

# **Estimating Household Health Benefits From Transport Policies**

**Australian Conference of Economists (ACE) 2017  
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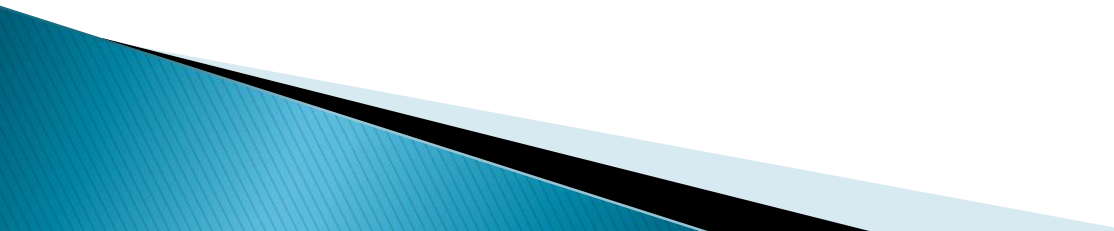
**Presenter:  
Dr Madhumita IYENGAR**

**Faculty Of Science & Engineering,  
Queensland University of Technology, Brisbane  
20 July 2017**

# Presentation Outline

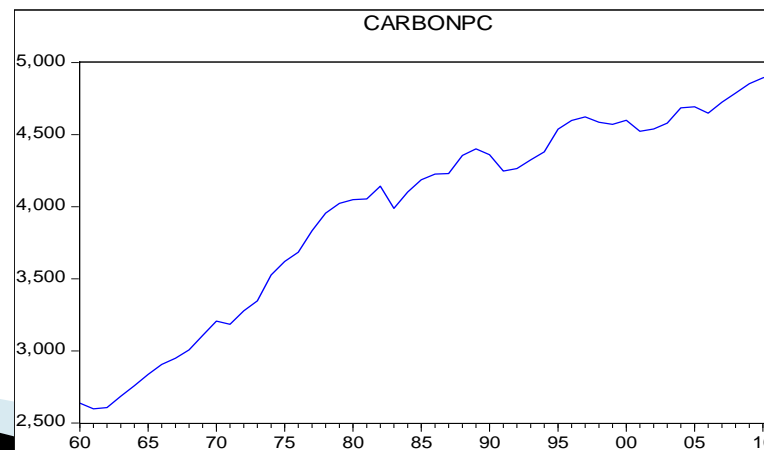
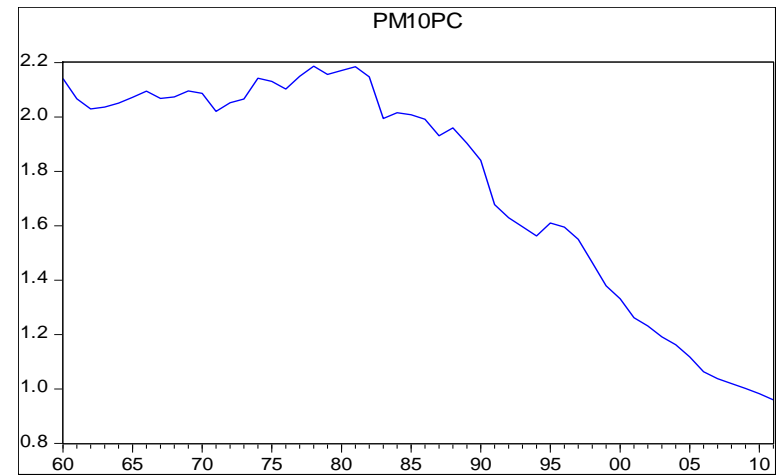
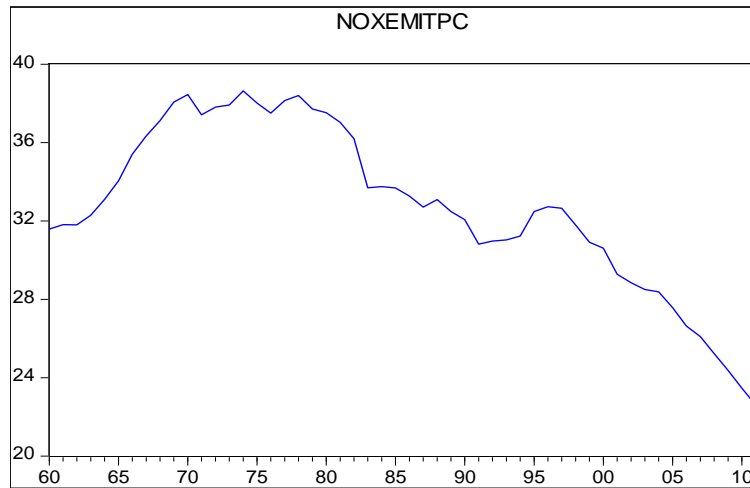
- ▶ Objectives
  - ▶ Transport Policy
  - ▶ Health Impacts of Policy
  - ▶ The Methodology – Economic Model
  - ▶ Results from the Empirical Model
  - ▶ Study Findings
  - ▶ Limitations and Way Forward
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# Objectives of the Study

- ▶ To estimate monetary health benefits from non-health policy
  - ▶ A generic Economic model to quantify policy induced household health benefits
  - ▶ Empirical research into the validity and reliability of methods for HIA
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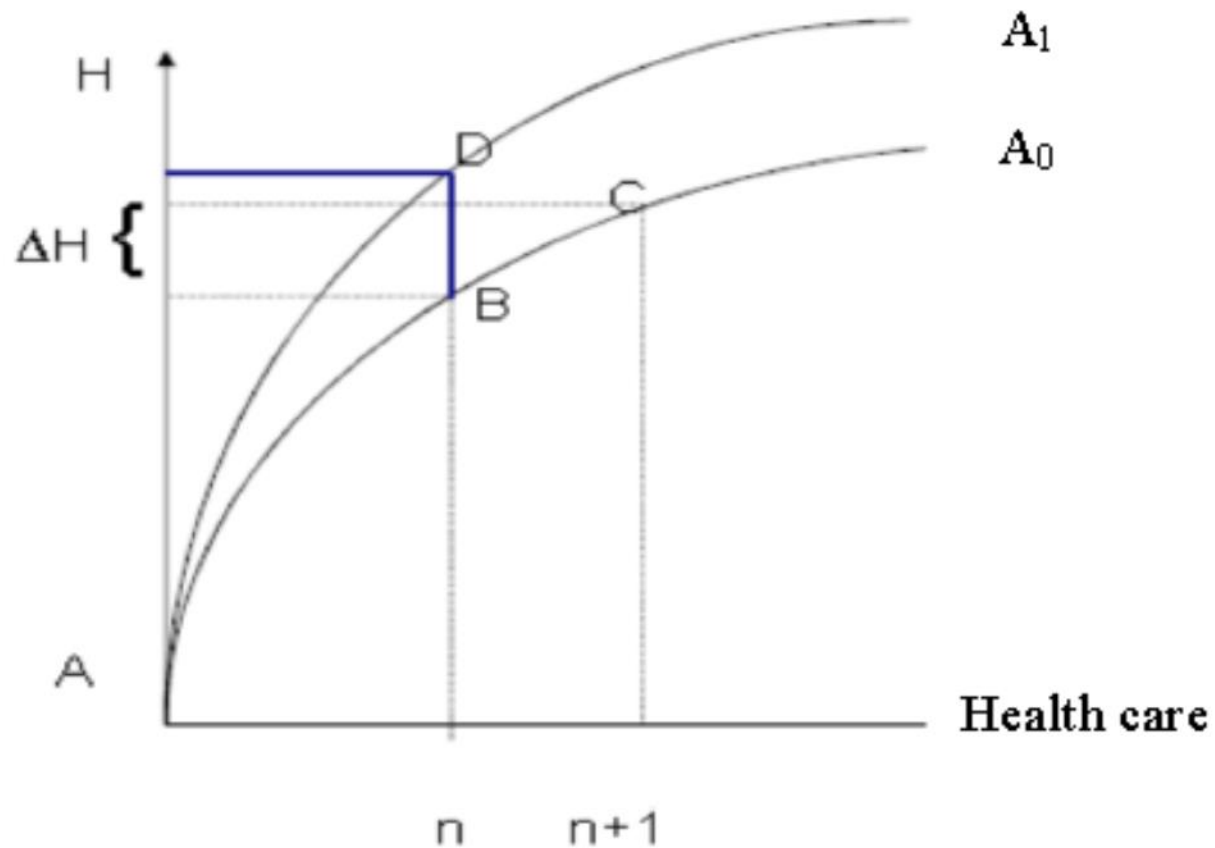
# Transport Policy – Emission Abatement Policy

- ▶ Long-term movements in Selected Transport Policy Variables in Australia, 1960-2010



# Health Impacts of Reduced Transport Emissions

*(Health Production Function)*



# The Methodology - Economic Model

The Model estimates the health production function (HPF) :

- ▶ Health Status= F (Yineq, HealthCare, ALCO, GPcon, EduFem, POP65, Policy)
- ▶ HealthCare= F (Yineq, Health Status, GPcon, EduFem, HHincome, Policy)
- ▶ Yineq = F (HealthCare, Health Status, GPcon, EduTot, Wage, Sickdays, Policy)

# Estimated Economic Model using 3SLS Method

Equation 1: Health Production Function Estimated in Log-linear Form (1960-2010)							
Model	M1	M2	M3	M4	M5	M6	M7
Dependent Variable (Y1): Health Status	Total Life Expectancy	Male Life Expectancy	Female Life Expectancy	All Cause Mortality	Potential Life Years Lost (Male)	Potential Life Years Lost (Female)	Acute Morbidity
Adjusted R <sup>2</sup>	0.995	0.996	0.994	0.992	0.996	0.992	0.912
DW Statistics	1.9	1.72	1.79	2	1.99	2.11	2.06
Explanatory Variables	Coefficients <i>t-Statistics</i>	Coefficients <i>t-Statistics</i>	Coefficients <i>t-Statistics</i>	Coefficients <i>t-Statistics</i>	Coefficients <i>t-Statistics</i>	Coefficients <i>t-Statistics</i>	Coefficients <i>t-Statistics</i>
Constant	3.497 7.570	3.628 8.213	3.352 6.770	12.174 4.998	13.591 4.975	20.492 4.745	13.059 3.054
Income Inequality	-0.063 -1.953	-0.054 -1.689	-0.071 -2.144	0.168 0.831	0.555 2.772	0.844 2.678	1.647 5.560
Health Expenditure(-1)	-0.032 -1.151	-0.020 -0.738	-0.043 -1.420	0.150 1.282	0.182 1.097	0.555 2.129	0.814 3.034
Alcohol consumption per capita	0.061 2.375	0.051 2.002	0.074 2.536	-0.740 -2.271	-0.263 -1.534	-0.555 -2.409	-0.207 -0.698
Ratio of female to Total in High Education	0.022 1.629	0.014 1.057	0.027 1.820	-0.063 -1.076	-0.087 -1.059	-0.255 -2.003	-0.304 -1.687
Population over 65yrs	0.265 3.602	0.279 3.978	0.282 3.440	-2.284 -3.771	-2.289 -5.236	-3.149 -4.656	-0.295 -0.538
Carbon Emissions Per Capita	0.057 0.817	0.026 0.390	0.075 1.036	0.134 0.355	-0.110 -0.260	-1.041 -1.563	-2.371 -2.689
Nitrogen Emissionsn Per Capita	-0.008 -0.558	-0.015 -1.023	0.003 0.168	-0.244 -1.668	-0.198 -2.122	-0.201 -1.353	0.076 0.351
PM10 Emissions Per Capita	-0.062 -2.235	-0.059 -2.193	-0.058 -1.959	0.391 2.966	0.546 3.238	0.693 2.619	1.387 3.757
GP Consultation Per Capita	0.069 1.757	0.051 1.333	0.082 1.949	-0.216 -1.110	-0.436 -1.855	-0.916 -2.467	-1.692 -4.292

Green highlight denotes statistical significance at 5% level of confidence

Blue highlight denotes statistical significance at 10% level of confidence

# Estimated Health Production Function

Important health determinants along with transport policy variables (transport emissions of PM<sub>10</sub>, NO<sub>x</sub> and Carbon) are:

- ▶ availability of health care services
- ▶ household income,
- ▶ income inequality,
- ▶ education level (particularly female education),
- ▶ aging population,
- ▶ air pollution,
- ▶ wage differential in the labour market

# Health Benefits Estimation

▶ Health Benefits: 
$$MWP_i = \frac{\Delta H}{\Delta AQ_i} \times W + \frac{\Delta HExp}{\Delta AQ_i} + \frac{\Delta Yineq}{\Delta AQ_i}$$

## Ist Step:

Using Parameters from the estimated HPF Model (Morbidity and Mortality Models)

Derived Household Health Benefits (MWP) from ALOSday Model											
	Coefficient in the HPF Eqn	Mean Health Status/ Morbidity days	Mean Exposure to Pollutant emission	Daily Per Capita Wage (\$)	Coefficient in the Health Exp Eqn	Mean Health Exp	Mean Exposure to Pollutant emission	Coefficient in the Income Inequality Eqn	Mean Income Inequality	Mean Exposure to Pollutant emission	Mean Household Exp per capita (\$)
PM10 (gm)	1.387	7.42	1757.51	34.89	1.339	1568.30	1757.51	0.826	31.75	1757.51	12228.21
Nox (kg)	0.076	7.42	32.75	34.89	0.099	1568.30	32.75	0.121	31.75	32.75	12228.21
Carbon (kg)	2.371	7.42	3969.57	34.89	2.515	1568.30	3969.57	1.539	31.75	3969.57	12228.21
Derived Benefits (MWP) from Mortality Rate Model				Mean Average Wage Earnings per capita (\$)							
PM10 (gm)	<b>0.391</b>	963.36	1757.51	10468.43	0.934	1568.30	1757.51	0.367	31.75	1757.51	12228.21
Nox (10gm)	<b>0.244</b>	963.36	32.75	10468.43	0.219	1568.30	32.75	0.321	31.75	3275.31	12228.21
Carbon (kg)	<b>0.134</b>	963.36	3969.57	10468.43	1.776	1568.30	3969.57	0.352	31.75	3969.57	12228.21

# Health Benefits Estimation

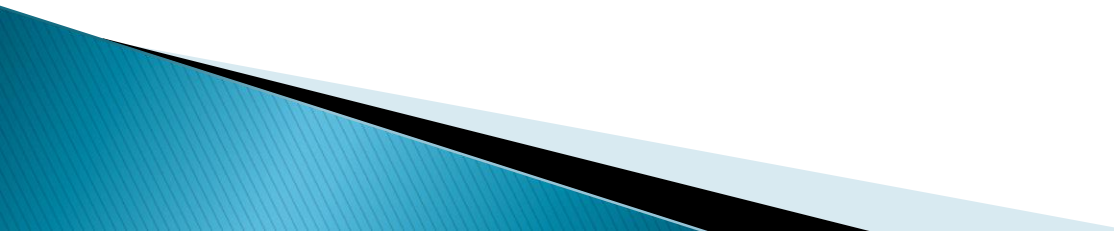
- ▶ **2<sup>nd</sup> Step:** Deriving Annualised Monetary Benefits to a Household

Reduction in the Pollution level by	MWP for Health Status (\$)	MWP for Health Exp (\$)	MWP for reduced Income Inequality(\$)	Benefits from each Pollutant Reduction (\$)	Total Household Benefits (\$)
<b>Health Status in terms of Morbidity (No.of Acute Care Days)</b>					
1gm PM10 per m3	1.52	1.19	182.49	185.20	1781.53
1kg Nox per m3	4.46	4.74	1434.45	1443.65	
1 kg Carbon per m3	1.15	0.99	150.54	152.68	
<b>Mortality Rate as a Health Status variable</b>					
1gm PM10 per m3	21.61	0.83	81.16	103.60	4677.52
1kg Nox per m3	723.37	10.50	3801.59	4535.46	
1kg Carbon per m3	3.29	0.70	34.46	38.46	

# Study Findings

- ▶ Long run health determinants identified
- ▶ Monetary household health benefits estimated using MWP approach: the morbidity model gain < the mortality model.
- ▶ Health gains from a policy initiative would vary depending on the population health status indicator and spatial indicators.
- ▶ Spatial health inequalities influences the policy induced health gains leading to either under or over-estimated costs and benefits.
- ▶ Therefore, no uniform health status value should be used and *Maximum Benefits* principle to be applied.

# Limitations & Way Forward

- ▶ Mixed Method - quantitative and qualitative evidence are needed
  - ▶ Exploring spatial Health Inequality issues
  - ▶ Use of primary data in HPF
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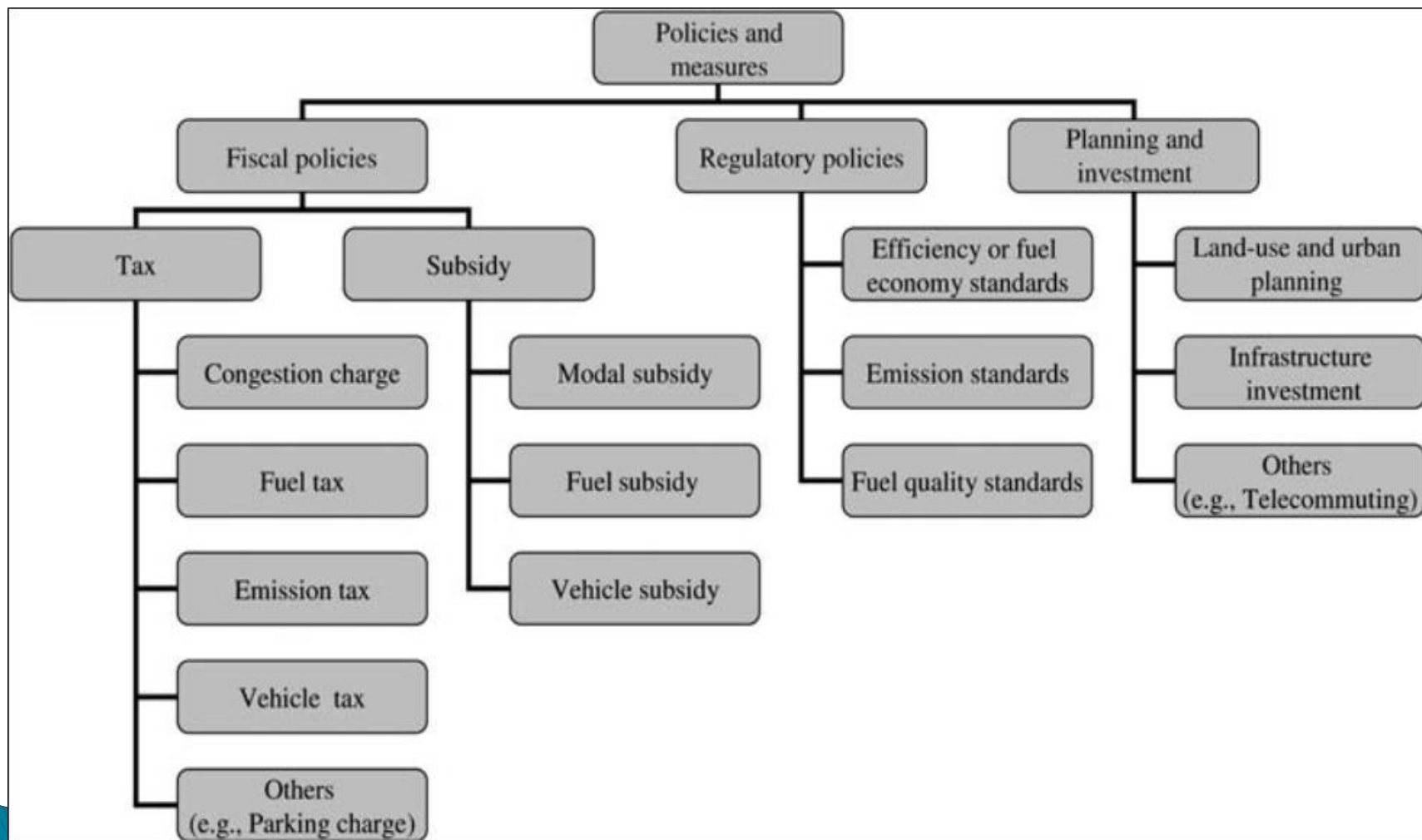
# !! Thank You !!

## Any questions?

Contact Madhumita IYENGAR:

- ▶ [madhucanberra@gmail.com](mailto:madhucanberra@gmail.com)
- ▶ Ph: 0432 261 541

# Policies & Measures to Reduce Transport Externalities (Road Transport)



# Estimated Economic Model using 3SLS Method

**Equation 2 : Demand For Health Care Service Estimated in Log Linear Form (1960-2010)**

Dependent Variable (Y2): Health Expenditure (-1)	Health status (Y1) in terms of						
	Total Life Expectancy	Male Life Expectancy	Female Life Expectancy	All Cause Mortality	Potential Life Years Lost (Male)	Potential Life Years Lost (Female)	Acute Morbidity
Adjusted R <sup>2</sup>	0.99	0.99	0.99	0.99	0.99	0.99	0.99
DW Statistics	1.87	1.79	1.8	1.77	1.84	1.82	2.06
Explanatory Variables	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients
	<i>t-Statistics</i>	<i>t-Statistics</i>	<i>t-Statistics</i>	<i>t-Statistics</i>	<i>t-Statistics</i>	<i>t-Statistics</i>	<i>t-Statistics</i>
Constant	7.100 <i>0.654</i>	2.830 <i>0.269</i>	4.993 <i>0.465</i>	-13.718 <i>-6.349</i>	-12.402 <i>-6.896</i>	-12.284 <i>-6.637</i>	-13.269 <i>-7.725</i>
Income Inequality	-0.652 <i>-4.836</i>	-0.599 <i>-4.358</i>	-0.686 <i>-5.059</i>	-0.566 <i>-4.226</i>	-0.591 <i>-4.618</i>	-0.614 <i>-4.737</i>	-1.508 <i>-8.191</i>
Health Status	-4.063 <i>-1.682</i>	-3.047 <i>-1.314</i>	-3.608 <i>-1.500</i>	0.468 <i>1.979</i>	0.274 <i>1.245</i>	0.200 <i>1.084</i>	0.703 <i>4.141</i>
Ratio of female to Total in High Education	0.486 <i>7.510</i>	0.465 <i>7.243</i>	0.475 <i>7.480</i>	0.450 <i>7.510</i>	0.448 <i>7.935</i>	0.446 <i>7.723</i>	0.375 <i>5.890</i>
Carbon Emissions Per Capita	1.841 <i>7.482</i>	1.793 <i>6.986</i>	1.884 <i>7.868</i>	1.776 <i>7.816</i>	1.732 <i>6.717</i>	1.853 <i>8.105</i>	2.515 <i>8.796</i>
Nitrogen Emissionn Per Capita	-0.286 <i>-2.110</i>	-0.298 <i>-1.969</i>	-0.222 <i>-1.817</i>	-0.219 <i>-1.835</i>	-0.185 <i>-1.728</i>	-0.179 <i>-1.625</i>	-0.099 <i>-0.719</i>
PM10 Emissions Per Capita	-1.013 <i>-7.174</i>	-0.980 <i>-6.343</i>	-0.954 <i>-7.698</i>	-0.934 <i>-6.911</i>	-0.939 <i>-6.831</i>	-0.893 <i>-7.799</i>	-1.339 <i>-9.961</i>
Household Total Expenditure Per Capita	0.539 <i>4.588</i>	0.545 <i>4.314</i>	0.511 <i>4.608</i>	0.562 <i>6.443</i>	0.525 <i>4.957</i>	0.482 <i>5.125</i>	0.214 <i>2.372</i>
GP Consultation Per Capita	0.831 <i>5.135</i>	0.777 <i>4.700</i>	0.853 <i>5.318</i>	0.681 <i>4.250</i>	0.769 <i>5.058</i>	0.811 <i>5.352</i>	1.538 <i>8.990</i>

Green highlight denotes statistical significance at 5% level of confidence

Blue highlight denotes statistical significance at 10% level of confidence

# Estimated Economic Model using 3SLS Method

**Equation 3 : Income Inequality Equation Estimated in Log Linear Form (1960-2010)**

Dependent Variable (Y3): Income Inequality	Health status (Y1) in terms of						
	Total Life Expectancy	Male Life Expectancy	Female Life Expectancy	All Cause Mortality	Potential Life Years Lost (Male)	Potential Life Years Lost (Female)	Acute Morbidity
Adjusted R <sup>2</sup>	0.768	0.815	0.809	0.783	0.816	0.815	0.887
DW Statistics	1.83	1.82	1.83	1.78	1.91	1.8	1.91
Explanatory Variables	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients	Coefficients
	<i>t-Statistics</i>	<i>t-Statistics</i>	<i>t-Statistics</i>	<i>t-Statistics</i>	<i>t-Statistics</i>	<i>t-Statistics</i>	<i>t-Statistics</i>
Constant	-2.582 <i>-0.151</i>	-2.650 <i>-0.156</i>	-2.358 <i>-0.134</i>	1.354 <i>0.207</i>	1.700 <i>0.284</i>	1.648 <i>0.272</i>	-9.454 <i>-3.169</i>
Health Expenditure(-1)	0.524 <i>0.817</i>	0.491 <i>0.739</i>	0.541 <i>0.841</i>	0.500 <i>0.794</i>	0.533 <i>0.779</i>	0.547 <i>0.847</i>	-0.607 <i>-2.894</i>
Health Status	0.940 <i>0.277</i>	0.904 <i>0.294</i>	0.935 <i>0.249</i>	0.027 <i>0.062</i>	-0.033 <i>-0.100</i>	-0.007 <i>-0.023</i>	0.671 <i>7.825</i>
Carbon Emissions Per Capita	0.389 <i>0.469</i>	0.414 <i>0.475</i>	0.372 <i>0.458</i>	0.352 <i>0.449</i>	0.385 <i>0.420</i>	0.358 <i>0.433</i>	1.539 <i>3.392</i>
Nitrogen Emissions Per Capita	0.362 <i>1.200</i>	0.363 <i>1.254</i>	0.357 <i>1.165</i>	0.321 <i>1.119</i>	0.331 <i>1.152</i>	0.333 <i>1.174</i>	-0.121 <i>-0.737</i>
PM10 Emissions Per Capita	-0.309 <i>-1.055</i>	-0.306 <i>-1.092</i>	-0.316 <i>-1.060</i>	-0.367 <i>-1.231</i>	-0.334 <i>-1.244</i>	-0.345 <i>-1.288</i>	-0.826 <i>-7.147</i>
Total Higher Education Students	-0.146 <i>-1.093</i>	-0.140 <i>-1.062</i>	-0.149 <i>-1.064</i>	-0.132 <i>-1.007</i>	-0.140 <i>-1.052</i>	-0.141 <i>-1.084</i>	0.092 <i>1.866</i>
Wage Earnings Per Capita	-0.668 <i>-1.575</i>	-0.646 <i>-1.556</i>	-0.683 <i>-1.519</i>	-0.624 <i>-1.507</i>	-0.660 <i>-1.563</i>	-0.665 <i>-1.605</i>	0.107 <i>4.232</i>
AcuteCare Morbidity	0.473 <i>3.004</i>	0.461 <i>2.855</i>	0.461 <i>2.925</i>	0.465 <i>2.873</i>	0.490 <i>3.155</i>	0.492 <i>3.149</i>	
GP Consultation Per Capita	0.601 <i>1.891</i>	0.614 <i>1.921</i>	0.604 <i>1.876</i>	0.626 <i>1.989</i>	0.602 <i>1.873</i>	0.601 <i>1.924</i>	1.054 <i>7.451</i>

Green highlight denotes statistical significance at 5% level of confidence

Blue highlight denotes statistical significance at 10% level of confidence

# Transferability of the Economic Model

- ▶ Annualized Monetary Benefits from Pollution Reduction to a Representative Household: **High Income Local Area**

Reduction in the Pollution level by	MWP for Health Status (\$)	MWP for Health Exp (\$)	MWP for reduced Income Inequality(\$)	Benefits from each Pollutant Reduction (\$)	Total Household Benefits (\$)
<b>Health Status in terms of Morbidity (No.of Acute Care Days)</b>					
1gm PM10 per m3	2.24	1.19	257.11	260.54	2507.64
1kg Nox per m3	6.59	4.74	2020.99	2032.32	
1 kg Carbon per m3	1.70	0.99	212.09	214.78	
<b>Mortality Rate as a Health Status variable</b>					
1gm PM10 per m3	31.93	0.83	114.34	147.10	6636.62
1kg Nox per m3	1068.87	10.50	5356.02	6435.39	
1kg Carbon per m3	4.86	0.70	48.56	54.12	

# Transferability of the Economic Model

Annualized Monetary Benefits from Pollution Reduction to a Representative Household: **Low Income Local Area**

Reduction in the Pollution level by	MWP for Health Status (\$)	MWP for Health Exp (\$)	MWP for reduced Income Inequality(\$)	Benefits from each Pollutant Reduction (\$)	Total Household Benefits (\$)
<b>Health Status in terms of Morbidity (No. of Acute Care Days)</b>					
1gm PM10 per m3	1.08	1.19	137.72	139.99	1345.87
1kg Nox per m3	3.18	4.74	1082.53	1090.45	
1 kg Carbon per m3	0.82	0.99	113.61	115.42	
<b>Mortality Rate as a Health Status variable</b>					
1gm PM10 per m3	15.42	0.83	61.25	77.50	3502.05
1kg Nox per m3	516.07	10.50	2868.93	3395.50	
1kg Carbon per m3	2.35	0.70	26.01	29.06	