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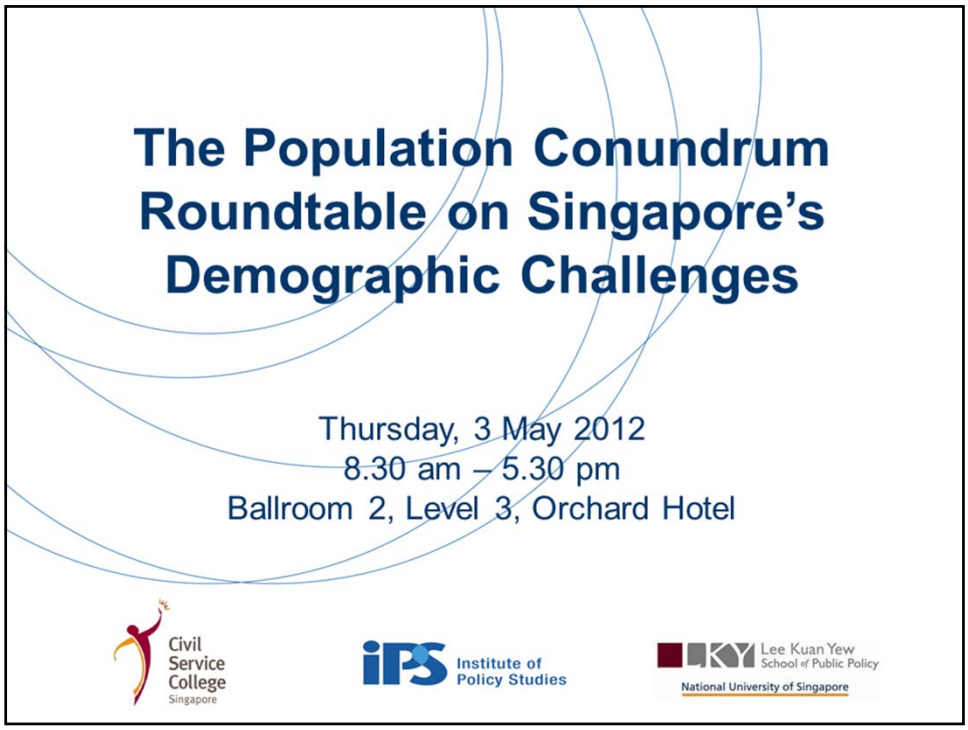


# Population and the Environment:
## Implications of Large Population on Singapore

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The Population Conundrum
Roundtable on Singapore's Demographic Challenges

03 May 2012
Ballroom 3, Orchard Hotel

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## Two Aspects

- Intuitive arguments
  - Benefits
  - Costs
- Empirical analysis
  - How population affects carbon dioxide emissions
  - To calculate the amount of investment in capital stock required to maintain per capita capital stock constant, aka Hartwick Rule
- On-going research
  - We develop a specific analytical framework and collect data

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## Benefits

- Rationale
  - Higher population brings more labor force
  - More labor force constitutes higher production capacity
  - Higher production capacity brings higher income and growth
- Two channels of accrued benefits
  - Higher income can pay for the past environmental degradation
  - Higher income demand for more higher quality of life, and hence better environment

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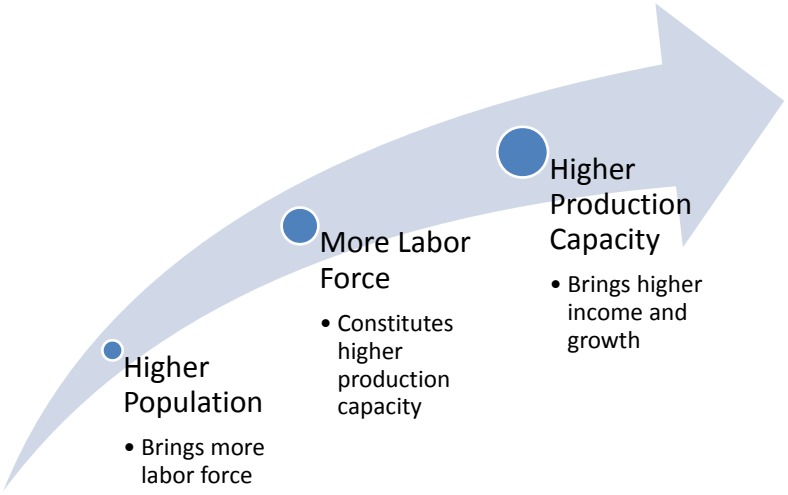
## Benefits of Higher Population

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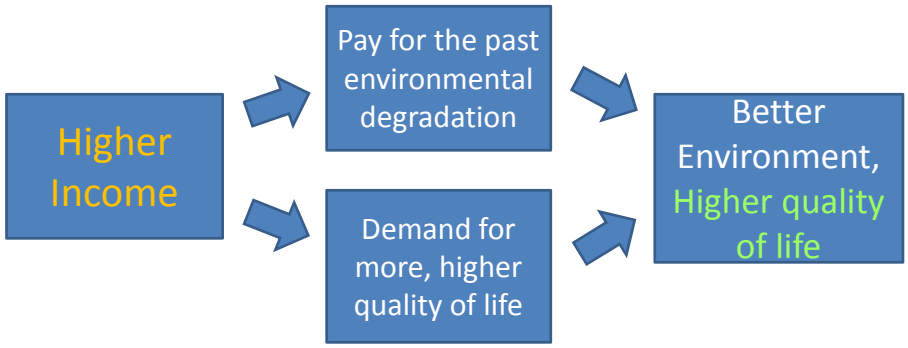
## Two Channels of Accrued benefits

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## Costs: Five Key Areas

- Congestion
  - Costs in utilizing resources including parks and recreation and open spaces; high density housing leads to more negative externalities ,e.g., noise, and congestion; traffic congestion concurrently more emissions, hence pollution
- Waste
  - More Waste Generation; higher subsidies needed for recycling; land pressure for landfills; aesthetics of land and scenic views affected by landfills, and incinerators. There will also be locational issues in siting economic infrastructures and facilities, thus raising the NIMBY Syndrome.
- Consumption per capita
  - Should increase and this in turn will increase demands for energy which in turn will increase costs of production for business, making Singapore less competitive. Costs of living will also increase for consumers, and this will make Singapore less attractive to both business, and migrants.

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## Costs: Five Key Areas (cont'd)

- Spending on public goods
  - will increase which in turn may increase society's tax burden as well as affect priorities in allocation of public budget to environment vs non-environment goods .
  - Depending on the present income levels, present economic status, priorities for more environmental goods may be reduced.
- Singapore's resilience to natural calamities such as flooding
  - Will also be stressed with a higher population , and simply because of high population living densities.

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## Quality of Physical Infrastructure

- Education facility
- Transportation
- The elderly facility
- More prisons (?)
- Waste incineration/disposal facility
- Water supply facility
- Energy supply facility
- Recreation facility
- Government facility

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## Population and the Environment: Empirical Analysis

- The impacts of population on $CO_2$ emissions
  - A few ASEAN and South Asian countries
  - OECD countries
  - Singapore study is on the way
- STIRPAT Model (Saluja and Chang, 2007)
  - Impact is a function of (Population; Affluence; Technology)
  - Population: Two sets
    - Total population
    - Working age (15-64)
      - The more in working age, the more energy consumption
  - Technology: energy intensity
    - The higher the energy intensity, the lower the technology
  - Affluence: GDP per capita

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## Results: Total Population

| Country | Constant | Population | GDP per capita | Energy Intensity |
|---|---|---|---|---|
| India | -0.71 | 4.29** | 0.44** | 0.12 |
| Pakistan | -0.67 | -2.50 | 0.79** | 0.02 |
| Philippines | -0.52 | 1.27* | 1.50*** | 1.14*** |
| Thailand | -0.85 | 5.97*** | 1.33** | 0.52* |
| Indonesia | -0.45 | 1.25 | 1.55*** | 0.20 |

- Overall population exerts a significant impact on $CO_2$ emissions

Notes: *** denotes significant at the 1% level, ** significant at the 5% level and * Significant at the 10% level

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## Results: Working Age (15-64)

| Country | Constant | Population | GDP per capita | Energy Intensity |
|---|---|---|---|---|
| India | -0.60 | 2.21 | 0.46 | 0.21 |
| Pakistan | -0.84 | 2.72 | 0.87** | -0.01 |
| Philippines | -0.52 | 2.46 | 1.48*** | 1.14*** |
| Thailand | -0.86 | 6.37 | 1.20** | 0.52 |
| Indonesia | -0.39 | -3.25 | 1.75*** | 0.24 |
| China | -0.43 | 1.17 | 1.55*** | 1.47*** |

- Working age population appears to have an insignificant impact on $CO_2$ emissions.

Notes: *** denotes significant at the 1% level, ** significant at the 5% level and * Significant at the 10% level

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## Population Aging and Carbon Emissions in OECD Countries (Menz and Welsh, 2012)

- Carbon Emissions per Capita is a function of
  - GDP; Population; Age Composition; Cohort Composition; Urbanization Rate; Share of Coal in Electricity Generation
  - Age Composition is further grouped by
    - Less than 15; 15-29; 30-44; 45-59; 60-74; 75 and above
  - Cohort Composition is further grouped by
    - Born 1920 and before; 1921-40; 1941-1960; after 1960
- Key Results
  - Age group (45-59) has a significant negative impact on carbon dioxide emissions
  - People aged 60-74 represent the most carbon-intensive age group
  - People born after 1960 are relatively emission-intensive

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## Results: Basic Specifications

| | No Age Effects | Age Effects | Age (30 – 59) |
|---|---|---|---|
| $CO_2$(1-) | 0.64*** | 0.68*** | 0.65*** |
| Population | 0.68*** | 0.68*** | 0.78*** |
| Per capita Income | 0.30*** | 0.34*** | 0.36*** |
| Urbanization | 0.33*** | 0.30*** | 0.31*** |
| Coal share | 0.002*** | 0.002*** | 0.002*** |
| Age < 15 | | - | - |
| 15 – 29 | | 0.26 | - |
| 30 – 44 | | -1.10 | -1.17** |
| 45 – 59 | | -1.44* | -1.77*** |
| 60 – 74 | | -0.88 | - |
| Age > 75 | | -0.10 | - |

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## Year-of-Birth Effects

| | Cohort Effects | Age and Cohorts | Age/Key Cohorts |
|---|---|---|---|
| $CO_2$(1-) | 0.70*** | 0.68*** | 0.68*** |
| Population | 0.57*** | 0.77*** | 0.75*** |
| Per capita Income | 0.31*** | 0.32*** | 0.34*** |
| Urbanization | 0.27*** | 0.28** | 0.27*** |
| Coal share | 0.002*** | 0.001*** | 0.001*** |
| Age < 15 | - | - | - |
| 15 – 29 | - | 1.53** | 0.72 |
| 30 – 44 | - | 1.37 | - |
| 45 – 59 | - | 1.89 | - |
| 60 – 74 | - | 3.00* | 1.80* |
| Age > 75 | - | 3.94* | - |
| Born 1920 and before | -2.18*** | -5.06*** | -3.31*** |
| 1921 – 1940 | -0.32 | -1.07 | - |
| 1941 – 1960 | -1.52*** | -2.71*** | -2.14*** |
| After 1960 | - | - | - |

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## Population and Sustainable Development

- Constant consumption over time is considered at least weakly sustainable
  - No population growth and technological improvement are assumed
- With positive population growth and technological progress
  - The amount of savings required for the constant consumption over time could be less than the amount of savings needed under the case of no population growth and technological progress
- The surplus can be invested in ecological services
  - It can enhance environmental quality.

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## Going Forward and Key Questions

- What is the optimal population size for Singapore
  - Cost-benefit analyses
  - Economic analyses of population dynamics
    - A driver for economic growth and well-being
    - A liability for the environment
- How to achieve the optimum population size is another research question
  - TFR
  - Migration

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## Thoughts on Optimum Population

- Demographical or Population projections (under various scenarios) are not determining Optimum Population.
- Conceptual definition of optimum population
  - MC=MB of population size
  - This is dependent on a number of factors affecting costs and benefits of increasing population size
- There is no one magic number and where one sees a study purporting to be an optimum population
  - It is most likely to have derived that number from one single criteria, e.g., the largest per capita output

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## Thoughts on Optimum Population (cont'd)

- Whatever the population size, it will affect our quality of life
  - Space and hence degree of congestion, and externalities
  - Enjoyment of available environmental resources
  - Competition for jobs, income and employment
  - Innovative capacity
  - Speed of decision-making and implementation of policies
  - Share of burden in providing financial support for health, education, social safety net, etc.

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## Thoughts on Optimum Population (cont'd)

- Increased research and study is required
- Getting empirical data is essential to even begin to talk about various population sizes or population growth
- It is the costs and benefits of increased population growth that is crucial to determining the optimum population size

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