THE ECONOMIC CONSEQUENCES OF OUTDOOR AIR POLLUTION

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BETTER POLICIES FOR BETTER LIVES

Structure of the presentation

- **OECD's CIRCLE project**
- **Overview of the air pollution report**
- **Methodology**
- **Main results**
- **Conclusions**

THE OECD'S CIRCLE PROJECT

The OECD CIRCLE project

- **Two key objectives:**
  - **Quantify how changes in environmental quality, climate change, degradation and scarcity of natural resources affect the economy, and prospects for long-term growth (costs of inaction)**
  - **Assess benefits, as well as trade-offs, associated with policy responses to these environmental challenges (benefits of policy action)**
- **Regional and sectoral quantitative approach where possible, coupled with more general insights where needed**
  - **Market impacts: production function approach**
  - **Non-market impacts: valuation approach**

CIRCLE project themes

Climate change	Report published in 2015
Air pollution	Report recently published
Land-water-energy nexus	Report to be published of this year
Water	Scoping paper to be published this year
Biodiversity and ecosystems	Scoping paper published in 2015
Resource scarcity	Scoping paper published in 2015 and further work planned for the next biennium

AIR POLLUTION REPORT

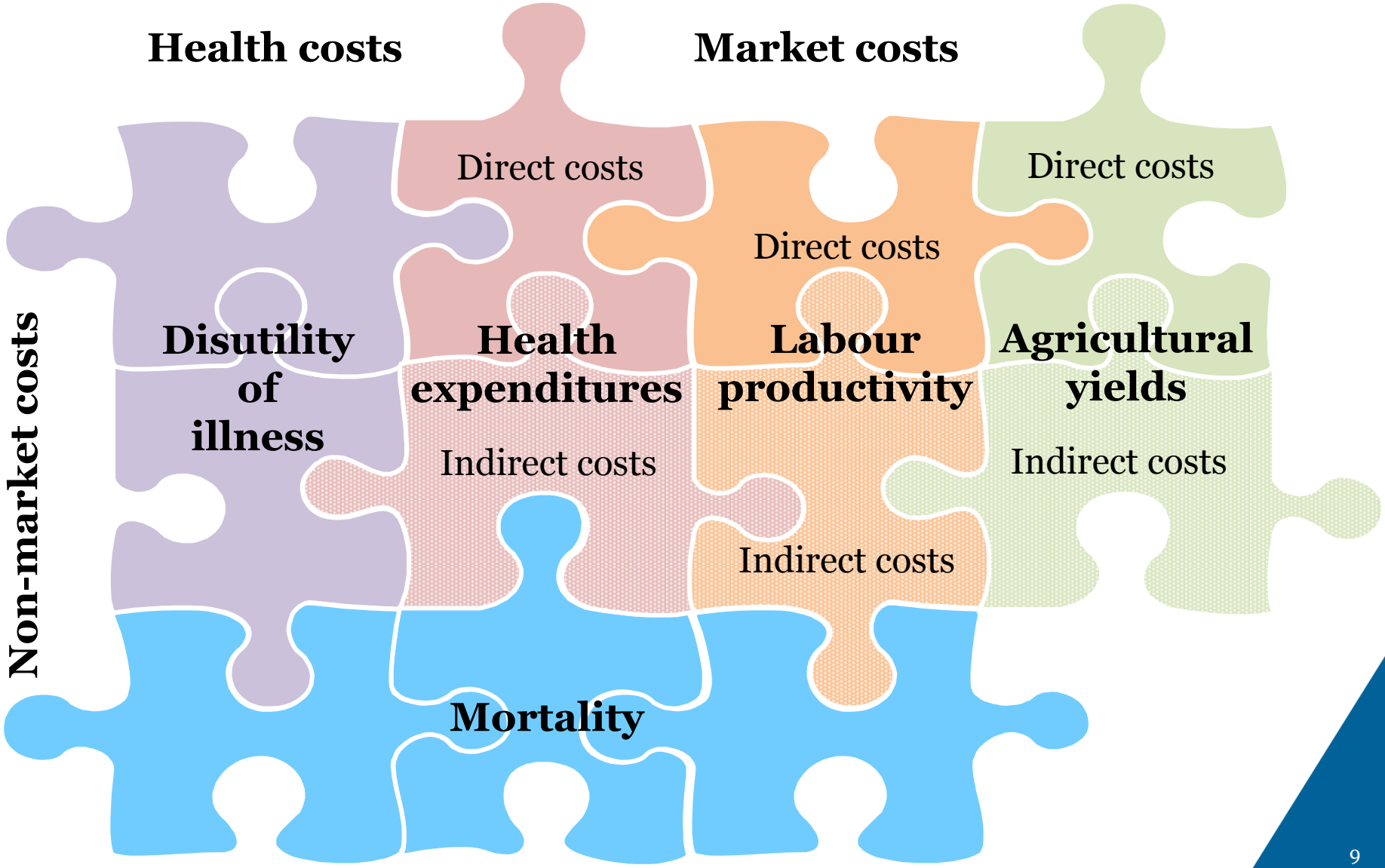
Impacts of air pollution

- Health impacts
  - Mortality
  - Morbidity: illness (especially respiratory and cardiovascular diseases)
- Other impacts
  - Agriculture
  - Biodiversity and ecosystems
  - Buildings and cultural heritage
  - Visibility

Economic consequences

- The impacts of air pollution on health and the environment have economic consequences (e.g. through labour productivity changes)
- Economic feedback effects best captured in a general equilibrium framework, which considers direct and indirect effects
- Some economic costs cannot be calculated in a general equilibrium framework (e.g. mortality)

Types of costs



Previous studies (I)

- Mayers and van Regemorter (2008): air pollution feedbacks in Europe (GEM-E3 model)
  - Utility is derived from consumption, leisure and health status
- Vrontisi et al. (2016): benefits of air pollution policies in the EU (GEM-E3 model)
  - Simpler approach, similar to what done for climate change in PESETA

Previous studies (II)

- Studies with the EPPA model
  - Health incorporated in the EPPA model as a consumption tradeoff between healthcare and leisure expenditures

  - Matus (2005; 2011): costs of air pollution impacts and benefits of policies in China
  - Matus et al. (2008): air pollution health effects in the US
  - Nam et al. (2009): welfare loss from air pollution in Europe

Chosen approach

- Global study
- Calculate market costs in a general equilibrium framework
  - Following Vrontisi et al. (2008) and existing work on climate change
- Calculate non-market costs separately based on results from valuation studies

-> overview of both aspects and types of costs

METHODOLOGY

Methodological steps

Effects of air pollution impacts on economic growth to 2060

Economic activity	• ENV-Linkages model
Emissions	• ENV-Linkages model • Emission coefficients from IIASA's GAINS model
Concentrations	• EC-JRC's TM5-FASST model
Biophysical impacts	• Impacts on crop yields with TM5-FASST model • Health impacts using functions based on GBD
Economic costs	• Economic feedbacks using ENV-Linkages model • Non-market costs calculated based on results of valuation studies

The ENV-Linkages model

- Computable General Equilibrium (CGE) model
  - Multi-regional, multi-sectoral
  - All economic activity is part of a closed, linked system
  - Simultaneous equilibrium on all markets
  - Structural trends, no business cycles

- Dynamics
  - Solved iteratively over time (recursive-dynamic)
  - Capital vintages

The ENV-Linkages aggregation

25 regions and 35 sectors

Agriculture	Manufacturing
Paddy rice	Paper and paper products
Wheat and meslin	Chemicals
Other grains	Non-metallic minerals
Vegetables and fruits	Metals n.e.s.
Sugar cane and sugar beet	Fabricated metal products
Oil seeds	Other manufacturing
Plant fibres	Motor vehicles
Other crops	Electronic equipment
Livestock	Textiles
Forestry	
Fisheries	
Natural resources and energy	**Services**
Coal	Land transport
Crude oil	Air transport
Gas extraction and distribution	Water transport
Other mining	Construction
Petroleum and coal products	Trade other services and dwellings
Electricity (5 technologies*)	Other services (government)

Emission projections

- Emissions linked to projections of economic activities in ENV-Linkages using data from GAINS
  - Emissions from combustion linked to fossil fuel inputs in relevant sectors (e.g. power generation)
  - Other emissions linked to output (e.g. chemicals)
- Pollutants
  - sulphur dioxide (SO_2)
  - nitrogen oxides (NOx)
  - black carbon (BC)
  - organic carbon (OC)
  - carbon monoxide (CO)
  - volatile organic compounds (VOCs)
  - ammonia (NH_3)

Concentrations

- Impacts of air pollution depend on the levels of concentrations of pollutants in the air
- Calculating concentrations needs
  - Downscaling from macro regions to local level
  - Data on regional emissions and geographical variables (e.g. presence of urban areas in a certain region)

- Concentrations of particulate matter (PM2.5) and ground level ozone (O3) calculated with the EC-JRC's TM5-FASST

Biophysical impacts

- Concentrations are used to calculate impacts
  - increased mortality (premature deaths)
  - increased morbidity (number of sick days, hospital admissions…)
  - changes in crop yields

- Health impacts are calculated based on the Global Burden of Disease (GBD)
  - Uncertainty range reflects two specifications of the concentration-response function used

- Agricultural impacts are calculated using TM5-FASST

Valuation of health impacts

- Market impacts
  - Additional health costs
- Non-market impacts
  - Cost of premature deaths
  - Costs of pain and suffering

Baseline unit values (for OECD; USD, 2005 PPP exchange rates)

Effect	Cost element	Value
Mortality, deaths	Welfare cost	3 million
Chronic bronchitis in adults (new cases)	Welfare cost	61,610
	Healthcare cost	13,070
	Productivity	0
Bronchitis in children (cases)	Welfare cost	680
	Healthcare cost	57
Equivalent hospital admissions	Welfare cost	575
	Healthcare cost	3,430
Restricted activity days	Welfare	106
Minor restricted activity days	Welfare	48

Source: OECD (2016) "The Economic Consequences of Outdoor Air Pollution". Based on Holland (2014)

Market costs

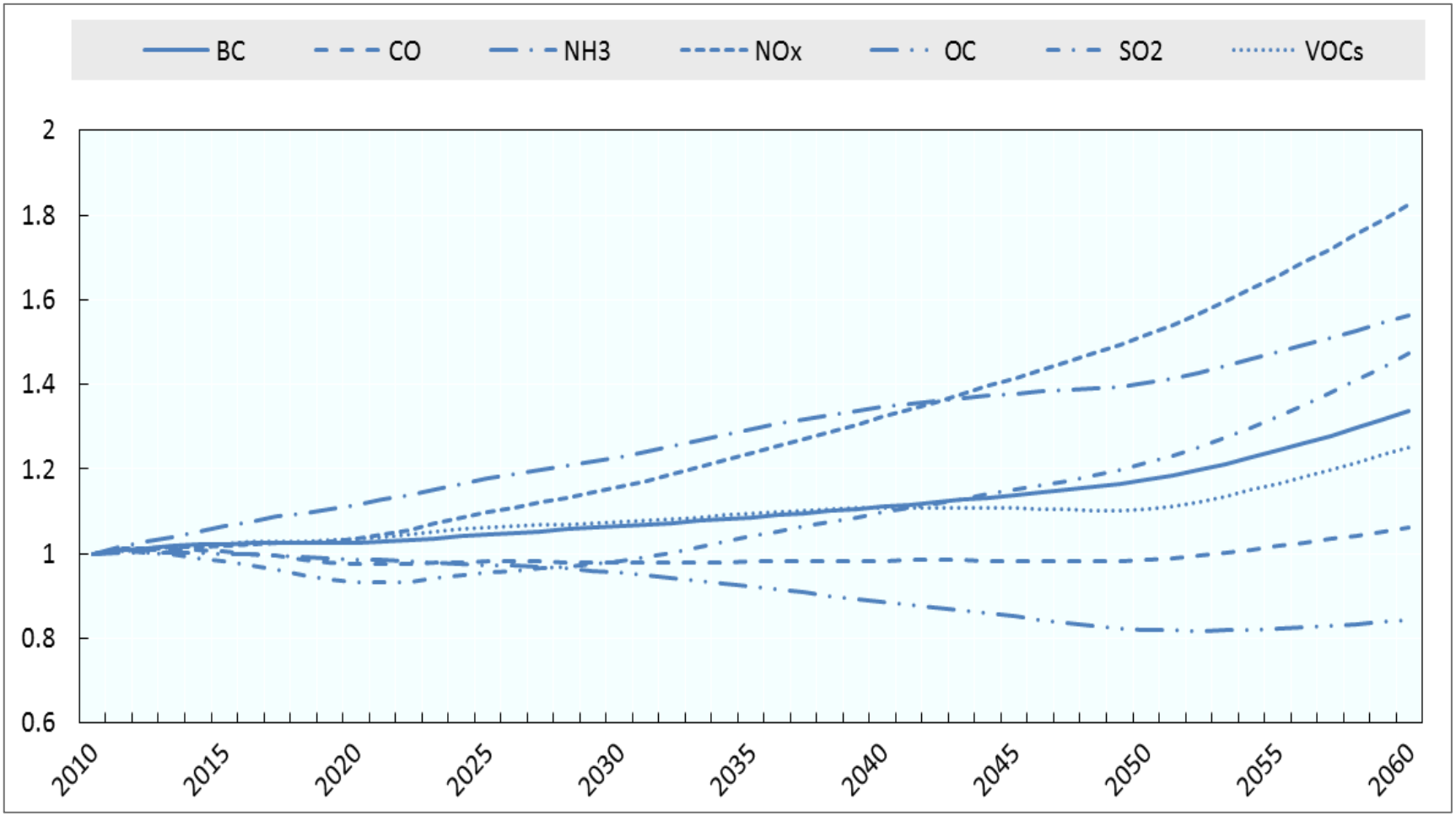
- Study economic feedbacks in ENV-Linkages (production function approach)
  - Health expenditures
    - Cases of bronchitis in children
    - Cases of chronic bronchitis in adults
    - Hospital admissions
  - Labour productivity
    - Linked to increasing number of work days lost
  - Agriculture
    - Reduced crop yields

Non-market costs: the VSL

- The unit values for mortality, are based on the OECD VSL methodology
- The 2012 book ***Mortality Risk Valuation in Environment, Health and Transport Policies*** established a new method for calculating country-specific VSL based on income levels
- The 2014 book ***The Costs of Air Pollution*** combined estimates of mortalities caused by outdoor air pollution from the 2010 *GBD study* with VSL figures to find economic costs of almost USD 1.6 trillion in 2010 for OECD countries alone

RESULTS

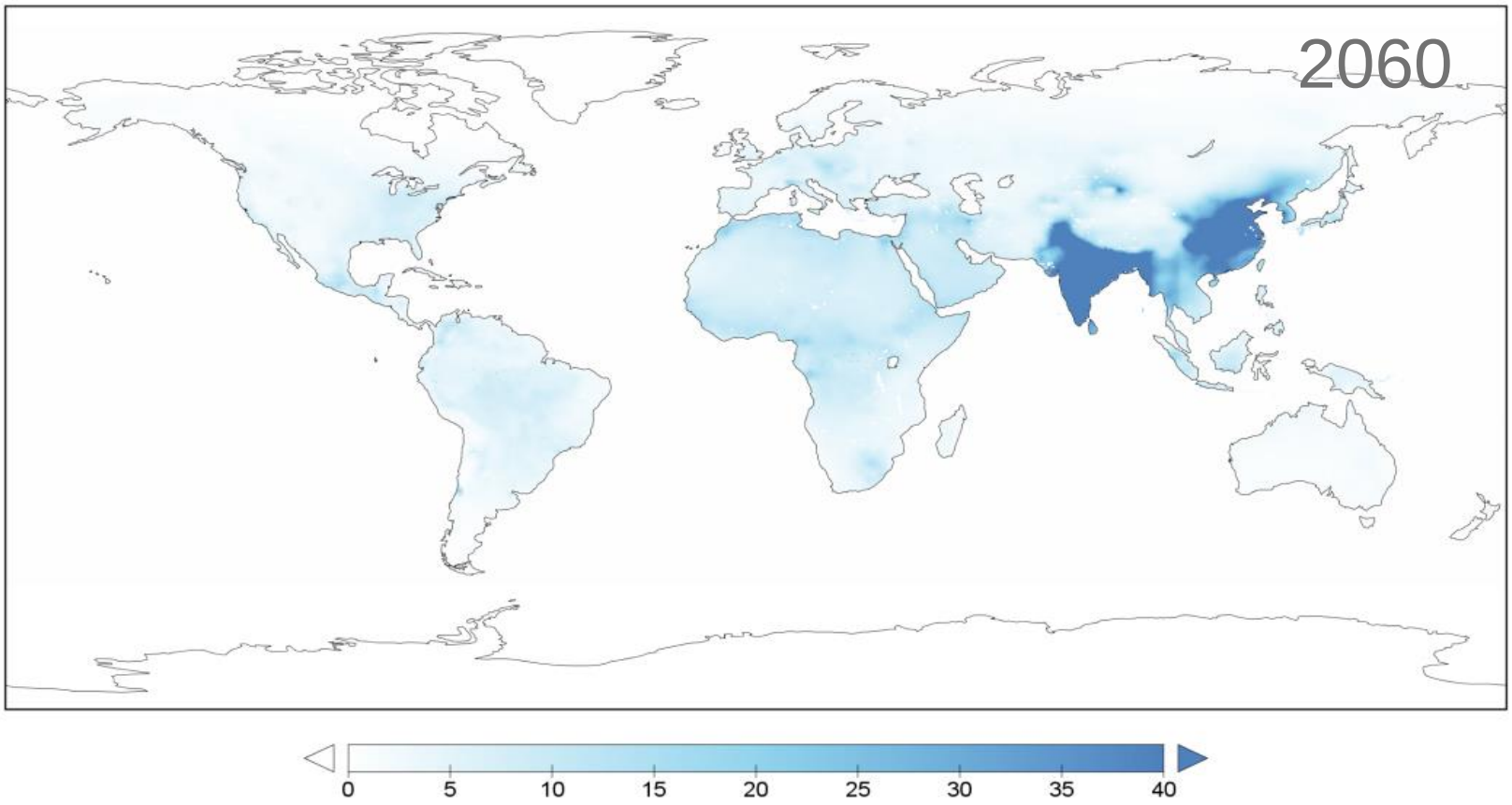
Projections of air pollutants emissions



Source: OECD (2016), The economic consequences of outdoor air pollution

Concentrations of air pollutants

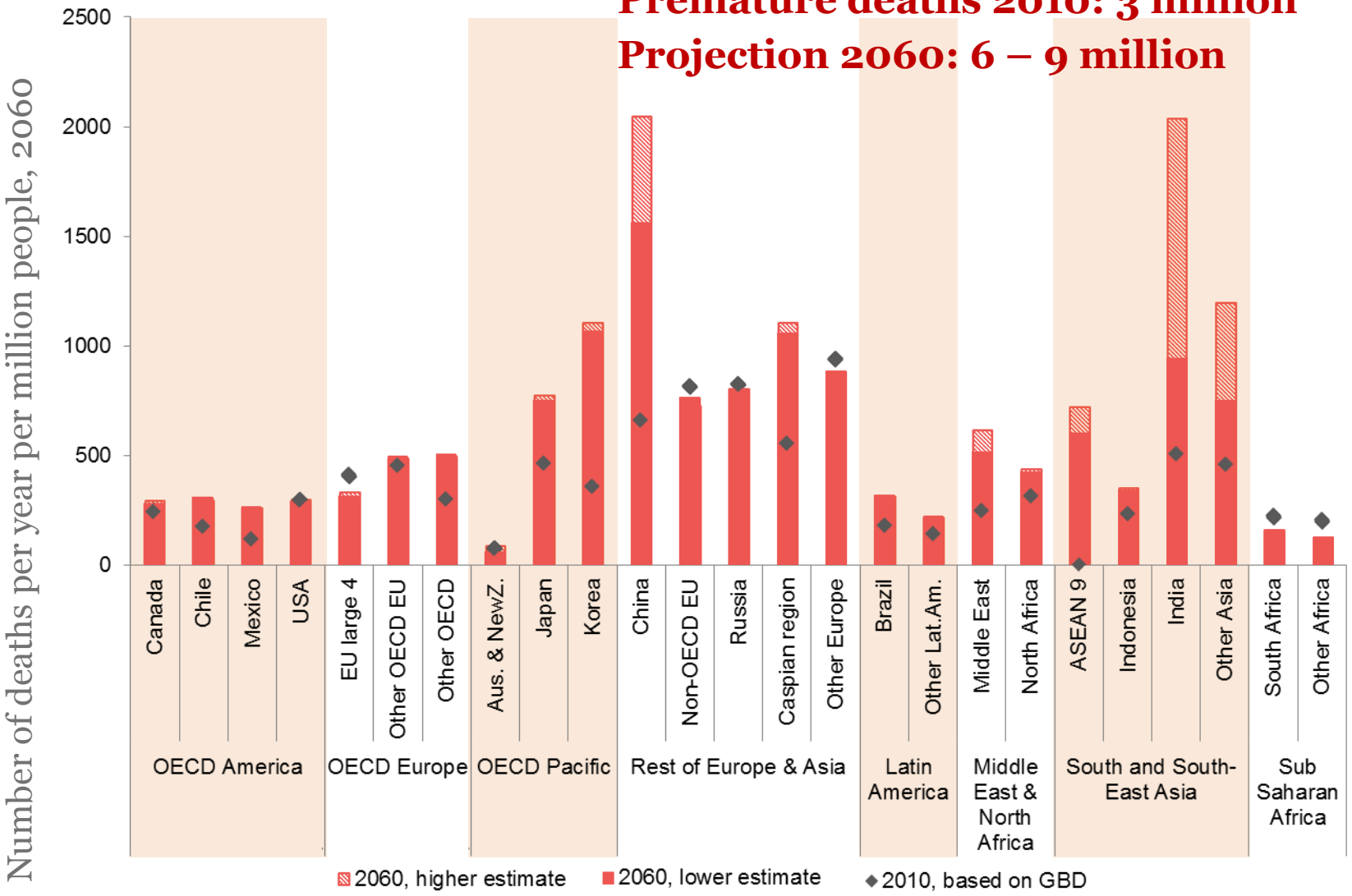
Annual average total anthropogenic PM2.5 (µg/m3)



Source: OECD (2016), The economic consequences of outdoor air pollution

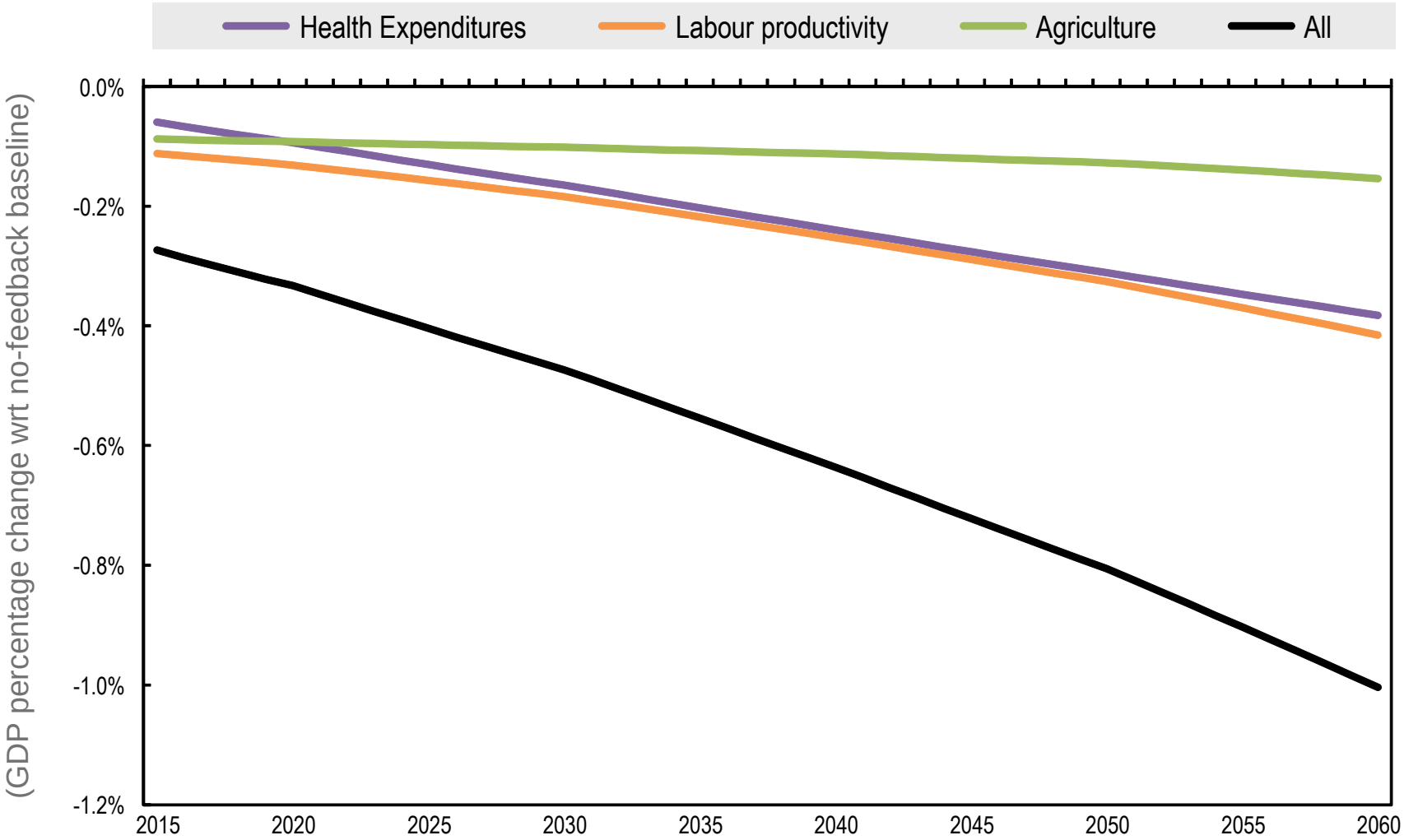
Premature deaths caused by outdoor air pollution

Premature deaths 2010: 3 million
Projection 2060: 6 – 9 million



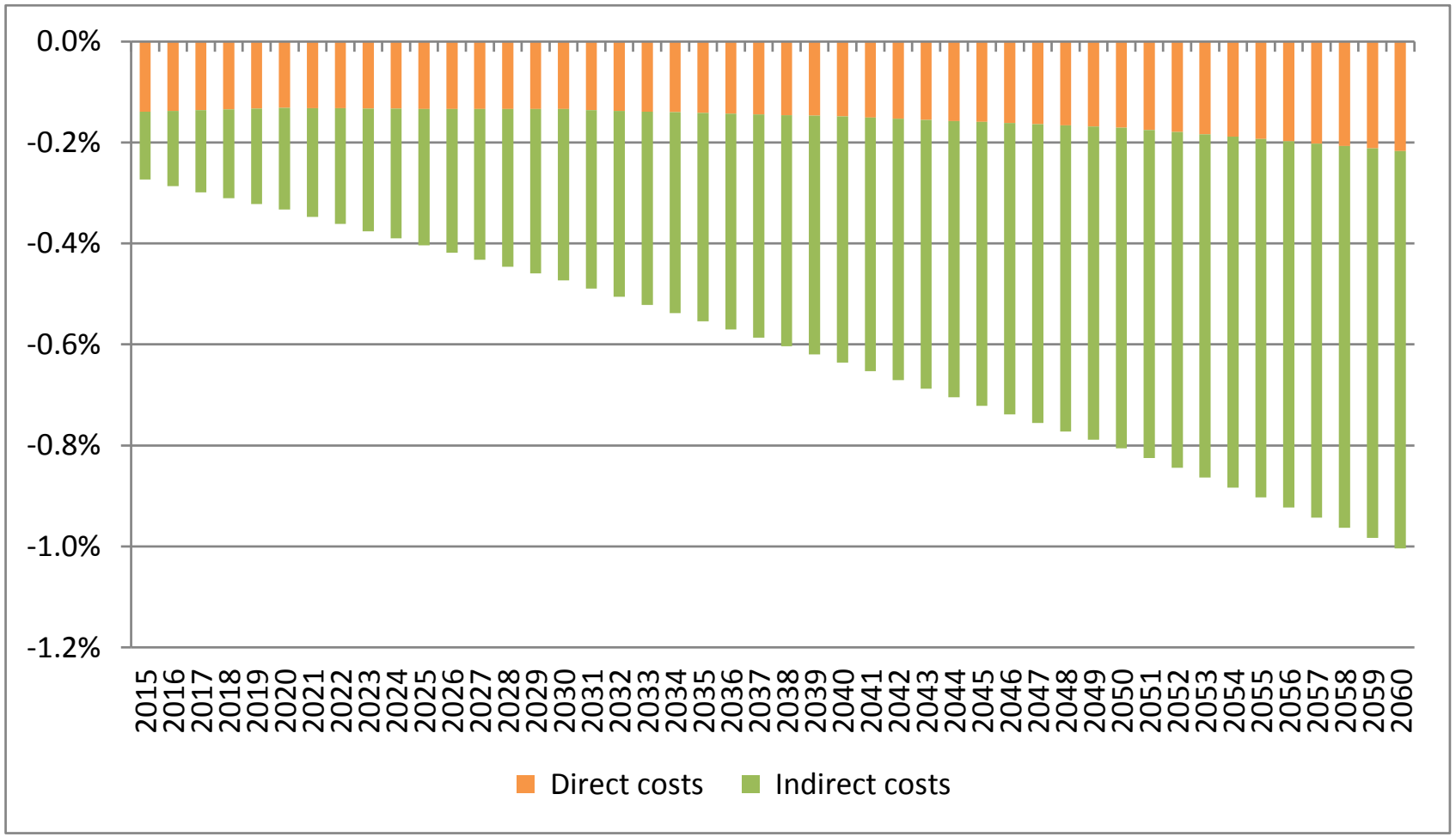
Source: OECD (2016), The economic consequences of outdoor air pollution

Market costs: global GDP changes over time



Source: OECD (2016), The economic consequences of outdoor air pollution

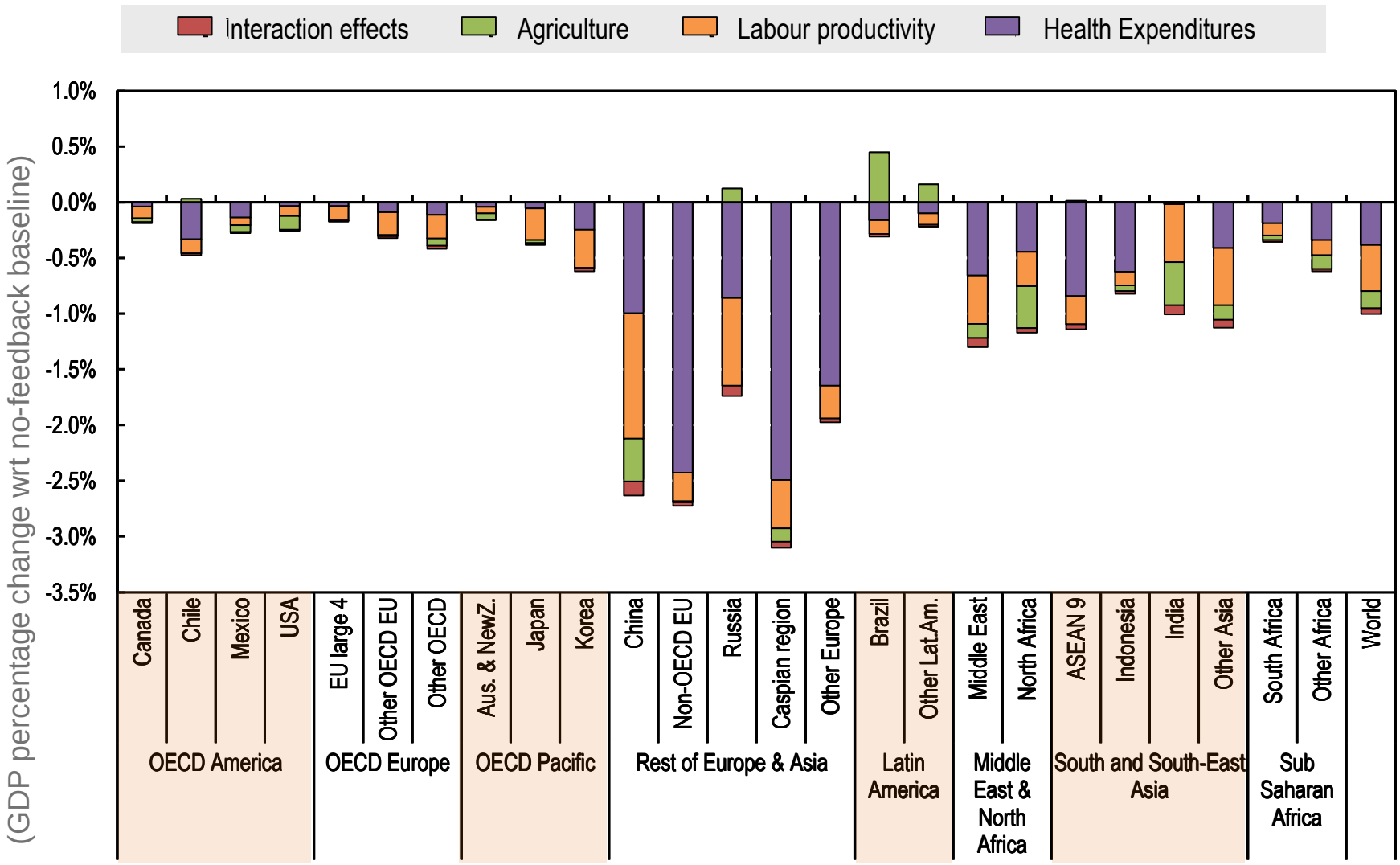
Market costs: direct and indirect costs



(GDP percentage change wrt no-feedback baseline)

Source: OECD (2016), The economic consequences of outdoor air pollution

Regional market costs



Source: OECD (2016), The economic consequences of outdoor air pollution

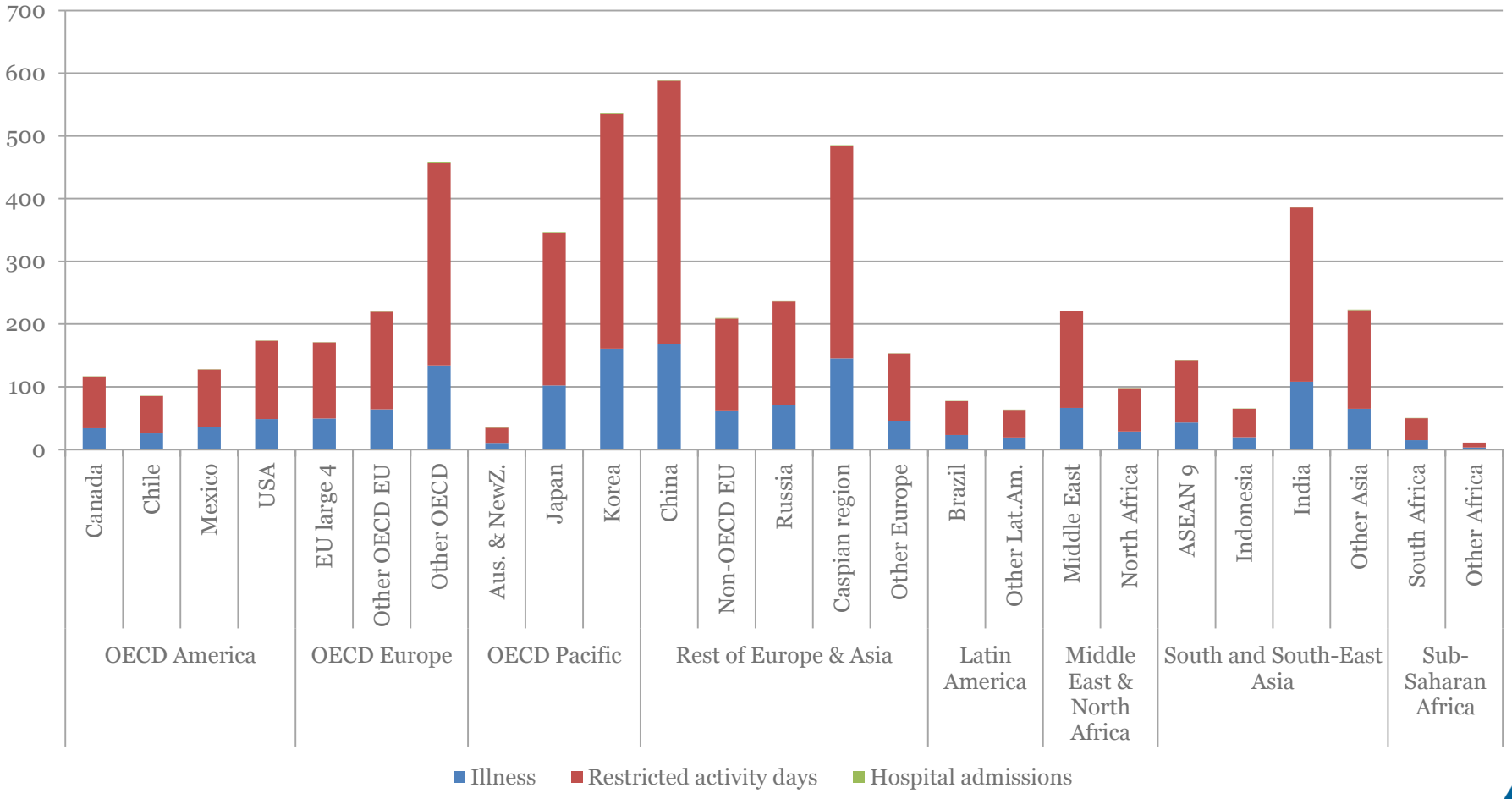
Non-market costs: mortality

	2015	2060
OECD America	440	1100 - 1140
OECD Europe	730	1660 - 1690
OECD Pacific	250	680 - 710
Rest of Europe & Asia	1130	7730 - 9850
Latin America	80	470
Middle East & North Africa	110	1030 - 1180
South and South-East Asia	380	5300 - 9950
Sub-Saharan Africa	40	330 - 340
World	**3160**	**18300 - 25330**
OECD	**1420**	**3440 - 3540**
Non-OECD	**1740**	**14860 - 21790**

(Billions of USD, 2010 PPP exchange rates)

Source: OECD (2016), The economic consequences of outdoor air pollution

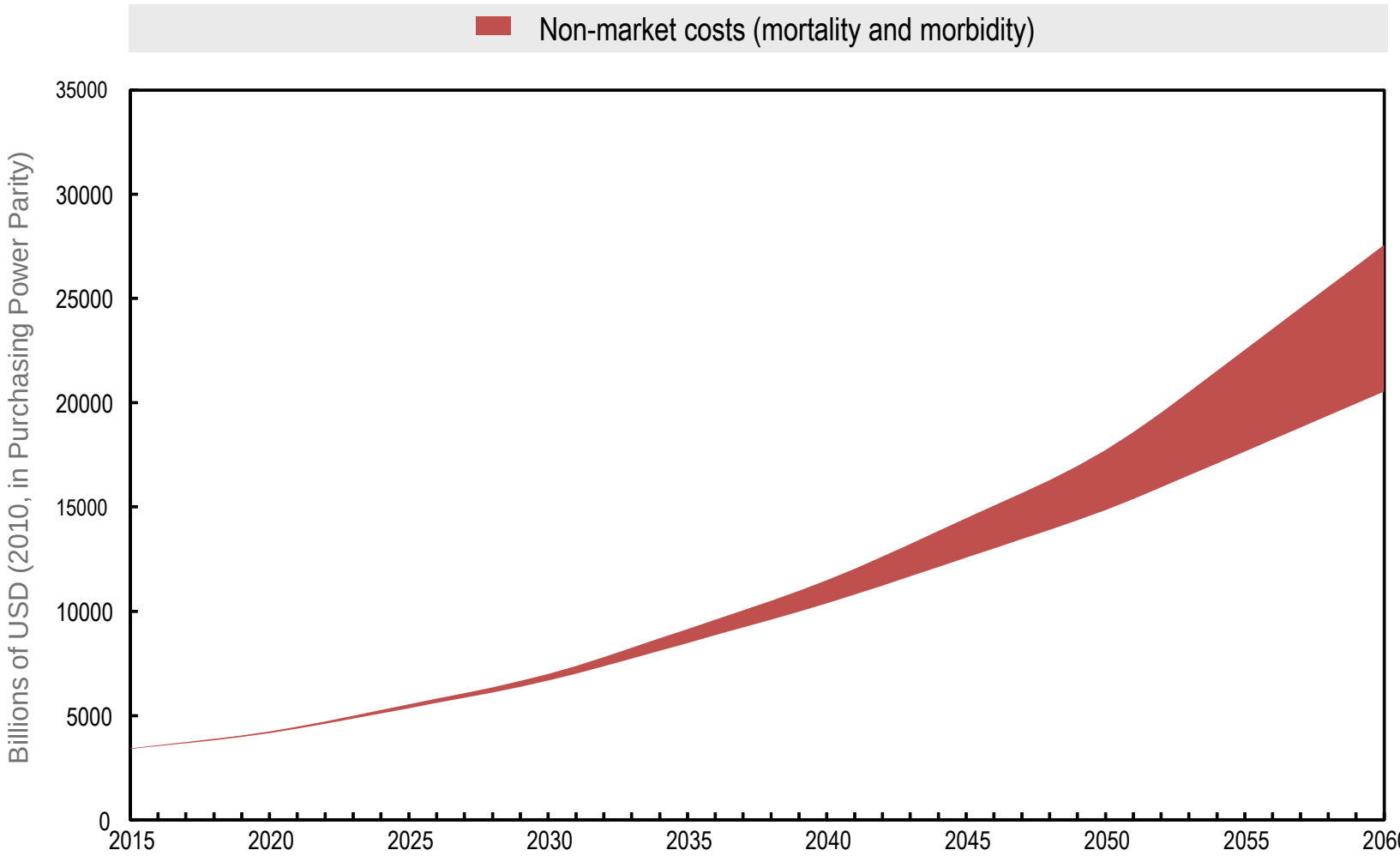
Non-market costs: morbidity



(USD per capita, 2010 PPP exchange rates, 2060)

Source: OECD (2016), The economic consequences of outdoor air pollution

Non-market costs



Mortality costs: USD 3 trillion in 2015 -> USD 18 – 25 trillion in 2060

Morbidity costs: USD 300 billion in 2015 -> USD 2 trillion in 2060

Source: OECD (2016), The economic consequences of outdoor air pollution

CONCLUSIONS

Conclusions (I)

- The potential market costs of outdoor air pollution could reach a yearly GDP loss of 1% by 2060
- Higher costs in China, Caspian region and South East Asia
- Most market costs are health related (health expenditures and labour productivity)
- Indirect economic consequences as induced by the market impacts play an important role, which dominates morbidity impacts in the long term

Conclusions (II)

- The potential economic consequences of both market and non-market impacts are very large
- Specifically this report finds:
  - number of premature deaths (6-9 million by 2060)
  - market costs (a yearly GDP loss of 1% by 2060)
  - welfare costs (USD 18-25 trillion by 2060 for mortality impacts)

- Combined, the magnitude of the problem implies a strong call for policy action

THANK YOU!

For more information:

www.oecd.org/environment/CIRCLE
www.oecd.org/environment/modelling

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