Powering Down Pollution: Health and Economic Benefits of PM_{10} Reductions from Coal Station Closures

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Background and motivation

- Coal-fired power stations in Australia are closing due to net-zero targets and declining profitability.
- Regional communities (e.g. Latrobe Valley) face major economic and social transition challenges.
- Effective transition funding requires a full picture of both costs **and** benefits.
- Existing research focuses on job losses and electricity prices, but coal plant closures come with amenity and health benefits.
- This paper investigates potential **health and productivity gains** from improved air quality post-closure.

Conceptual framework

- Hypothesis: Reduced pollution improves health, productivity, and lowers healthcare costs.
- Natural experiment: Hazelwood's 2017 closure in Latrobe vs. Muswellbrook (no closure).
- Method: Difference-in-differences analysis of pollution and health outcomes.
- Aim: Quantify local health and economic benefits from cleaner air.

Methodology overview

3 key estimations

1. **How much did local PM_{10} reduce** in the 2017-18 period following the March 31 closure of Hazelwood coal fired-power station and coal mine.
2. What were the **health effects** of this lower PM_{10}?
3. What is the **economic and productive value** of these health effects?

Estimating the PM_{10} reduction

$$PM10_i = B_0 + B_1 Post + B_2 Treatment + B_3 Post*Treatment + B_4 Local\_PM10\_Emissions + B_5 Bushfire + B_6 Dust\_storm$$

Where,

$PM_{10\,i}$ – Monthly average PM_{10} level, by LGA

Post – Indicator variable that =1, if the time period is after treatment time (1 April 2017)

Treatment – Indicator variable that =1, if the LGA is the treatment group (Latrobe)

Post*Treatment – interaction term showing the treatment effect

Local Industrial PM_{10} – All other local PM_{10} emissions

Bushfire – Indicator variable that =1, if there was a catastrophic bushfire nearby

Dust_storm – Indicator variable that = 1, if there was a dust_storm, land burn or significant urban pollution

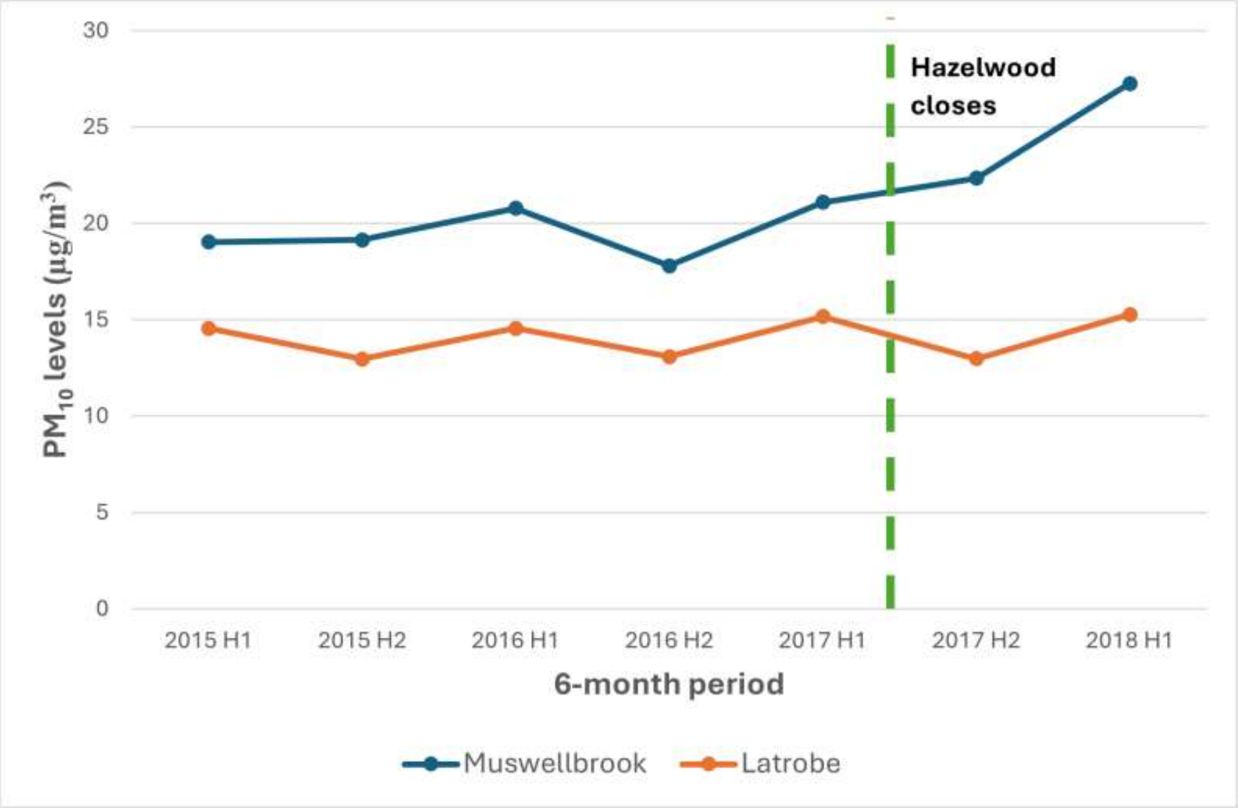
Results: Fall in air pollution from Hazelwood closure

Local PM_{10} = Post + Treatment + Post*Treatment + Industrial PM_{10} + Bushfire + Dust_storm + Post*Treat*Bushfire + Post*Treat*Industrial PM_{10}

Variable	Cluster Coeff.	Cluster SE	p-value (cluster)
Post	4.381	0.036	0.005
Treat	-0.694	0.302	0.261
Post*Treat	-8.584	0.113	0.008
Industrial PM_{10} (00,000s KG)	0.039	0.002	0.040
Bushfire	5.013	0.060	0.008
Dust storm	2.110	0.062	0.019
Post* Treat* Bushfire	-0.342	0.062	0.114
Post* Treat* Industrial PM_{10}	0.054	0.002	0.029
Constant	12.155	0.450	0.024

Regression clustered by LGA

Results: Fall in air pollution from Hazelwood closure



Other local industrial emissions in KG

LGA	2015 PM_{10} emissions	2016 PM_{10} emissions	2017 PM_{10} emissions	2018 PM_{10} emissions
Latrobe	6,814,454	7,936,742	8,021,327	9,987,005
Muswellbrook	23,952,857	20,795,857	19,895,857	21,795,857

Estimating health cases attributable to PM_{10}

- PM_{10} reductions (Apr 2017 – Jun 2018) are **linked to changes in disease and mortality rates**.
- Focus on three major PM10-related diseases:
  - **cardiovascular disease (CVD)**
  - **chronic obstructive pulmonary disease (COPD)**
  - **asthma.**
- **These conditions rank high in national disease burden** (AIHW: #1, #6, #9 respectively).
- In Latrobe during 2017–18 there were 4,400 CVD cases, 11,059 asthma cases, 2,088 COPD cases, and 689 deaths.

Exposure response function

$$P_0 = P_e/(1 + ((RR - 1)(E_0 - B)/10))$$

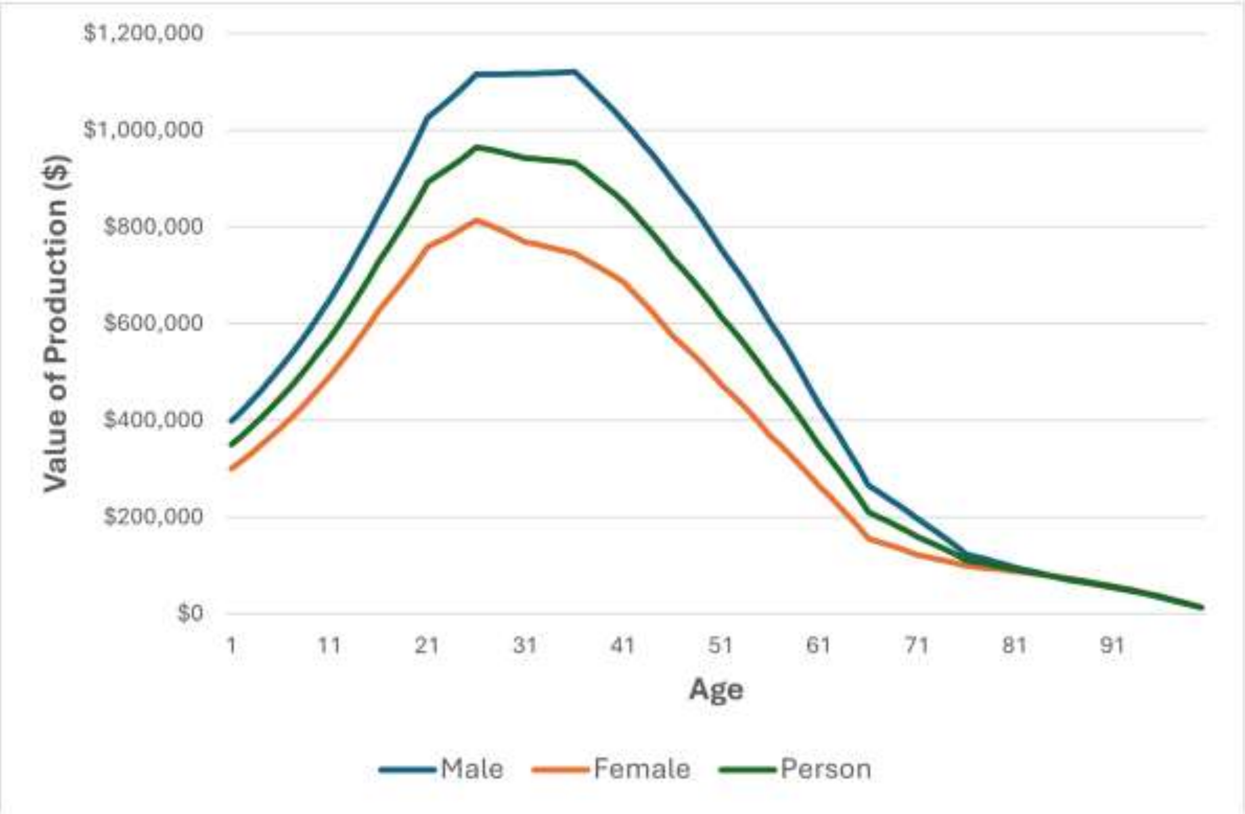
Where, for each different disease or mortality,

- P_0: cases before exposure
- P_e: observed health cases
- RR: relative risk of a disease/mortality (per additional 10 microgram per cubic metre increase in PM_{10})
- E_0: PM10 exposure level
- B: Minimum threshold PM_{10} level for health effects (5 micrograms)

Results: estimation of avoided health cases

	Deaths	CVD	Asthma	COPD
E_0 (observed PM_{10})	14.285 $\mu g/m^3$	14.285 $\mu g/m^3$	14.285 $\mu g/m^3$	14.285 $\mu g/m^3$
X_{PM} (estimated avoided PM_{10})	8.584$\mu g/m^3$	8.584 $\mu g/m^3$	8.584 $\mu g/m^3$	8.584 $\mu g/m^3$
E_0' (estimated PM_{10})	22.869$\mu g/m^3$	22.869 $\mu g/m^3$	22.869 $\mu g/m^3$	22.869 $\mu g/m^3$
B (threshold for health effect)	5.000 $\mu g/m^3$	5.000 $\mu g/m^3$	5.000 $\mu g/m^3$	5.000 $\mu g/m^3$
RR	1.043	1.013	1.039	1.098
P_e (observed post-exposure cases)	689	4440	11,059	2,088
P_0 (observed pre-exposure cases)	662.548	4387.047	10,672.539	1,913.856
P_0' (estimated pre-exposure cases)	639.837	4339.202	10,338.523	1,776.848
P_d (avoided cases)	22.711	47.845	334.016	137.008

Valuing health cases – value of a life lost



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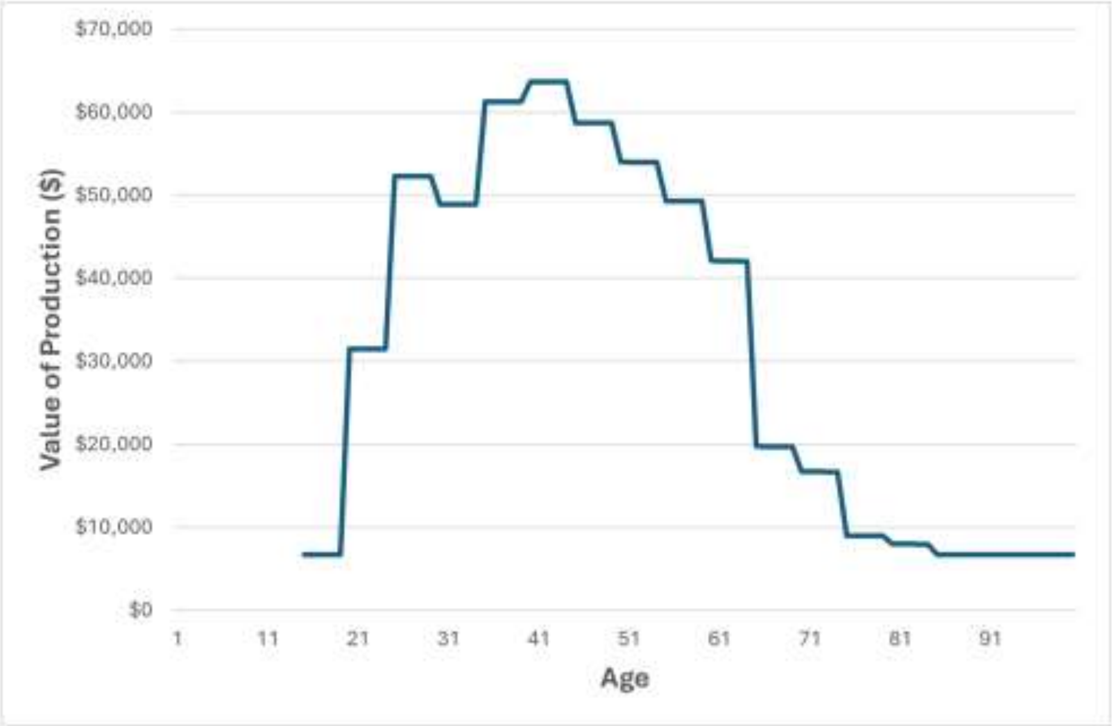
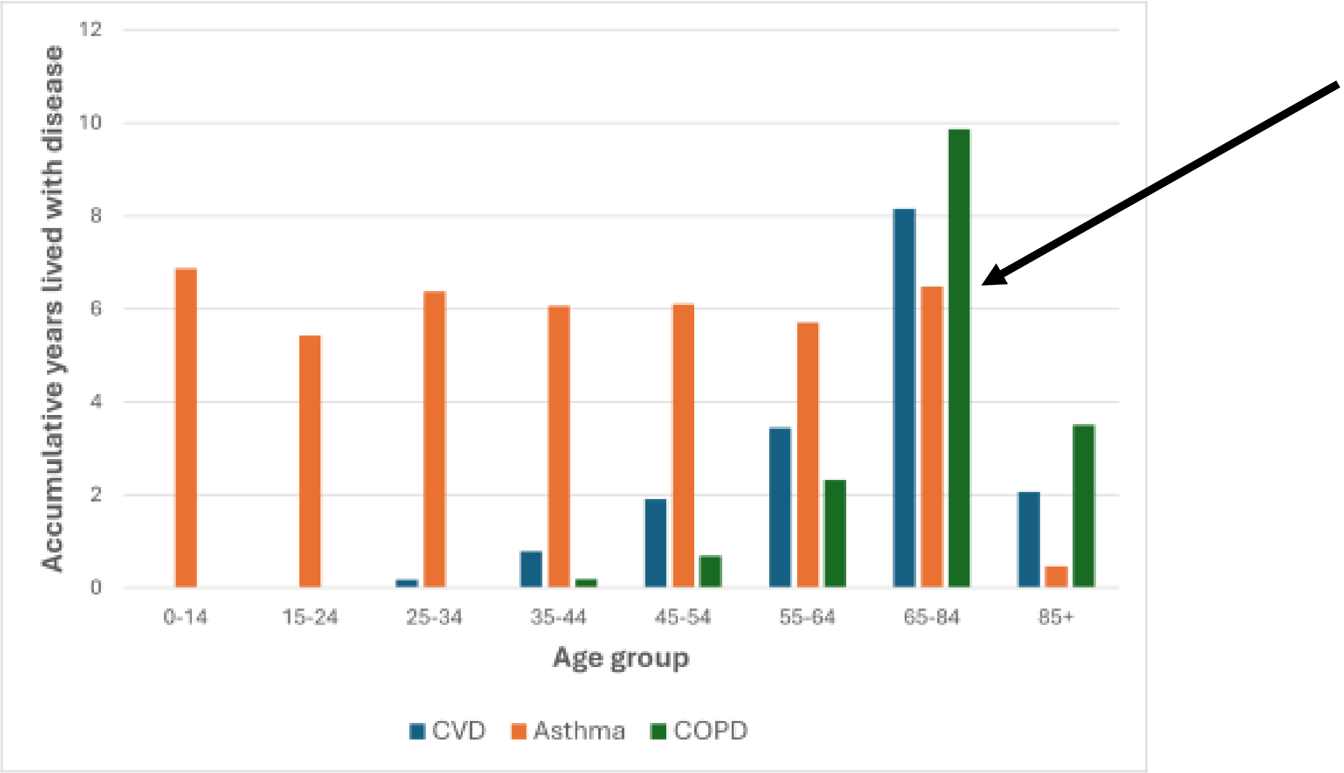
Valuing health cases – value of a healthy work year



Valuing health cases – disease spread across age



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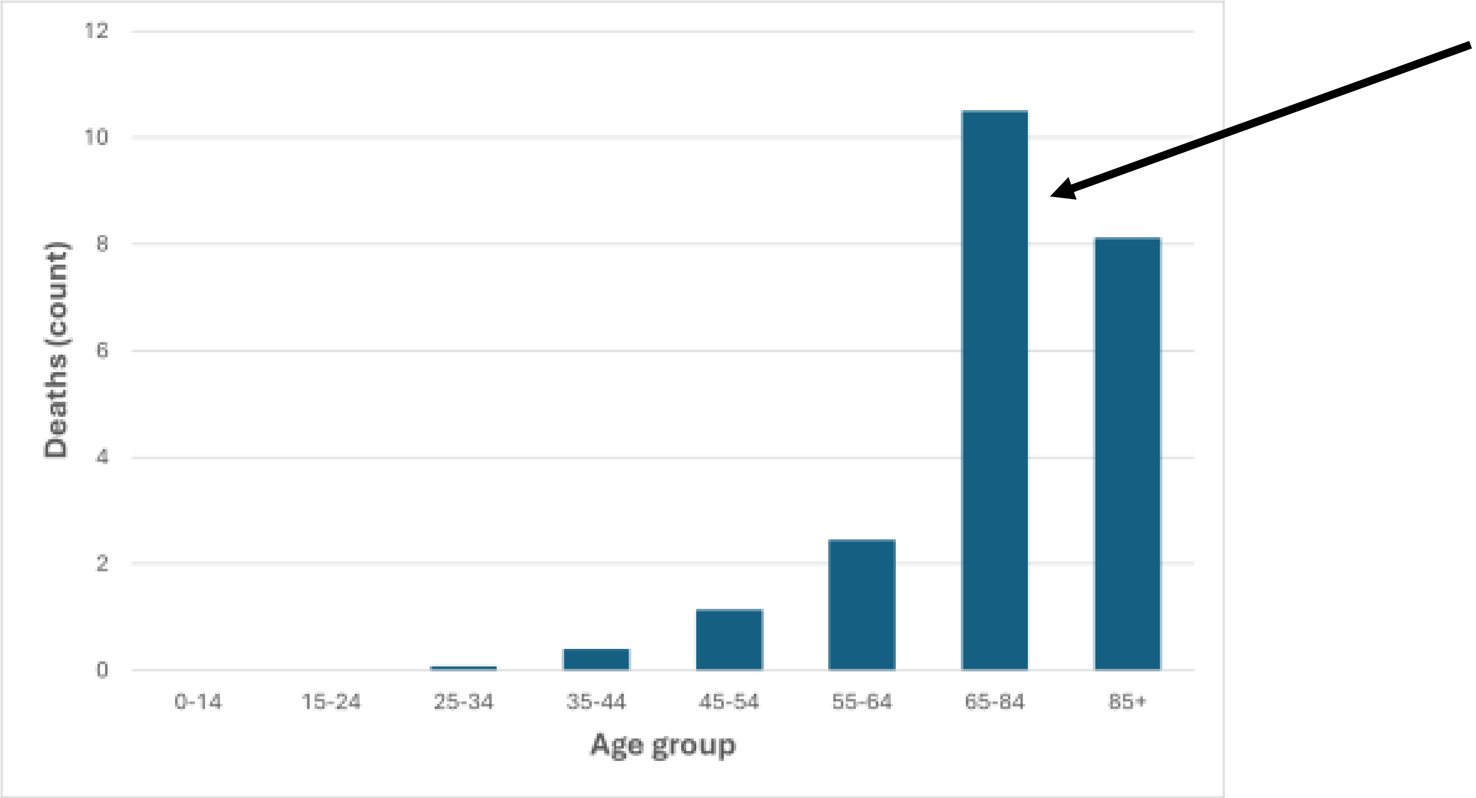
Valuing health cases – mortality spread across age



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Valuing health cases – avoided morbidity cost

	CVD	Asthma	COPD	All disease
15-24	0.00	$99,889.37	$0.00	$99,889.37
25-34	$8398.30	$310,891.22	$0.00	$319,289.52
35-44	$48,336.73	$364,907.54	$10,909.22	$424,153.49
45-54	$106,309.35	$331,240.96	$35,427.87	$472,978.18
55-64	$155,499.47	$250,869.21	$96,967.43	$503,336.11
65-84	$107,262.58	$83,268.41	$120,480.24	$311,011.22
85+	$13,615.18	$2,969.89	$21,475.32	$38,060.39
All age	$439,421.61	$1,444,036.60	$285,260.08	$2,168,718.29

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Valuing health cases – avoided medical treatment cost

Disease	Adjusted national costs (000,000's)	Per case treatment cost	Avoided health cases 2017-18	Avoided treatment costs
CVD	$12,697.72	$10581.44	47.84	$506,266.58
Asthma	$756.54	$282.27	334.02	$94,282.10
COPD	$738.42	$1149.54	137.01	$157,497.24

Valuing health cases – total avoided costs

	Mortality value	Morbidity value	Medical treatment value	Total
2017 AUD	$3,704,616.13	$2,168,718.29	$758,045.92	$6,631,380.34
2023 adjusted AUD	$4,472,768.54	$2,618,402.17	$917,025.00	$8,008,195.71

Comparison to results in contemporary literature

Study	Mortality	Asthma	COPD	CVD
This study (original)	+3.3%	+3.02%	+6.56%	+1.08%
This study (normalised)	+3.9%	+3.52%	+7.6%	+1.26%
Pope et al. (2002)	+4.0%			
Weinmayr (2010)		+2.8%		
Schikowski et al. (2005) (normalised)			+7.3%	
Liu (2022)				+1.69%

Policy implications

- Coal station closures bring measurable public health benefits.
- These benefits should be factored into regional economic transition planning.
- **Cleaner air aligns** with Latrobe's pivot to wellness, tourism, and recreation industries.
- **Environmental improvements can strengthen local comparative advantages in the post-coal economy.**

Limitations and areas for future work

- The study likely **underestimates total benefits**, it does **not measure**:
  - Impacts on **local school performance**
  - **Pain and suffering** from premature mortality and illness
  - **Minor health symptoms** (e.g. coughing, headaches, throat irritation)
  - **Long-term diseases** like lung cancer with delayed onset
  - **Property value increases** from improved air quality
- PM10 is used as a **proxy for broader pollution**, but coal plants emit other harmful pollutants (e.g. CO, SO_2).
- These pollutants are **positively correlated**, so measuring each separately risks **double-counting**, however single counting underestimates effects.
- Therefore, the true health and economic benefits of cleaner air are likely **larger than estimated**.

Appendix (i)

- No anticipation effects of power station emissions prior to closure, due to real time nature of electricity generation:

	2013	2014	2015	2016
Loy Yang (KG)	3,000,000	3,200,000	3,600,000	4,100,000
Yallourn (KG)	2,300,000	3,200,000	2,100,000	2,100,000
Loy Yang B (KG)	1,700,000	1,000,000	770,000	770,000
Total (KG)	7,000,000	7,400,000	6,470,000	6,970,000

- Robustness checks performed on DiD regression:
    - Placebo test, changing treatment date to 30 April 2016: no effect detected
    - Variation of model specification, removing interaction terms.
        - Does not remove treatment effect, but lowers magnitude of effect (suggests avoided omitted variable bias)

Appendix (ii)

- Other industrial emissions continued to rise to 2023, almost doubling between 2015-2023. Mainly from new waste treatment emissions and construction material mining.
- This may have led to PM levels staying relatively stable in Latrobe to 2023.

LGA	2015 PM_{10} emissions	2016 PM_{10} emissions	2017 PM_{10} emissions	2018 PM_{10} emissions
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- 2019: 9,990,000 KG
- 2020: 1,100,000 KG
- 2021: 1,200,000 KG
- 2022: 1,100,000 KG
- 2023: 1,200,000 KG