Projection of World Socio-economic and Industrial Activities for AIM/Enduse[Global]

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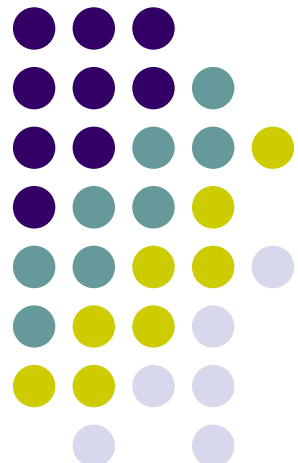
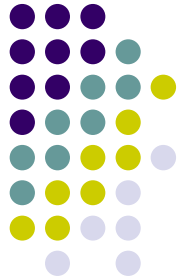
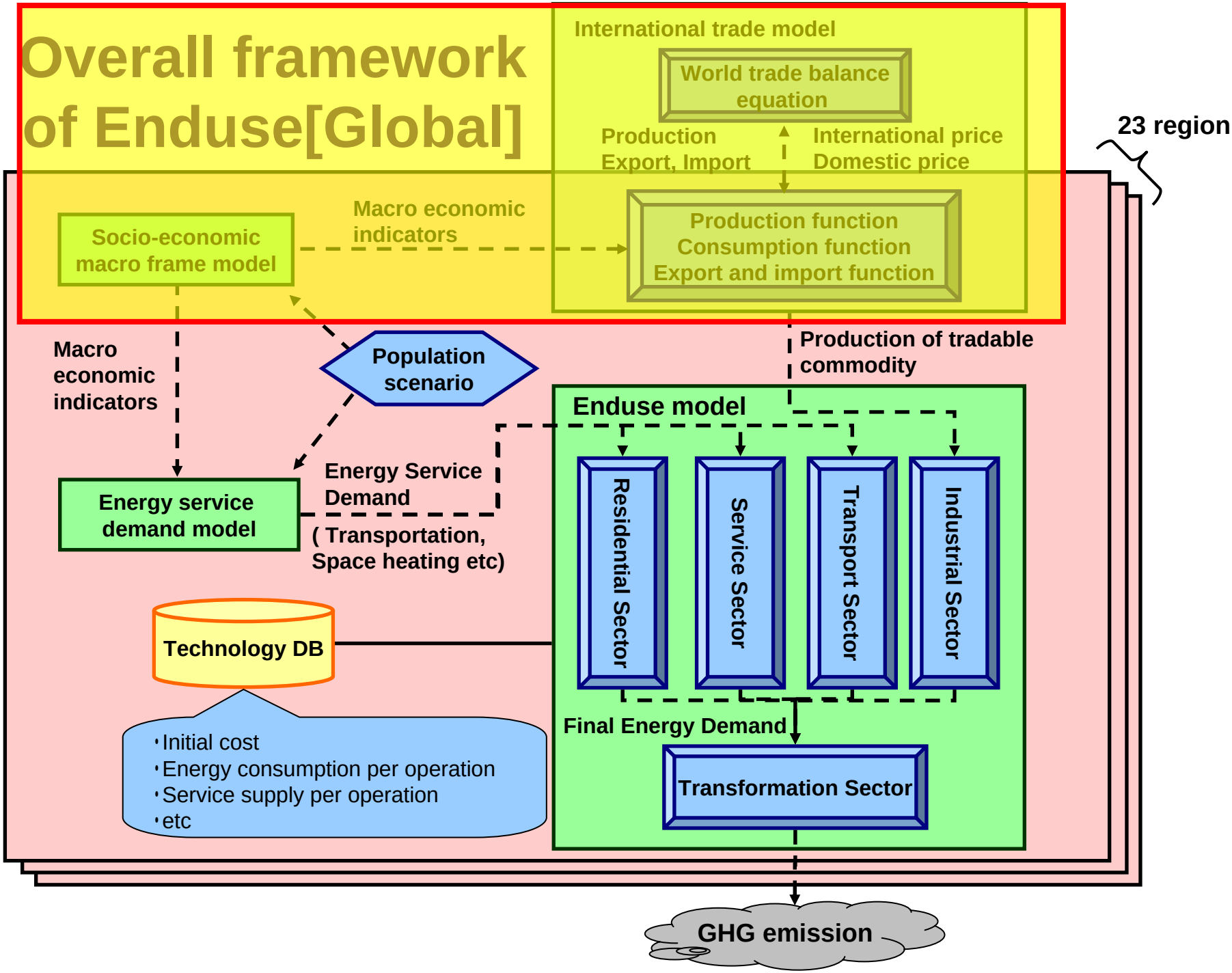


Outline of AIM Enduse[Global]

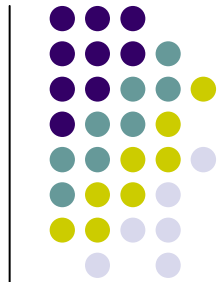


- Expansion of Enduse[Country] to cover world
- Target regions: 23 world regions

  (Japan, China, India, Indonesia, Korea, Thailand, Other South-east Asia, Other South Asia, Middle East, Australia, New Zealand, Canada, USA, EU-15 in Western Europe, EU-10 in Eastern Europe, Russia, Argentine, Brazil, Mexico, Other Latin America, South Africa, Other Africa, Rest of World)
- Time horizon: mid-long term (～2030, ～2050)
- Bottom-up type model
- Simulate GHG emissions under given energy service demand such as production of steel, transport volume, space heating, etc.

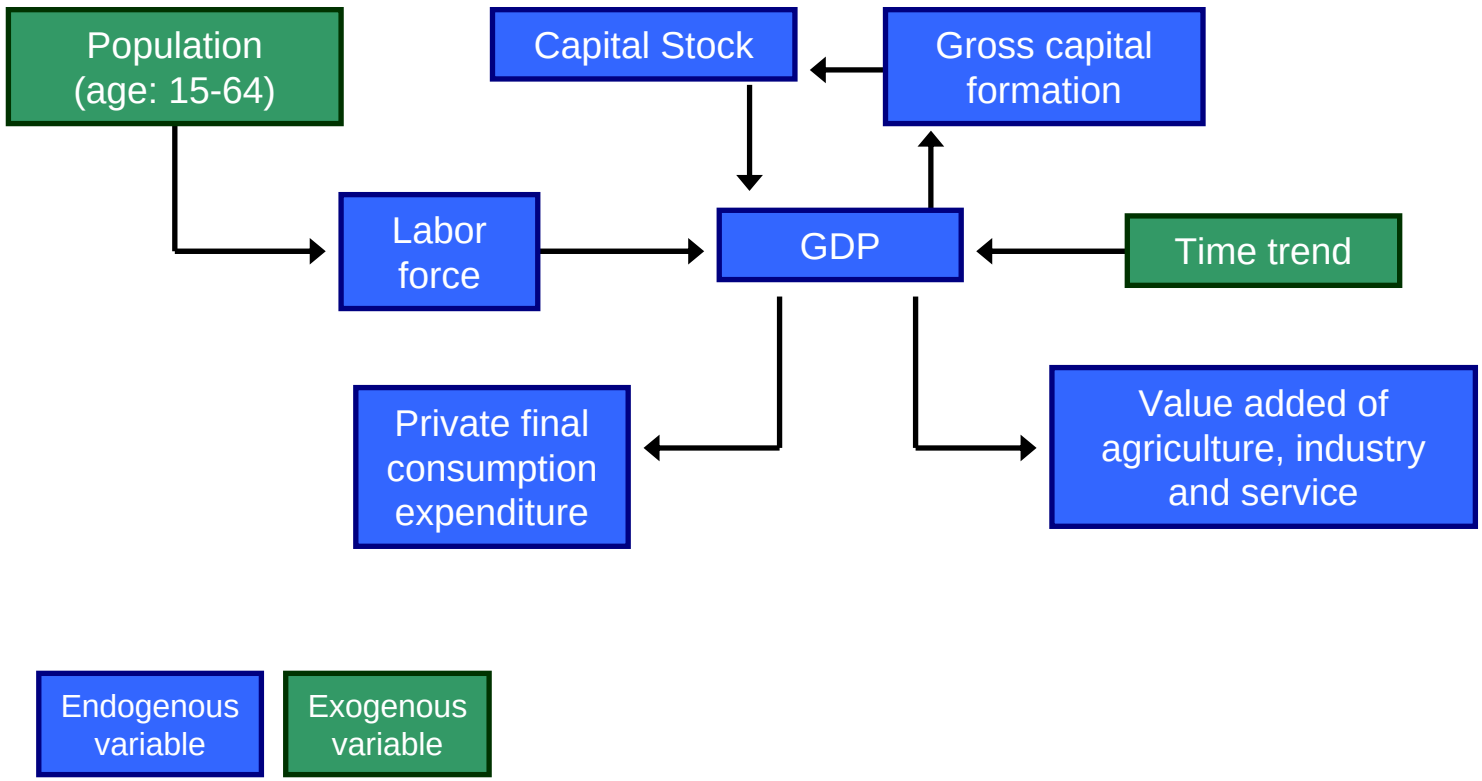

Overall framework of Enduse[Global]
International trade model
World trade balance equation
Production
Export, Import
International price
Domestic price
23 region
Socio-economic macro frame model
Macro economic indicators
Production function
Consumption function
Export and import function
Macro economic indicators
Population scenario
Production of tradable commodity
Enduse model
Energy service demand model
Energy Service Demand
(Transportation, Space heating etc)
Residential Sector
Service Sector
Transport Sector
Industrial Sector
Technology DB
Initial cost
Energy consumption per operation
Service supply per operation
etc
Final Energy Demand
Transformation Sector
GHG emission

Outline of socio-economic macro frame model



- Macroeconomic model which estimates macro economic indicators such as GDP, final consumption expenditure, capital formation, value added of 3 sectors
- Supply-side model (GDP is estimated from capital stock and labor force)
- Input is population
- 27 equations for each region
- Parameters are estimated by econometric approach (historical data is used to estimate parameters)

Structure of socio-economic macro frame model



Model performance test

- Dynamic simulation (1960 – 2005)
- Comparing simulated value with reported value
- Mean Absolute Percentage Error (MAPE*) are used as index

Mean Absolute Percentage Error (MAPE)

	GDP	Value added of agriculture	Value added of industry	Value added of service
Japan	1.2	6.9	3.6	1.9
China	3.5	6.5	7.1	8.4
India	4.1	6.1	6.2	6.2
Indonesia	2.1	4.5	5.9	4.0
Korea	4.3	5.8	4.6	6.9
Thailand	1.9	8.8	3.0	2.4
Other South-east Asia	4.1	5.0	4.7	5.2
Other South Asia	2.1	3.1	3.1	3.0
Middle East	4.6	14.9	9.7	8.9
Australia	1.8	17.8	5.1	3.6
New Zealand	1.5	10.2	3.9	3.0
Canada	3.5	6.9	6.3	2.5

	GDP	Value added of agriculture	Value added of industry	Value added of service
USA	1.7	6.5	2.6	1.6
EU-15 in Western Europe	1.8	3.0	2.1	1.9
EU-10 in Eastern Europe	3.4	7.6	4.4	4.3
Russia	7.7	6.3	8.2	9.6
Argentine	3.9	13.4	7.1	7.8
Brazil	2.2	10.2	9.5	9.5
Mexico	2.4	9.2	4.3	3.0
Other Latin America	3.0	5.9	5.0	4.2
South Africa	3.1	7.7	3.2	4.6
Other Africa	5.2	9.0	7.1	5.4
Rest of World	2.6	9.8	4.6	5.3

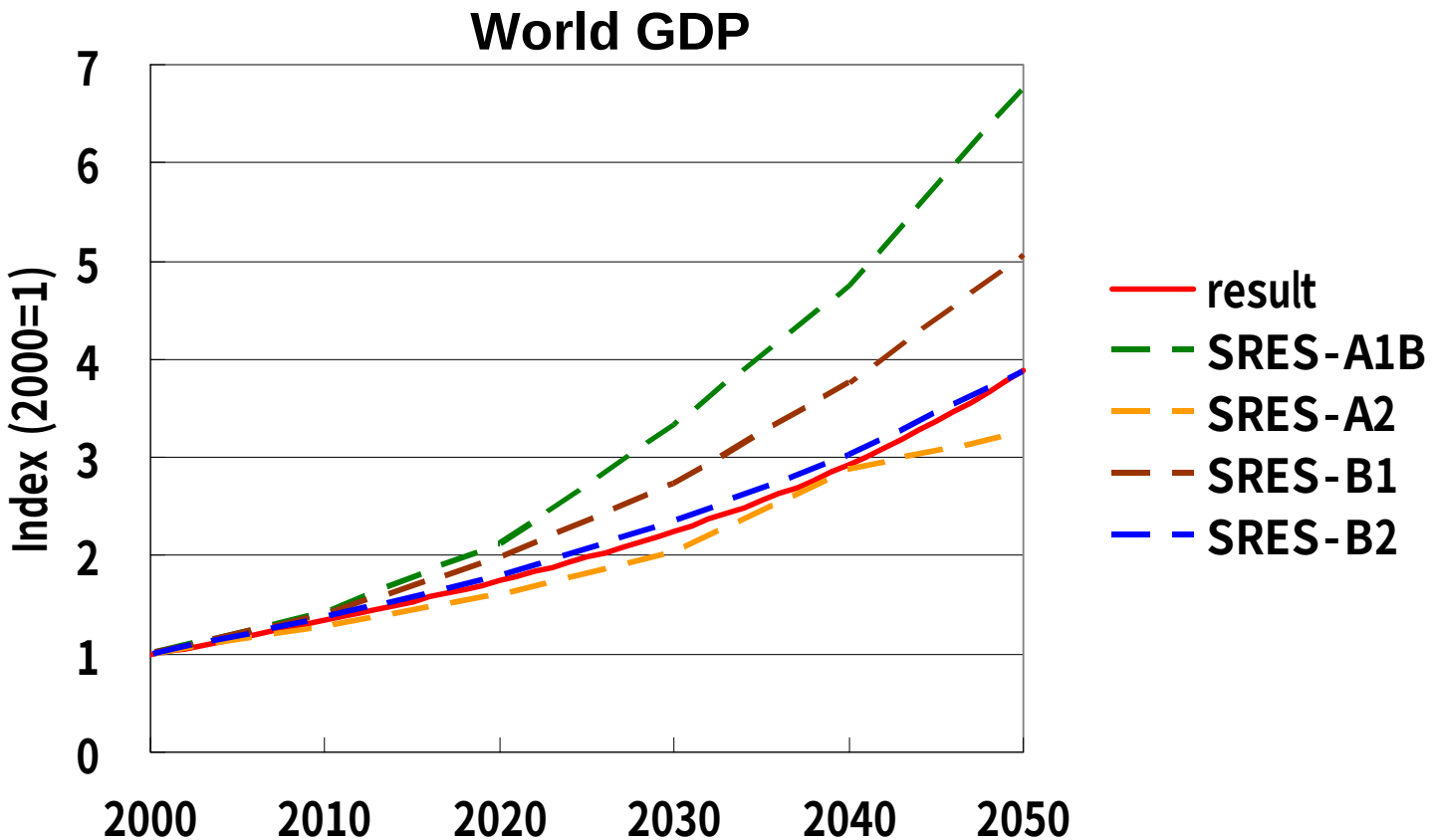
(%)

$$\text{MAPE} = \frac{\sum_t |Ye_t - Yr_t|}{\sum_t Yr_t}$$

Ye: estimated value, *Yr*: reported value

Simulation result (1)

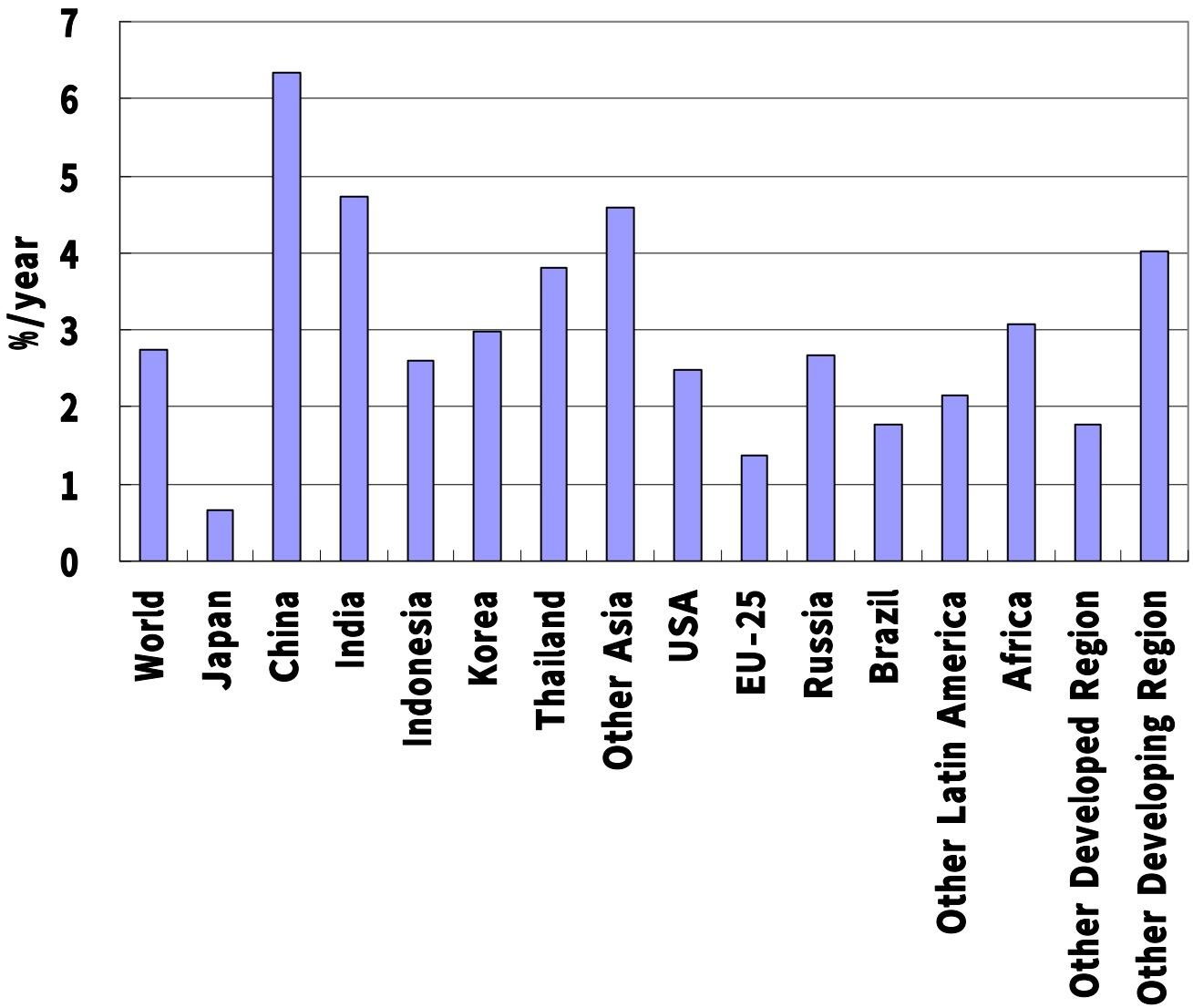
- Simulation 2000 - 2050
- Medium population of World population prospects (UN, 2006) are used as population scenario



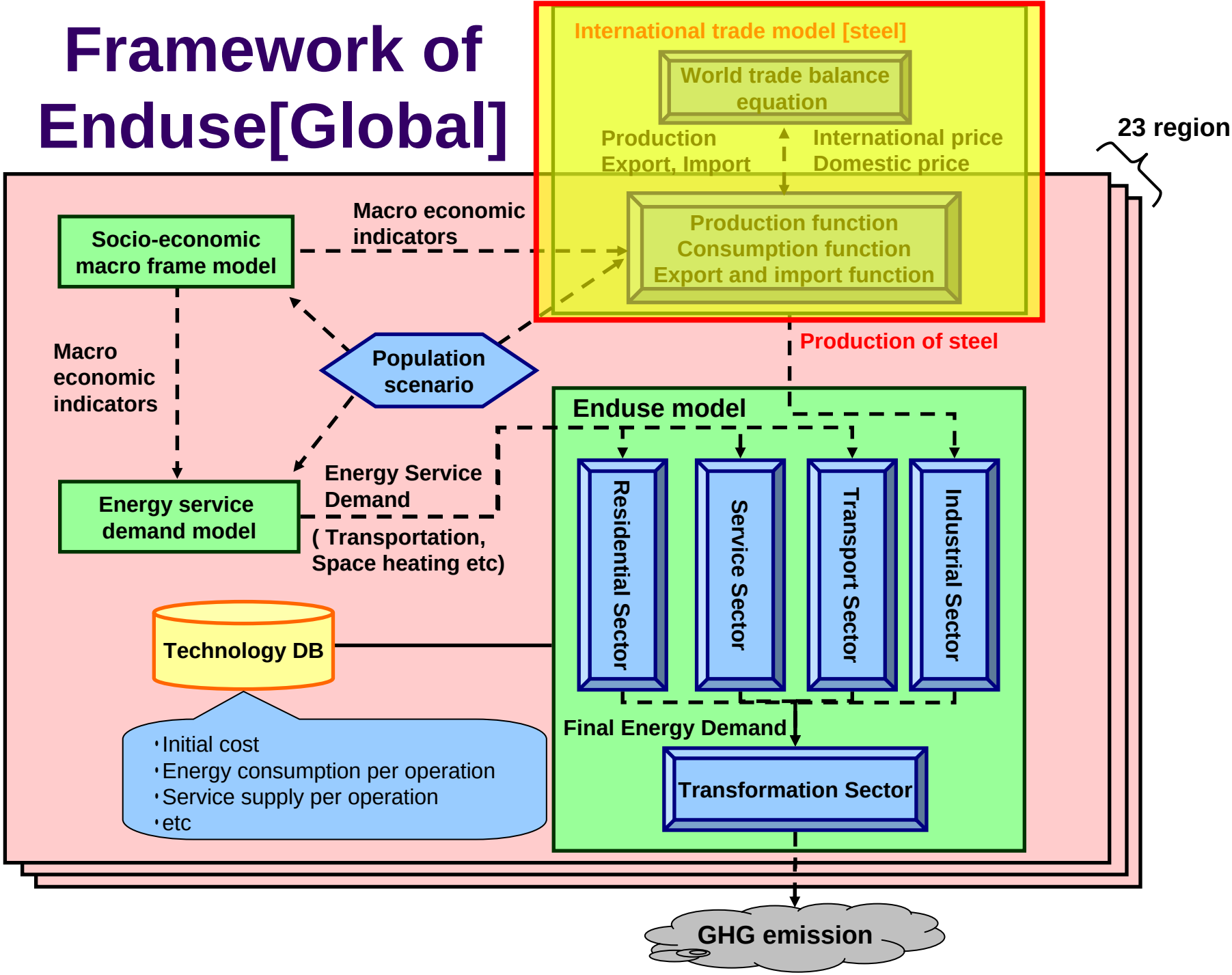
- Annual GDP growth rate of the world is projected to be 2.8%/year during 2000 - 2050
- It's very similar to B2 of SRES scenario

Simulation result (2)

Annual GDP growth rate (2000-2050) of regions



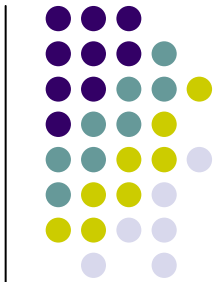
Framework of Enduse[Global]



Why international trade model [steel] is needed ?

- Steel is internationally traded
  (Amount of Internationally traded steel is 32 % of world steel production in 2005)
- Production of steel in each region depends not only consumption but also export and import
  (Production = Consumption + export - import)
- Export and import of steel are needed to be modeled to project future steel production

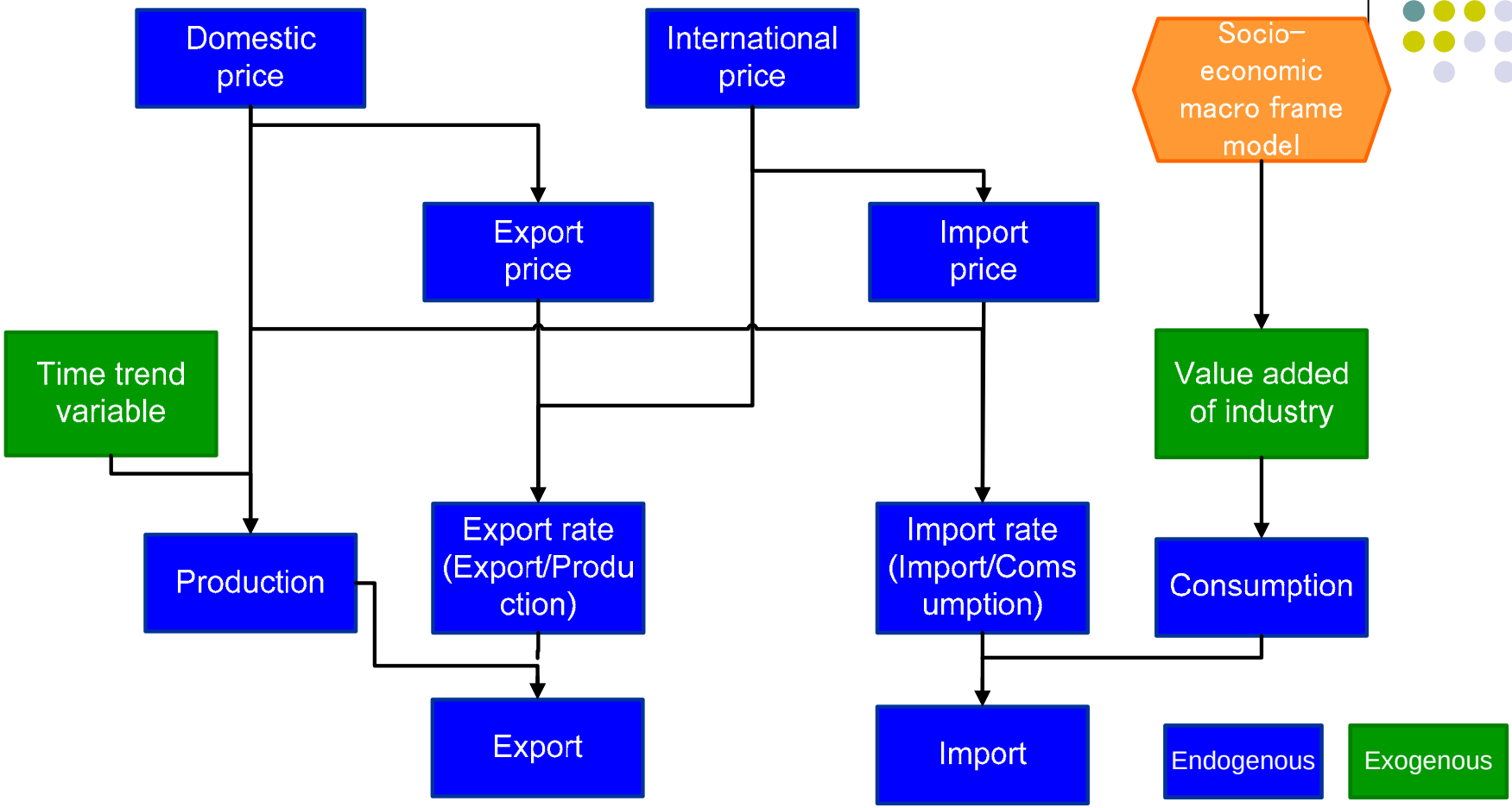
Outline of international trade model



- Partial equilibrium model
- Domestic market and international market reach equilibrium with steel price as intervening parameter
- Input is value added of industry of 23 regions
- Main outputs are production, consumption, export and import of steel for 23 regions
- 323 equations
- Parameters are estimated by econometric approach

(historical data is used to estimate parameters)

Structure of int. trade model



Domestic market equilibrium: $\text{Consumption}_i = \text{Production}_i - \text{Export}_i + \text{Import}_i$

World market equilibrium: $\sum_i \text{Export}_i = \sum_i \text{Import}_i$ i: region

Model performance test

- Dynamic simulation (1993 – 2005)
- Comparing simulated value with reported value
- Mean Absolute Percentage Error (MAPE) are used as indicator

	Production
World	3.9
Japan	2.7
China	11.4
India	3.2
Indonesia	22.8
Korea	2.9
Thailand	9.0
Other South-east Asia	9.1
Other South Asia	5.9
Middle East	3.4
Australia	9.9
New Zealand	5.7

	Production
Canada	3.2
USA	4.2
EU-15 in Western Europe	2.3
EU-10 in Eastern Europe	6.5
Russia	3.4
Argentine	5.6
Brazil	4.9
Mexico	6.9
Other Latin America	4.3
South Africa	3.7
Other Africa	9.2
Rest of World	2.5

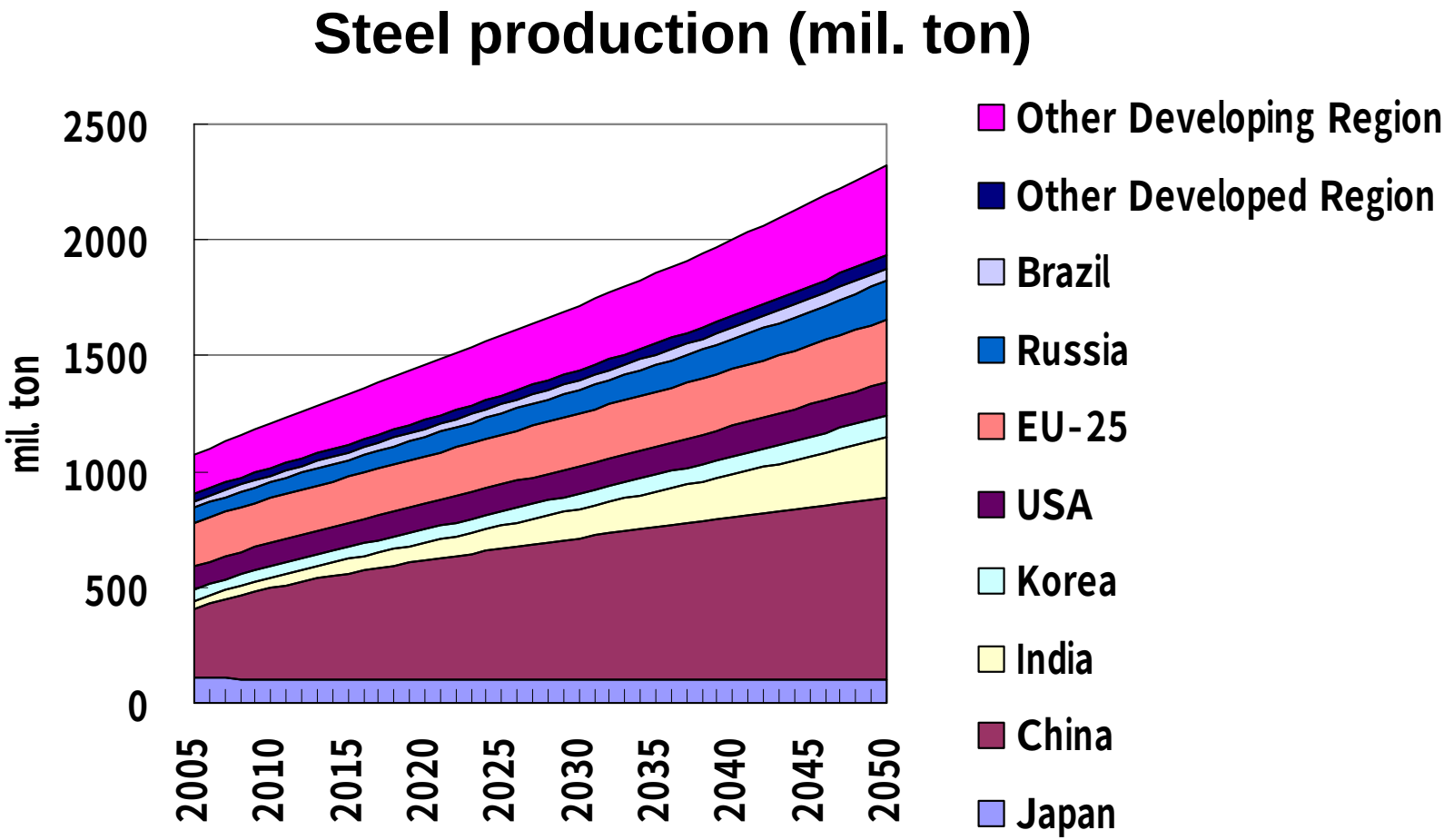
(%)

$$\text{MAPE} = \frac{\sum_t |Ye_t - Yr_t|}{\sum_t Yr_t}$$

Ye: estimated value , *Yr*: reported value

Simulation result

- Simulation from 2005 to 2050



Remaining Task

- Comparing simulated result of GDP and steel production with other research
- Development of other industries model

  (Cement, Paper and pulp, Petrochemical industry)
- Run Enduse[global] model using those result as input