separately for articulated and heavy rigid trucks<sup>3</sup>
- crashes involving fatalities only.

Crashes involving a fatigued heavy vehicle driver could not be rigorously examined because data on driver fatigue were inconsistently reported across jurisdictions in the NCD.

Tables B.4 and B.5 present results for models comparing crash rates in HVNL and non-HVNL jurisdictions separately for articulated and heavy rigid vehicles. Table B.6 presents results for the model comparing fatal heavy vehicle crash rates in HVNL and non-HVNL jurisdictions. Analysis in table B.6 is conducted using yearly crash rates to account for the low occurrence of fatal crashes in some jurisdictions, which leads to substantial variation in crash rates from one quarter to the next.<sup>4</sup>

Again, results from the preferred specification (specification 3) in all three models show there is insufficient evidence to suggest that the HVNL had a significant impact on heavy vehicle safety.

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<sup>3</sup> ‘Heavy rigid’ refers to motor vehicles greater than 4.5 tonnes Gross Vehicle Mass constructed with a load carrying area or fitted with special purpose equipment. ‘Articulated’ refers to motor vehicles constructed primarily for load carrying, consisting of a prime mover that has no significant load carrying area but with a turntable device which can be linked to one or more trailers.

<sup>4</sup> The number of fatalities at the year-quarter level is highly variable due to the small counts of fatalities (there are a number of jurisdictions for which no fatal crashes involving a heavy vehicle driver occurred in a given year-quarter). This makes results very sensitive to small changes in the analysis (such as removing the first two quarters of data, or adjusting the treatment period by one quarter). This makes it difficult to draw robust conclusions.



**Table B.4 Articulated vehicle crashes in HVNL and non-HVNL jurisdictions<sup>a</sup>**

Difference-in-differences results

	<i>Specification 1</i> <i>Baseline with fixed effects</i>	<i>Specification 2</i> <i>Baseline with fixed effects and jurisdiction-specific time trends</i>	<i>Specification 3</i> <i>Baseline with fixed effects, jurisdiction-specific time trends and control variables</i>
Effect of HVNL	-47.08***	-19.84	-13.39
Standard error	(15.00)	(27.68)	(27.80)
R-squared	0.56	0.60	0.61
Observations	279	279	279

<sup>a</sup> Results using quarterly data from January 2008 to December 2017. The HVNL was assumed to apply for relevant jurisdictions from the first quarter of 2014. The dependent variable is the number of articulated vehicle crashes (involving injury or death) per billion articulated vehicle kilometres. Standard errors have been corrected for clustering at the jurisdiction level. \* p<0.10, \*\* p<0.05, \*\*\* p<0.01.

Source: Commission estimates based on National Crash Database (BITRE, unpublished).

**Table B.5 Heavy rigid vehicle crashes in HVNL and non-HVNL jurisdictions<sup>a</sup>**

Difference-in-differences results

	<i>Specification 1</i> <i>Baseline with fixed effects</i>	<i>Specification 2</i> <i>Baseline with fixed effects and jurisdiction-specific time trends</i>	<i>Specification 3</i> <i>Baseline with fixed effects, jurisdiction-specific time trends and control variables</i>
Effect of HVNL	41.82***	2.70	0.187
Standard error	(12.97)	(24.16)	(24.52)
R-squared	0.70	0.78	0.78
Observations	279	279	279

<sup>a</sup> Results using quarterly data from January 2008 to December 2017. The HVNL was assumed to apply for relevant jurisdictions from the first quarter of 2014. The dependent variable is the number of heavy rigid vehicle crashes (involving injury or death) per billion heavy rigid vehicle kilometres. Standard errors have been corrected for clustering at the jurisdiction level. \* p<0.10, \*\* p<0.05, \*\*\*p <0.01.

Source: Commission estimates based on National Crash Database (BITRE, unpublished).

**Table B.6 Fatal heavy vehicle crashes in HVNL and non-HVNL jurisdictions<sup>a</sup>**

Difference-in-differences results

	<i>Specification 1</i> <i>Baseline with fixed effects</i>	<i>Specification 2</i> <i>Baseline with fixed effects and jurisdiction-specific time trends</i>	<i>Specification 3</i> <i>Baseline with fixed effects, jurisdiction-specific time trends and control variables</i>
Effect of HVNL	5.33	8.80*	7.99
Standard error	(3.28)	(5.11)	(5.12)
R-squared	0.42	0.54	0.54
Observations	70	70	70

<sup>a</sup> Results using yearly data from 2008 to 2017. The effect of the HVNL was measured from 2014 onwards. The dependent variable is the number of fatal heavy vehicle crashes (involving injury or death) per billion heavy vehicle kilometres. Standard errors have been corrected for clustering at the jurisdiction level.

\* p<0.10, \*\* p<0.05, \*\*\* p<0.01.

Source: Commission estimates based on National Crash Database (BITRE, unpublished).

## Heavy and non-heavy vehicle crashes in HVNL jurisdictions

As noted above, analysis in model 1 does not identify a pure treatment effect due to regulatory changes in non-HVNL jurisdictions that occurred in the post-reform period. To check the robustness of the above analysis, comparisons were drawn between heavy and non-heavy vehicles in HVNL jurisdictions to examine the impact of the HVNL on heavy vehicle safety.

### Model specification

Using model 2, the following difference-in-differences model for jurisdiction  $i$ , by vehicle type  $j$ , in year-quarter  $t$  was estimated, where  $Crash\ rate_{ijt}$  is the number of crashes per billion vehicle kilometres travelled for the respective vehicle type (heavy and non-heavy).

$$Crash\ rate_{ijt} = \beta_0 + vehicle_j + \gamma_i + \lambda_t + \beta_1 D_{it} + \beta_s state_i * vehicle_j * t + \beta' X_{it} + \varepsilon_{it}$$

Descriptions of the variables and parameters used in model 2 are detailed in table B.7. As in model 1, three specifications were conducted, with specification 3 being the preferred model.

**Table B.7 Model 2 variables and parameters**

Variable/ parameter	Variable or parameter descriptions	Included in specification:		
		(1)	(2)	(3)
$\beta_0$	Intercept	✓	✓	✓
$vehicle_j$	Dummy variable indicating 1 for heavy vehicles and 0 for non-heavy vehicles	✓	✓	✓
$\gamma_i$	Jurisdiction fixed effects for each vehicle type (heavy/non-heavy)	✓	✓	✓
$\lambda_t$	Time (year-quarter) fixed effects	✓	✓	✓
$D_{it}$	Dummy variable indicating 1 for heavy vehicles in the post-reform time period	✓	✓	✓
$\beta_1$	Effect of the HVNL (treatment effect)	✓	✓	✓
$state_i * vehicle * t$	Jurisdiction, vehicle-specific, linear time trends <sup>a</sup>		✓	✓
$\beta_s$	Vector of coefficients corresponding to each respective jurisdiction-vehicle specific, year-quarter interaction		✓	✓
$X_{it}$	Vector of control variables to account for changes in jurisdiction-level vehicle kilometres travelled (of both heavy and non-heavy vehicles) and jurisdiction populations over time			✓
$\beta'$	Vector of coefficients corresponding to each respective control variable			✓

<sup>a</sup> Jurisdiction, vehicle-specific linear time trends are incorporated through an interaction term between jurisdiction indicator variables, the vehicle type indicator variable, and a variable indicating the length of time since 2008 (the first data point in the NCD). This controls for unobserved factors (such as attitudes towards road safety and road management) that trend smoothly in each jurisdiction by vehicle type.

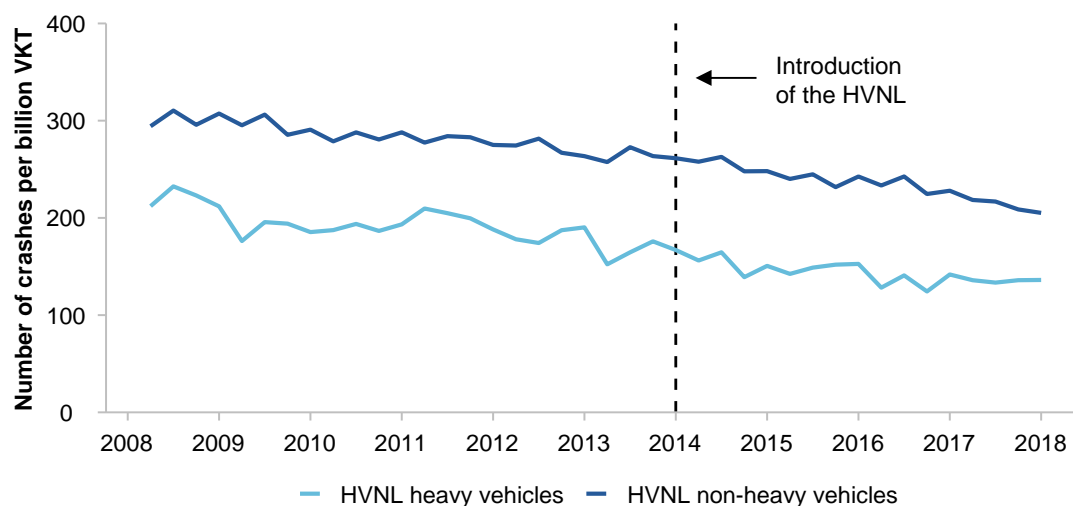
## Pre- and post-reform trends

Pre- and post-reform trends in crashes for heavy and non-heavy vehicles in HVNL jurisdictions are depicted in figure B.2. Crash rates are expressed as per billion vehicle kilometres travelled, for each respective vehicle type, to account for the different levels of vehicle activity across jurisdictions. Trends in crash rates in the pre-reform period provides evidence of a common trend (figure B.2).<sup>5</sup> There does not appear to be a substantial deviation from the common trend in the post-reform period, which again presents little evidence to support that the HVNL has had an impact one way or the other on heavy vehicle safety.

<sup>5</sup> The other two difference-in-differences assumptions discussed in box B.1 also appear to be satisfied.

**Figure B.2 Pre- and post-reform trends in heavy and non-heavy vehicle crash rates in HVNL jurisdictions<sup>a,b</sup>**

Crashes involving injury or death per billion vehicle kilometres travelled (VKT)



<sup>a</sup> Crashes (fatal and non-fatal) are expressed as crashes per billion vehicle kilometres travelled. Non-heavy vehicles include all vehicles other than articulated and heavy rigid trucks. Data for ACT not included. <sup>b</sup> The HVNL commenced on 10 February 2014 in all jurisdictions except for Western Australia and the Northern Territory.

Source: Commission estimates based on National Crash Database (BITRE, unpublished).

## Regression results

The estimates for model 2 are presented in table B.8. Results from the baseline specification (specification 1) suggest that the HVNL might have had a positive effect on safety (through a reduction in crash rates). However, the effect of the HVNL is not statistically significant in specification 2, suggesting that factors within jurisdictions that have a linear effect on heavy or non-heavy vehicle crash rates over time (such as jurisdiction-specific education campaigns) are important in explaining changes in crash rates. Consistent with model 1, results from the preferred specification (specification 3) suggest that the effect of the HVNL is small and not statistically significant.<sup>6</sup>

A caveat to this finding is that after the HVNL was enacted there may have been improvements in vehicle design of safety features that have asymmetrically benefitted heavy and non-heavy vehicles. Moreover, the estimates may be biased if other factors that affect crash rates (such as road safety enforcement campaigns) have been increasingly and effectively targeted at heavy or non-heavy vehicle drivers in the post-reform period.

<sup>6</sup> In the preferred specification (specification 3), states that signed up to the HVNL are associated with 1.044 fewer quarterly heavy vehicle crashes per billion kilometres travelled in the post-reform period on average. However, this result is not statistically significant.

**Table B.8 Heavy and non-heavy vehicle crashes in HVNL jurisdictions<sup>a</sup>**  
Difference-in-differences results

	<i>Specification 1</i> <i>Baseline with fixed effects</i>	<i>Specification 2</i> <i>Baseline with fixed effects and jurisdiction-specific, vehicle-specific time trends</i>	<i>Specification 3</i> <i>Baseline with fixed effects, jurisdiction-specific, vehicle-specific time trends and control variables</i>
Effect of HVNL	-20.53***	-1.04	-1.04
Standard error	(6.57)	(10.67)	(10.58)
R-squared	0.86	0.91	0.91
Observations	400	400	400

<sup>a</sup> Results using quarterly data from January 2008 to December 2017. The HVNL was assumed to apply for relevant jurisdictions from the first quarter of 2014. The dependent variable is the number of crashes (involving injury or death) per billion kilometres for the respective vehicle type. Standard errors have been corrected for clustering at the jurisdiction level. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Source: Commission estimates based on National Crash Database (BITRE, unpublished).

## Summing up

Overall, these results suggest that there is insufficient evidence to link the substantial improvements in heavy vehicle crash rates in the post-reform period to the HVNL. Rather, it appears that the decline is attributable to other factors, which could include improvements in vehicle design and safety features. While there are limitations associated with the use of each model, the fact that a similar conclusion is reached when using two alternative control groups, and when examining different crash types, supports this finding.

## B.3 Heavy vehicle productivity

The introduction of the HVNL and NHVR were expected to improve productivity by promoting consistent and transparent decision making relating to heavy vehicle mass limits and road network access (Chow, Kleyer and McLeod 2019, p. 13; CIE 2011, p. 14). This was expected to encourage the use of larger vehicles and reduce the costs of the freight task.

Heavy vehicle operators are allowed to carry loads above general mass limits through the mass management module of the National Heavy Vehicle Accreditation Scheme (NHVAS) (which provides for Concessional Mass Limits (CML) and Higher Mass Limits (HML)) and larger vehicle designs through the Performance-Based Standards (PBS) scheme (chapter 6). While these schemes existed before the national reforms, greater consistency in administration by the NHVR was expected to promote uptake.

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Although State and Territory and local governments hold ultimate responsibility for heavy vehicle access, NHVR has helped facilitate:

- access permit applications and assessments
- the pre-approval of permit routes
- gazetting of road networks through notices (chapter 6).

The reforms were also expected to improve productivity through reduced compliance and administration costs. These are discussed separately in chapter 6.

## Conceptual framework

Different productivity measures can be useful for different analytical purposes. One common measure of productivity is the ratio of outputs to inputs. It captures how efficiently inputs (such as labour and capital) are used to produce a given volume of output. However, this concept is not particularly useful in assessing the productivity agenda for reform in the national heavy vehicle sector. Cost efficiency, the ratio of costs to output, is a more appropriate measure as it is able to summarise overall productivity when there are many inputs and factors to consider.

A measure of heavy vehicle productivity is the cost efficiency of freight movements — that is, how cost efficiently a given amount and composition of freight can be delivered (box B.2). The main costs considered in box B.2 are:

- operating costs for heavy vehicle operators (including prices of fuel, tyres, repairs and maintenance and depreciation (ATAPGSC 2016, p. 7))
- infrastructure costs that road managers face (including maintenance and investment in roads, bridges and other road infrastructure).

A cost efficiency measure can accommodate the effects of improvements in heavy vehicle access. Access improvements would reduce kilometres travelled and travel time, hence increasing productivity on a cost efficiency measure, but could appear as a reduction on partial performance indicators (described below). This framework also recognises that decisions to allow a particular type of vehicle to access a road should consider the costs (including increased infrastructure costs) and the benefits (including lower operating costs for heavy vehicle operators).

This cost efficiency framework can be extended to include other types of costs such as accident costs and environmental externalities. It can also be applied to other transport modes. The framework can be further extended by considering the impact of the costs of freight transport services on other industries and to the quantity of freight demanded. This extension would enable analysis of economy-wide effects, such as analyses through computable general equilibrium models (box B.3).

Although this framework examines cost efficiency from the perspective of a whole road network, often infrastructure managers make decisions about specific road transport projects. Cost–benefit analysis guidelines for infrastructure managers consider similar factors (such as vehicle operating costs and infrastructure costs) in making these decisions (box B.4).

### Box B.2 Road transport cost efficiency and productivity

Improving heavy vehicle productivity across the road transport network can be conceived of as a cost minimisation problem. This assumes the volume of freight to be transported between origins and destinations is given (that is, independent of the cost of transport).

Total costs associated with freight movements can be expressed in terms of the cost of the tonne kilometres ( $TKM$ ), which is the sum of the tonnes ( $t$ ) carried by each vehicle movement ( $i$ ) of each vehicle type ( $j$ ) on each route ( $k$ ), multiplied by the length ( $km$ ) of those routes. Suppose each vehicle type has an operating cost per tonne kilometre for the vehicle operator ( $c_j^o$ ), and that each vehicle type incurs infrastructure costs to the road manager depending on the route ( $c_{jk}^I$ ). The minimisation problem for the total cost of freight movements ( $C$ ) is given below.

$$\begin{aligned} \min C &= \sum_i \sum_j \sum_k (c_j^o t_{ijk} km_k + c_{jk}^I) = \sum_j \sum_k \left( c_j^o \frac{\sum_i t_{ijk}}{n_{jk}} n_{jk} km_k + c_{jk}^I \right) \\ &= \sum_j \sum_k (c_j^o \bar{t}_{jk} n_{jk} km_k + c_{jk}^I), \quad s. t. \sum_j \bar{t}_{jk} n_{jk} \geq \bar{Q}_{Dk} \quad \forall k \end{aligned}$$

- $n_{jk}$  is the number of vehicle movements of type  $j$  on route  $k$
- $\bar{t}_{jk}$  is the average load of vehicles of type  $j$  on route  $k$
- $\bar{Q}_{Dk}$  is the given quantity of freight demanded on route  $k$ .

A summary measure of cost efficiency is the average cost per tonne. A reduction in average cost per tonne reflects productivity improvements, given a fixed quantity of freight. The average cost per tonne kilometre provides a different insight but is a partial measure of productivity because improved vehicle access would reduce both the numerator (costs) and denominator (tonne kilometres).

(continued next page)

## Box B.2 (continued)

### Example 1: Cost efficiency through access for larger vehicles

Consider a situation where 1000 tonnes of freight must be delivered from origin A to destination B, with only one route between these locations. There are two vehicle types, with 'standard' vehicles able to carry 10 tonnes of freight per trip, and 'large' vehicles able to carry 20 tonnes of freight per trip. Both vehicle types have the same operating cost per kilometre (so large vehicles have half the cost per tonne kilometre), and the same infrastructure costs on the route.

In this example shown below, large vehicles can deliver the freight in fewer vehicle movements and at a lower total cost than standard vehicles. Therefore, allowing large vehicles to access the route would promote cost efficiency.

Vehicle type ( $j$ )	Average load ( $\bar{t}_j$ )	Operating cost per tkm ( $c_j^O$ )	Infrastructure cost ( $c_j^I$ )	Route length (km)	Vehicle movements ( $n_j$ ) to deliver 1000 tonnes	Total cost ( $c_j^O \bar{t}_j n_j \text{ km} + c_j^I$ )	Total cost per tonne
Standard	10	1.0	100	1	100	1 100	1.10
Large	20	0.5	100	1	50	600	0.60

### Example 2: Effects of road infrastructure costs

Suppose now that allowing the large vehicle to travel on the route would require double the infrastructure cost relative to standard vehicles, for example due to reinforced infrastructure to prevent pavement damage or road widening requirements to safely facilitate access. In the example below, large vehicles can still deliver the freight in fewer vehicle movements and at a lower total cost than standard vehicles. Allowing large vehicles to access the route would still promote cost efficiency, but the cost savings relative to allowing standard vehicles only is smaller than in the first example.

Vehicle type ( $j$ )	Average load ( $\bar{t}_j$ )	Operating cost per tkm ( $c_j^O$ )	Infrastructure cost ( $c_j^I$ )	Route length (km)	Vehicle movements ( $n_j$ ) to deliver 1000 tonnes	Total cost ( $c_j^O \bar{t}_j n_j \text{ km} + c_j^I$ )	Total cost per tonne
Standard	10	1.0	100	1	100	1 100	1.10
Large	20	0.5	200	1	50	700	0.70



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### Box B.3      **Measuring economy-wide impacts**

Three tools to examine economy-wide impacts are: input-output tables; input-output modelling; and computable general equilibrium (CGE) modelling. Input-output tables are a point in time representation of the interdependencies (input-output flows) between different sectors in an economy. Input-output tables provide the underlying data used for input-output and CGE models. These models can be used to estimate the impact of a change to the economy, and assess the distributional effects of change across industries included in the input-output tables.

Input-output models rely on the assumptions that prices stay the same and the supply of resources (capital and labour) is limitless. Given these assumptions, input-output models are often only used when looking at open regional economies, or to evaluate 'relatively small changes in the economy', such that it can be assumed that 'all other things remain equal'.

CGE models overcome these shortcomings as they do not assume that there is an unlimited supply of resources available at fixed prices. Some assumptions of standard CGE models are that: material and capital inputs to production are not substitutable; all industries have constant returns to scale; and workforce participation is a fixed share of the working age population, and employment is a fixed share of workforce participants.

*Source:* Gretton (2013, pp. 10, 13).

### Box B.4      **Cost–benefit analysis in transport projects**

Cost–benefit analysis is used to assess future projects and the strengths and weaknesses of project options. It aims to summarise the combined costs and benefits to all members of society from a project in a single number.

Costs and benefits that are typically evaluated in road transport projects include:

- vehicle operating costs (such as fuel, tyres, vehicle repairs and maintenance)
- travel time costs (measured for example by average trip time, value of freight per hour)
- capital costs (such as design and construction, pavement, project management)
- infrastructure operating costs (such as maintenance and administration)
- accident costs (such as fatalities, injuries and property damage resulting from crashes)
- environmental externalities (such as noise and pollution).

Network and cross-modal effects may also be important. For example, improving road links could benefit the operation of a larger road network, and could affect demand for rail transport. Cost–benefit analysis can be accompanied by transport modelling to examine these effects.

There are further factors to consider for cost–benefit analysis involving heavy freight vehicles (for example, road widening projects and highway upgrades could allow for larger freight vehicles). Freight efficiency benefits that should be considered include the reductions in vehicle movements and driving and loading costs for a given volume of freight moved. These are measured by changing the vehicle composition between the base case and the project case for each heavy vehicle type. Secondary infrastructure works such as heavy vehicle rest areas should also be taken into account.

*Sources:* ATAPSC (2018); QLD TMR (2011).

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## **The Commission's approach**

Despite its advantages as a measure of productivity in theory, cost efficiency is complex to quantify. This is especially the case in a backward-looking analysis of the effect of past reforms. This ideally involves accurate information about what has happened, rather than assumptions about what could be (as is the case in a forward-looking analysis of future reforms). These difficulties are described further in the following section.

Consequently, partial indicators of performance were used in chapter 6, drawing on the best available data. Trends and observations in these indicators have been tied to qualitative evidence to help explain findings. Broadly, these partial indicators fall under two categories.

The first category contains factors affected by the HVNL reforms that would have an impact on cost efficiency. This includes access arrangements and numbers of vehicles operating above general mass allowances. Analysing changes to these factors provides an indication of how the HVNL might have affected productivity by improving cost efficiency. However, data limitations restrict the extent to which the actual change in cost efficiency can be identified, and there could be non-HVNL influences that explain changes in these factors (described further below). Furthermore, the costs of infrastructure upgrades required to accommodate access for vehicles have not been directly considered.

The second category contains partial indicators that broadly capture the state of heavy vehicle activity. BITRE's 2011 report took this approach in examining aggregate freight vehicle productivity, measured by partial indicators such as average vehicle freight load and average vehicle utilisation (kilometres travelled per vehicle). It also examined tonne kilometres per vehicle, which encapsulates both of the former two indicators, as well as labour productivity and fuel efficiency (BITRE 2011). Even though some of these indicators capture elements of cost efficiency, it is difficult to determine whether any changes are caused by the HVNL reforms because of other changes over time. Further, a positive reform outcome of increased heavy vehicle access could translate into lower 'productivity' on some of these indicators, such as average kilometres travelled and tonne kilometres per vehicle.

Although data limitations are a key constraint in productivity analysis, the Commission's reform agenda and the Australian Government's development of the National Freight Data Hub should help to improve this in the future (chapters 8 and 10). More accessible data on the number and sizes of heavy vehicles operating, as well as the routes they take, would enable more informed productivity analysis and decision making.

## **Difficulties quantifying and attributing productivity benefits to reforms**

### **Quantifying the change in productivity**

Accurately quantifying the change in productivity on a backward-looking basis is difficult given the complexity of the heavy vehicle system, data limitations, and limitations of available productivity measures.

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Detailed longitudinal data on different heavy vehicle types and access arrangements are needed to understand changes in heavy vehicle productivity from a cost efficiency perspective. There are many types of vehicle combinations and these have different access arrangements (chapter 6). Schemes that affect mass allowances add further complexity to the types of vehicles available and their access arrangements.

Changes in access for different vehicle types on different roads, and changes in ease of uptake of the PBS scheme and NHVAS mass management module will have different impacts on heavy vehicle activity, cost efficiency and therefore productivity. Allowing a larger type of freight vehicle to access a key freight route is likely to have larger productivity benefits than allowing that type of vehicle on a small road that does not have much heavy vehicle traffic. Increased uptake in the PBS scheme for large freight vehicles is also likely to have larger benefits than for smaller vehicles.

Sufficiently detailed data to accurately quantify changes in heavy vehicle cost efficiency are unavailable (discussed below). Consequently, partial indicators of performance were used to examine changes in the productivity of freight-carrying heavy vehicles in chapter 6, but these also have limitations (discussed above).

There are also insufficient productivity measures for non-freight carrying heavy vehicles. As these vehicles do not contribute to the national freight task, their ‘value’ cannot easily be measured by, for example, tonnes moved and kilometres travelled (CIE 2011, pp. 37–38).

The lack of detailed data also limits the estimation of economy-wide impacts of heavy vehicle reform (box B.5). This ideally requires data on how individual industries use specific heavy vehicles because changes in access and ease of uptake for particular vehicle types will have larger productivity impacts on industries relying more heavily on that vehicle type. For example, an increase in access for truck and dog vehicle combinations will benefit operators in the construction business, more than say, operators in the agricultural industry, who rely more on larger vehicles such as B-doubles. These changes will have different flow-on effects, depending on the size of the impact on affected industries, and how important these industries are to other industries and the broader economy.

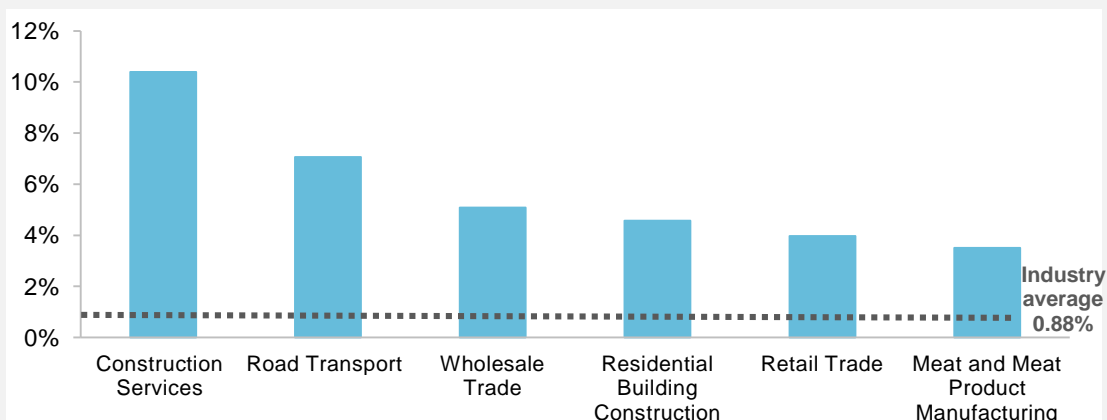
A consideration in quantifying the effects of changes to heavy vehicle access and ease of uptake is that it may affect the demand for other modes of freight transport, and alter total transport productivity. For example, an increase in heavy vehicle access may decrease road freight costs. This may lead to an increase in the demand for road transport but a decrease in the demand for rail transport. Quantifying the change in total transport productivity would need to take into account the effect on both the road and rail transport sectors.

## Box B.5 Data to analyse economy-wide impacts of heavy vehicle reform

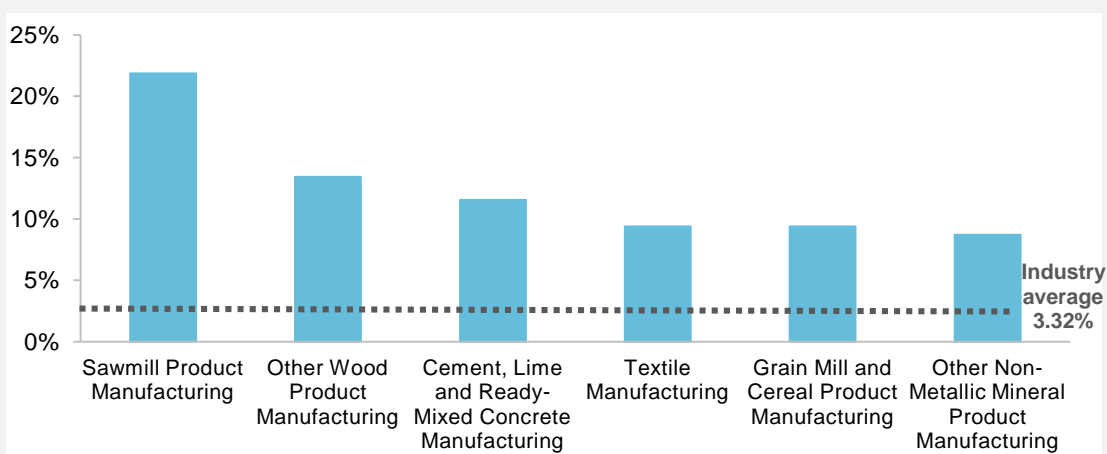
Data from ABS input-output tables show that operators in many industries use road transport. Major users include construction services, wholesale trade, and residential building construction, as shown in the figure below. Other industries, including various manufacturing industries, spend relatively less on road transport, but it represents a large share of their total costs.

More detailed input-output tables are needed to estimate the economy-wide impacts of heavy vehicle reforms. Although it is likely that heavy vehicles encompass a large share of road transport costs, road transport is a broad category that captures both passenger and freight transport. Only a subset of freight transport costs will involve heavy vehicles. Heavy vehicle reforms also do not affect all types of heavy vehicles equally. Heavy vehicle costs should be split into specific types of heavy vehicles, where the shares differ for each industry, in order to accurately assess how a change might affect the broader economy.

### Top six users of road transport — use of road transport as a share of expenditure on road transport services by all industries<sup>a</sup>



### Top six industries by road transport cost shares — cost of road transport to industry as a share of the respective industry's total costs<sup>a</sup>



<sup>a</sup> Domestic costs and expenditure, excluding taxes.

Source: Commission estimates based on ABS (*Australian National Accounts: Input-Output Tables, 2016–2017*, Cat. no. 5209.0.55.001).

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## Attributing changes in productivity to the national reforms

Even if the change in productivity could be accurately quantified, attributing the change to the national reforms is an additional challenge.

There are many factors unrelated to the HVNL and NHVR that impact heavy vehicle activity, uptake and productivity that are difficult to control for. These include increased demand for road freight transport due to economic factors (such as the construction boom) and changes in rail freight costs, and increased productivity due to technological change. Further, changes in vehicle access are primarily the decision of the infrastructure managers, and it is uncertain how much the HVNL and NHVR would have influenced these decisions in each case.

In addition, there is no neat division between the pre-reform and post-reform periods. Transition to the national system has taken place over a number of years, and is still occurring. Many initiatives that are part of the national laws predate the COAG reforms, for example, the PBS scheme, which was introduced in 2009.

Finally, some changes in access, uptake and heavy vehicle activity that may be due to the reforms are unlikely to be immediately observable. For example, there may be a lag in the uptake of larger heavy vehicles, as operators gradually renew their fleets over time.

## Other studies on the effects of heavy vehicle reforms on productivity

A number of studies have attempted to quantify benefits of heavy vehicle reforms on productivity, often using a cost savings framework (table B.9). Many of these examine the forward-looking effects of future reforms, rather than conduct a backward-looking analysis of past reforms. The studies rely on various simplifying assumptions, and do not take into account the full complexities of the system. For example, studies that estimate flow-on effects to other industries (using methods discussed in box B.3) typically do not take into account how reforms affect specific types of heavy vehicles and hence specific industries. Rather, they assume that reforms affect all industries that use ‘road transport’ (or other broad transport categories) in the same way, resulting in large estimates of economy-wide benefits.

**Table B.9 Summary of past research on effects of heavy vehicle reforms on productivity**

<i>Study</i>	<i>Overview of method for estimating productivity</i>	<i>Heavy vehicle reform analysed (B = backward-looking, F = forward-looking)</i>	<i>Estimated benefits<sup>a</sup> (\$b)</i>	<i>Study limitations</i>
NTC (2011), CIE (2011)	Using a top-down approach, the study took estimated costs and benefits of HVNL reforms calculated in previous studies, and then used additional information and assumptions to attribute the costs and benefits across specific reform areas.	HVNL reforms (F)	3.9–8.7 from 2011 to 2030	<ul style="list-style-type: none"> <li>Assumes nationally consistent laws will be administered, which has not fully eventuated in practice.</li> <li>Estimates can be assumption driven. For example, total Restricted Access Vehicle (RAV) benefits assumed to be double PBS benefits from another study.</li> </ul>
	Using a bottom-up approach, the study estimated: productivity improvements (such as reduced kilometres travelled) from substituting towards higher productivity vehicles; shares of vehicles and freight task affected; and uptake rates. These estimates were converted to labour, capital and variable input productivity improvements for the heavy vehicle sector, which were used as inputs to a computable general equilibrium (CGE) model to calculate economy-wide benefits.	HVNL reforms — PBS (F) HVNL reforms — non-PBS RAV (F) HVNL reforms — HML (F)	0.55 a year 2.1 a year 0.16 a year	<ul style="list-style-type: none"> <li>Assumes nationally consistent laws will be administered.</li> <li>Estimates can be assumption driven. For example, uptake in RAV per cent kilometres travelled assumed to be ten times higher with than without a consistent decision making framework.</li> <li>CGE modelling assumes productivity improvements affect each industry that uses 'other transport', without taking into account differing effects from changes to specific vehicle types.</li> </ul>
	Under the bottom-up approach, the study made assumptions about the productivity of oversize overmass (OSOM) vehicles (because they do not carry freight) which led to benefits similar in size to HML vehicles.	HVNL reforms — OSOM (F)	0.16 a year	
Hassall (2014)	The study used data from a survey of PBS operators to estimate productivity benefits (based on cost savings relating to vehicle kilometres travelled) associated with three different levels of PBS network access. Estimates were projected forward based on assumed growth rates and shares of PBS vehicles for specific vehicle types.  The study estimated flow-on effects to other industries using input-output modelling, where input-output tables were modified to separate the heavy vehicle industry from 'other' road transport. The modified tables are based on estimated costs for heavy rigid, heavy articulated and other vehicles, by product group carried.	Hypothetical PBS access scenarios (F)	4.7–8.7 direct cost savings from 2011 to 2030; 5.6 flow-on effects from 2011 to 2030	<ul style="list-style-type: none"> <li>Analysis limited to hypothetical scenarios for PBS vehicles.</li> </ul>

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Table B.9 (continued)

Study	Overview of method for estimating productivity	Heavy vehicle reform analysed (B = backward-looking, F = forward-looking)	Estimated benefits <sup>a</sup> (\$b)	Study limitations
Deloitte Access Economics (2019)	<p>The study estimated the yearly percentage change in the capital productivity index of the 'transport, postal and warehousing' industry over four years after the NHVR was introduced, and compared this with:</p> <ul style="list-style-type: none"> <li>the hypothetical increase in 'road transport' productivity necessary to realise productivity benefits estimated in the Regulation Impact Statement</li> <li>productivity for a benchmark group made up of wholesale trade, manufacturing and mining industries.</li> </ul>	HVNL reforms (B)	No reported values, but concluded the reforms did not put the industry on a better trajectory	<ul style="list-style-type: none"> <li>Aggregate view of productivity changes in 'transport, postal and warehousing' industry does not make it possible to identify how much of the change is in the heavy vehicle industry, let alone attribute changes to reforms.</li> </ul>
	<p>The study's policy scenarios analysed effects of:</p> <ul style="list-style-type: none"> <li>increased heavy vehicle access, via rising share of B-doubles, transition of B-triples operating on B-double routes, and AB-triple and BAB-quad vehicles operating on road train routes</li> <li>increased freight loads through more vehicles operating at HML.</li> </ul> <p>The study estimated effects of proposed policies on vehicle operating costs, based on net tonne kilometres, changes in vehicle class shares, and average loads. The study calculated flow-on effects to other industries using input-output modelling.</p>	Study's proposed reforms (F)	<p>13.6 direct cost savings from 2020 to 2050;</p> <p>0.9 flow-on effects from 2020 to 2050</p>	<ul style="list-style-type: none"> <li>Proposed policy scenario of increased access abstracts from complexities of opening access in reality, including infrastructure considerations.</li> <li>Input-output modelling assumes productivity benefits affect each industry using 'road transport', without taking into account differing effects from changes to specific vehicle types.</li> </ul>
Chow, Kleyer and McLeod (2019)	<p>The study summed estimated benefits (cost savings) from:</p> <ul style="list-style-type: none"> <li>increasing uptake of PBS vehicles</li> <li>increasing uptake of NHVAS mass management module</li> <li>facilitating use of non-PBS RAVs.</li> </ul> <p>Estimated benefits to date were derived from trends in actual numbers of vehicles under PBS and NHVAS mass management module schemes, and assumed growth rates in the absence of reform. Future benefits were estimated according to assumed vehicle growth rates with and without the reform. Cost savings included vehicle operating costs, labour costs, road damage and externalities.</p>	HVNL reforms (B, F)	4.5–9.3 from 2012 to 2033	<ul style="list-style-type: none"> <li>Estimates can be assumption driven. For example, benefits of facilitating use of non-PBS RAVs assumed to be the same as benefits from increased PBS uptake.</li> <li>Benefits do not take into account changes in vehicle access.</li> </ul>

<sup>a</sup> Includes freight productivity benefits only. Excludes other benefits, such as safety and environmental benefits, and compliance and administration cost savings.

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## Data and data limitations

The Commission examined heavy vehicle productivity using public data from the ABS and Department of Infrastructure, Transport, Cities and Regional Development (DITCRD), and unpublished administrative datasets from the NHVR and TCA (table B.10).

Collectively these datasets offer detailed insights into heavy vehicle productivity. Each data source provides a different piece of the picture under the conceptual framework (box B.2). For example:

- ABS data provide some information on numbers of vehicles, average loads and kilometres travelled for broad vehicle types, but does not have information on the roads they are travelling on
- DITCRD data on key freight routes provide an indication of the roads accounting for the most tonne kilometres
- NHVR data provide information on vehicles operating at higher mass, as well as access arrangements on particular roads for specific heavy vehicle types (via permits, pre-approvals and gazetted routes), but has limited information on how many vehicle movements occur on those roads or how access arrangements have changed over time
- TCA data provide some information on the number of vehicle movements on particular roads by vehicle type.

Data from multiple sources were used to examine particular issues where possible. For instance, NHVR data on heavy vehicle gazetted network access were compared to DITCRD key freight routes, and numbers of vehicle movements on some expanded networks were examined using TCA data.

Some datasets suffer from data quality issues (table B.10). For example, NHVR data are sourced from NHVR's administrative and operational systems, and are not designed for quantitative analysis. TCA data on vehicle movements capture a limited number of vehicles that may not be representative of the whole heavy vehicle fleet. These issues have restricted the Commission's analysis of the productivity impacts of the HVNL and NHVR.



**Table B.10 Data used to examine heavy vehicle productivity**

<i>Source</i>	<i>Dataset</i>	<i>Description and limitations</i>
Australian Bureau of Statistics (ABS)	Survey of Motor Vehicle Use (SMVU) (ABS 2019b)	<p>The SMVU has been conducted periodically from 1976 to 2018, and every 2 years since 2010. The SMVU includes samples of vehicles registered in Australia, and contains estimates relating to the fleet (for example, vehicle types, vehicle size and state of registration) and vehicle use (for example, tonnes carried, commodity carried and kilometres travelled).</p> <p>Some limitations of the SMVU are that:</p> <ul style="list-style-type: none"> <li>• there is no information about whether vehicles are operating under schemes such as PBS, CML and HML</li> <li>• geographical information on vehicle movements is limited to the type of area (for example, capital city, intrastate, and other areas)</li> <li>• publicly available SMVU data do not allow for light rigid trucks and heavy rigid trucks to be separated under HVNL definitions.</li> </ul>
	Motor Vehicle Census (MVC) (ABS 2018)	<p>The MVC has been conducted periodically from 1971 to 2019, and every year since 2001. The MVC includes all vehicles registered in Australia, and provides more detailed information on the vehicle fleet compared with the SMVU (for example, light and heavy rigid trucks can be easily separated) but there is no information on vehicle use.</p> <p>Similar to the SMVU, there is no information about whether vehicles are operating under schemes such as PBS, CML and HML.</p>
	Road Freight Movements Survey (RFMS) (ABS 2015)	<p>The RFMS was conducted in 2014, and includes a sample of vehicles registered in Australia. The survey contains estimates about the movement of road freight. The RFMS provides more geographical information on vehicle movements relative to the SMVU (for example, vehicle movements by state of origin and destination, by vehicle type and commodity type).</p> <p>However, as the RFMS is a once-off survey, time comparisons are not possible. It also does not contain information about vehicles operating under schemes such as PBS, CML and HML.</p>
Department of Infrastructure, Transport, Cities and Regional Development (DITCRD)	Key freight routes (DITCRD 2019)	<p>The DITCRD provided geospatial data underlying their published maps on key freight routes across Australia. These routes connect nationally significant freight locations and experience high heavy vehicle traffic, higher volumes of freight, or involve the transport of important commodities.</p>
National Heavy Vehicle Regulator (NHVR) — unpublished data	Permit applications	<p>The NHVR provided de-identified permit application data from its operational systems from February 2014 to September 2019. The datasets include information on application type, application status, road manager, vehicle configuration and PBS status, and geospatial data on permit routes for applications under the new system.</p> <p>A number of factors affect comparability of the data over time. First, states have gradually transferred responsibility for permits to the NHVR. Second, NHVR introduced a new application system for all permits from October 2017 — data cannot easily be compared between old and new systems due to changes in how applications are submitted and updated. Further, there are inconsistencies that affect data quality. For example, vehicle details are not reported for PBS vehicles, and can only be obtained by linking with NHVR's PBS approvals data (discussed below) through manually reported PBS identification numbers.</p>

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**Table B.10** (continued)

<i>Source</i>	<i>Dataset</i>	<i>Description and limitations</i>
	Pre-approved permit routes and areas	The NHVR provided data on pre-approved permit routes and areas, including information on road managers and vehicle types. However, there are data quality issues — for example, some pre-approved routes or areas have been gazetted but not yet updated in these data. Some geospatial data were also provided but these do not capture all pre-approved routes and areas.
	Gazetted networks	The NHVR provided geospatial datasets of gazetted networks for 2018 and 2019. These included gazetted routes and areas, as well as restrictions, by vehicle type and mass allowance. The NHVR holds older records, which have not been provided, but these are not standardised across jurisdictions or over time.
	PBS approvals	The NHVR provided data on all PBS approvals from about 2014 to 2019, including information on vehicle combination type, PBS access level, and commodity carried. The data can be used to calculate the number of approved PBS combinations.
	National Heavy Vehicle Accreditation Scheme (NHVAS)	The NHVR provided data on the number of operators participating in each NHVAS module (including the mass management module, which is a requirement for CML and HML), by state, from 2015-16 to 2018-19. These data are consistent with data in the NHVR's published annual reports.
	Registration data	The NHVR provided registration data for 2018 and 2019. However, these data are limited because prime movers and trailers are registered separately, making it difficult to determine the composition of the fleet according to vehicle combinations (such as B-doubles).
Transport Certification Australia (TCA) — unpublished data	Intelligent Access Program (IAP) data	The TCA provided aggregated and de-identified data drawn from vehicle movements under the IAP in 2018-19. One dataset contained information on vehicle movements by road segment and vehicle type, and another contained information on journeys by vehicle type for different origins and destinations. The IAP is a requirement in only some states for vehicles operating at HML or PBS vehicles, and may be imposed as a condition of a permit. This means vehicles in these datasets are a subset of all heavy vehicles so the data may not be fully representative.

## B.4 Further analysis for the final report

The analysis in the draft report is a work in progress and has been restricted by limited data as well as time constraints. The final report will include further work, incorporating additional analysis of the data it has received to date, new data and information, as well as stakeholder feedback and comments on its analysis and conclusions. In the area of heavy vehicle productivity, areas of focus for further analysis will include changes in heavy vehicle access and usage over time. In the area of transport safety, additional data sources will be incorporated as they become available. The Commission will continue to engage with data providers going forward for the final report.

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