Development of Iron Stock & Flow Model in Japan and China

Reina Kawase
Kyoto University

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Background & Contents

It is important issue to grasp the relationship between socioeconomic activities and material use.

But we don't know the whole material flow due to a lack of data: physical and monetary data.

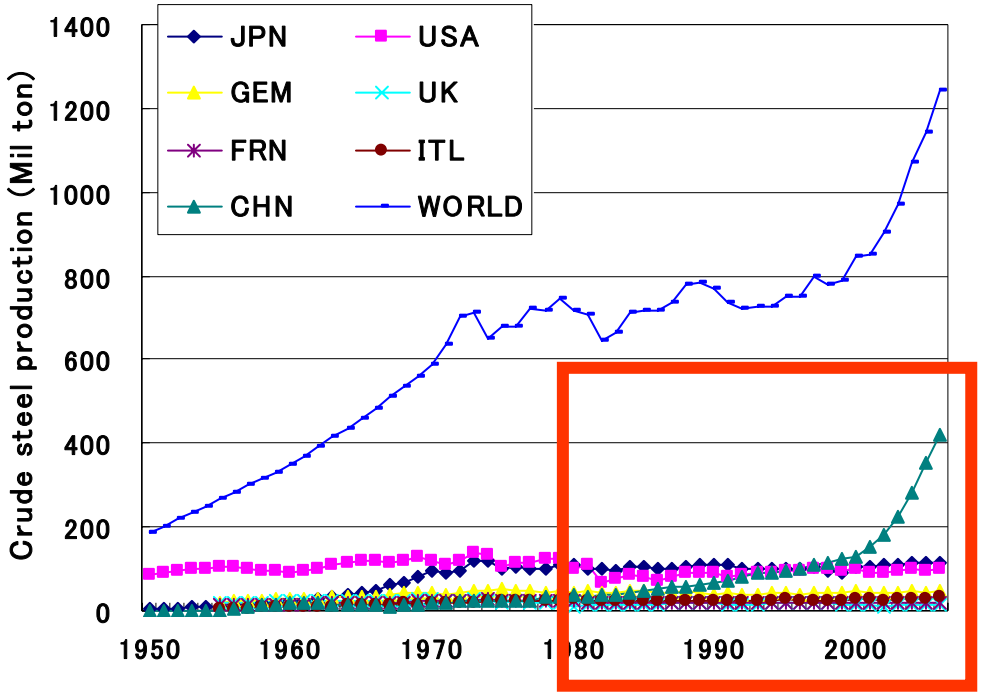
Especially, STEEL is energy intensive raw materials, so its use in the future is the focus of attention as not only Material Use but also Energy Consumption.

1. Background
2. Outline of Material Stock and Flow Model

   Data, Structure, Formulation, Evaluation
3. Results in Japan and China

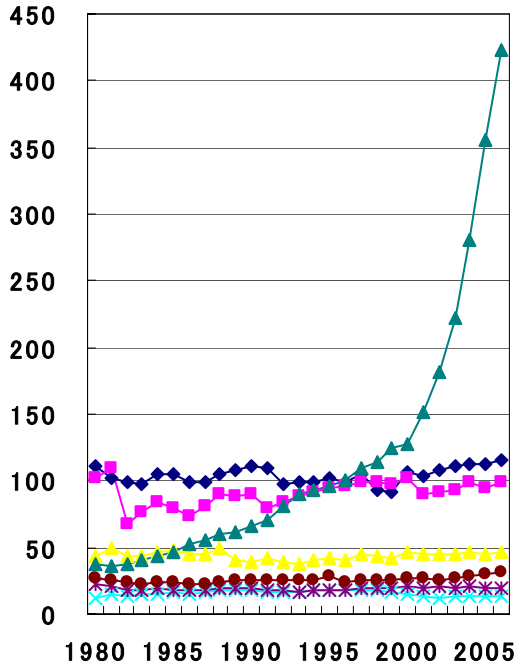
   Scrap generation and Stock by goods
4. Estimation Steel Investment under the saturation of Steel Stock per Capita
5. Future Task

China's steel sector in the world



China: 34% of world steel production

1996-2006 => 4 times



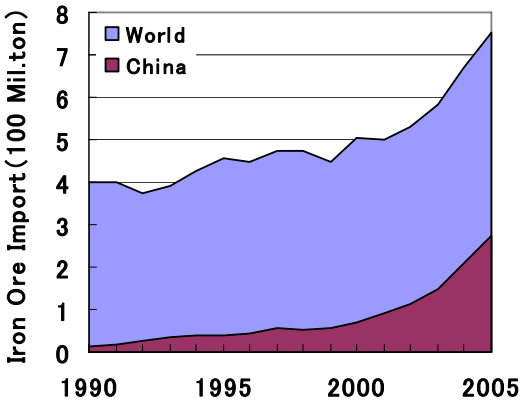


Table. Crude Steel Production

Rnak	Country	Mil ton
1	China	422.7
2	Japan	116.2
3	U.S.A	98.6
4	Russia	70.8

Outline of Developing MSFM

Objective

Estimate 1) Iron and Steel Stock and Flow in the society
2) Flow&Stock which cannot be obtained from statistics
→ Stock, Scrap

Country

Japan, China

Econometric Method

Input-Output function of production sectors

Demand function of final demand goods

Goods balance, Material balance, Stock

1. **Preparing data** over the past several dacades
2. Constructing theoretical models (**Formulation**)
3. Estimating parameters by **regression analysis**
4. **Evaluating** the performance of the models

Data

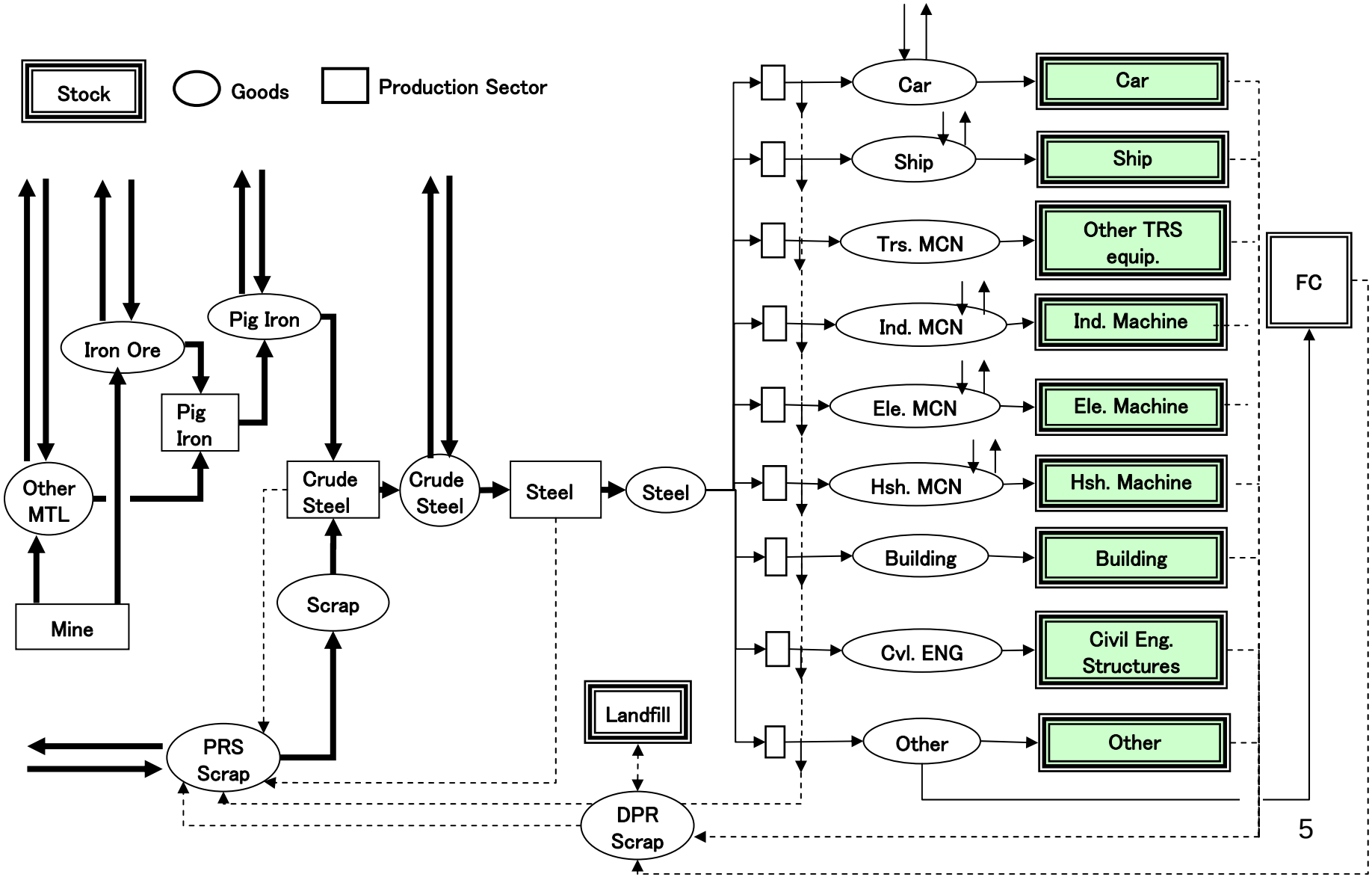
Physical data

Steel Statistic Yearbook, International Historical Statistics, *etc.*

Socioeconomic data

Summary of Japanese long-term statistics, ECONOMATE, I-O table, *etc.*

2.Iron and Steel Flow and Stock



2.Formulation

Production sector

$$X_j^{prd} = \sum_i a_i^j \cdot X_{i,j}^{csm} - SCR_j^{prd}$$

Goods balance

$$X_i^{prd} + X_i^{imp} = X_i^{exp} + X_i^{csm} + X_i^{inv}$$

$$\sum_j SCR_j^{prd} + \sum_i SCR_i^{dpr} + SCR^{imp} = SCR^{csm} + SCR^{exp} + SCR^{ldf}$$

Stock

$$STK_{if,t} = (1 - dpr_{if})STK_{if,t-1} + X_{if}^{inv}$$

Home scrap

$$SCR_{"CRD"}^{prd} = a_1 \cdot CR^2 + a_2 \cdot CR + C$$

Steel input to goods

$$X_i^{prd} = \sum_k d_k \cdot XDF_{i,k}$$

Table: Driving force of steel consumption

Goods	Driving Force	units
Car	Car production	units
Ship	Ship production	G.T.
Train	Train production	units
Machine	Output of Machines	Mil. yuan
Cvl Eng Structures	Railway rail length	km
Building	Floor area	m2
Other	Output of Metal products	Mil. Yuan

Regression Analysis

term

Japan: 1970–2002

China: 1985–2005

method

OLS / AR1

3.Estimation of parameters: regression analysis

Steel input to Building

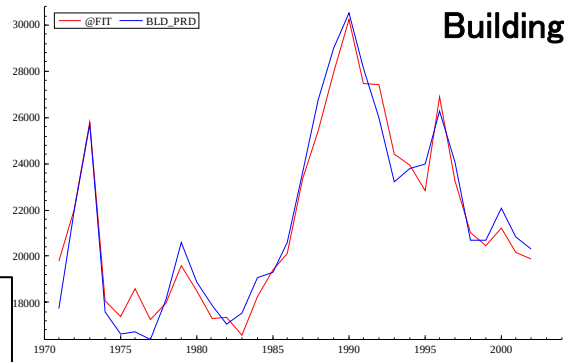
$$= 1185 + 0.094 * Floor$$
$$+0.95 * (Floor(-1) - 1185 - 0.094 * Floor)$$

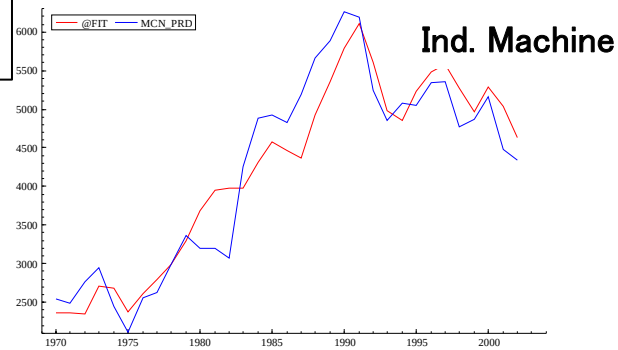
Steel input to Ind. Machine

$$= 600 + 0.16 * Mcn$$

Steel input per Floor area

→Report : 0.089 [ton/m^2]





Pig iron production

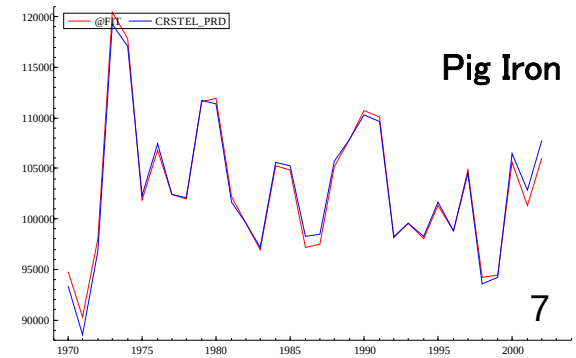
$$= -633 + 0.58 * Ironore + 0.85 * Pellet$$

Estimation

Statistics

Crude steel production

$$= -1644 + 0.90 * Pigiron + 0.81 * Scrap$$



Balance or Iron ore

$$Ironore_{imp} + 0.9648 * Ironore_{prd}$$
$$= 6.4 + 0 * Ironore_{exp} + 0.9997 * Ironore_{csm}$$

4.Evaluation of Model Performance

Evaluation

Each equation by regression analysis : t value, R2 value, Darbin-Watson ratio

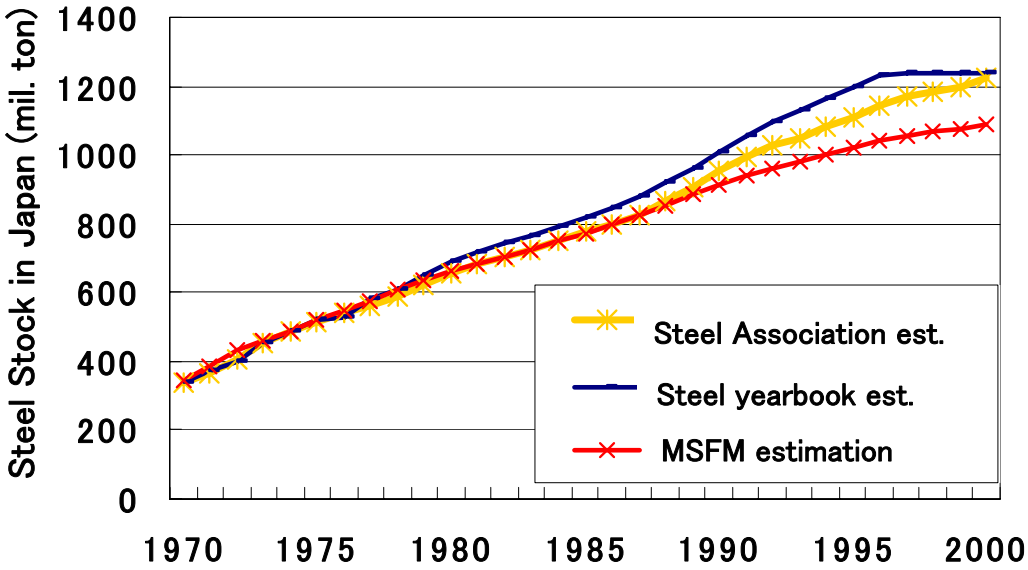
Model performance by Partial test(PT) & Final test(FT) : Mean Absolute Percentage Error

Table :Index of Model Evaluation

Variables	PT	FT	R2 Value	DW Ratio
Car production	3.31	3.31	0.96	1.23
Ship production	9.09	9.09	0.88	1.03
Floor area	2.96	8.22	0.95	1.20
Cvl Eng Structures	4.80	7.13	0.69	1.34
Ind. Machines	7.91	7.91	0.89	0.71
Ele. Machines	8.39	8.39	0.53	0.64
Hsh. Machines	19.28	19.28	0.56	0.47
Steel balance	0.00	3.48	1.00	2.84
Crude steel consumption	3.62	5.67	0.83	1.41
Crude steel balance	0.00	4.23	1.00	2.26
Pig iron consumption	0.79	4.49	0.99	0.35
Iron ore consumption	0.62	5.63	0.99	1.40
Iron ore import	0.02	5.64	1.00	1.13
Pellet balance	0.00	28.90	1.00	1.49
Home scrap generation	0.94	4.46	0.97	1.14

$$\text{MAPE} = \frac{\left|\sum_t \left(Xe_t - X_t\right)\right|}{\sum_t X_t} * 100 \ (\%)$$

4. Comparison with other researches

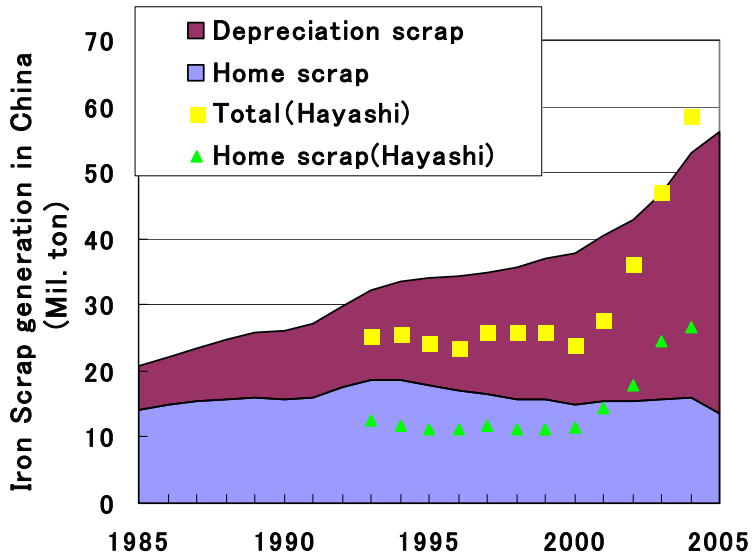


2000

Steel Assoc. : 1.22 bil. ton

Steel yearbook : 1.24 bil. ton

MSFM estimation: 1.10 bil. ton



2004

Home scr. : 26.5 Mil. ton

Dpr. scr. : 32.0 Mil. ton

MSFM Home scr. : 13.6 Mil. ton

MSFM estimation : 36.9 Mil. ton

Iron scrap supply and demand (China)

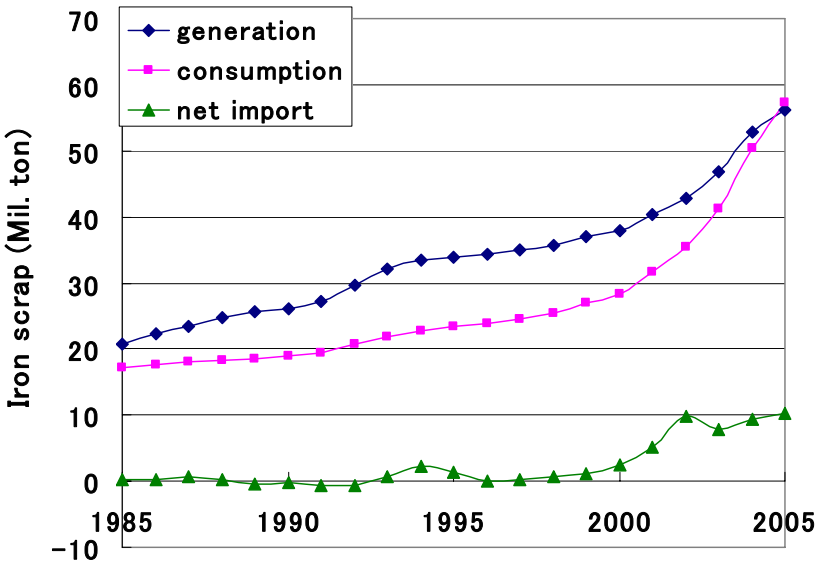


Fig. SD balance of Iron scrap

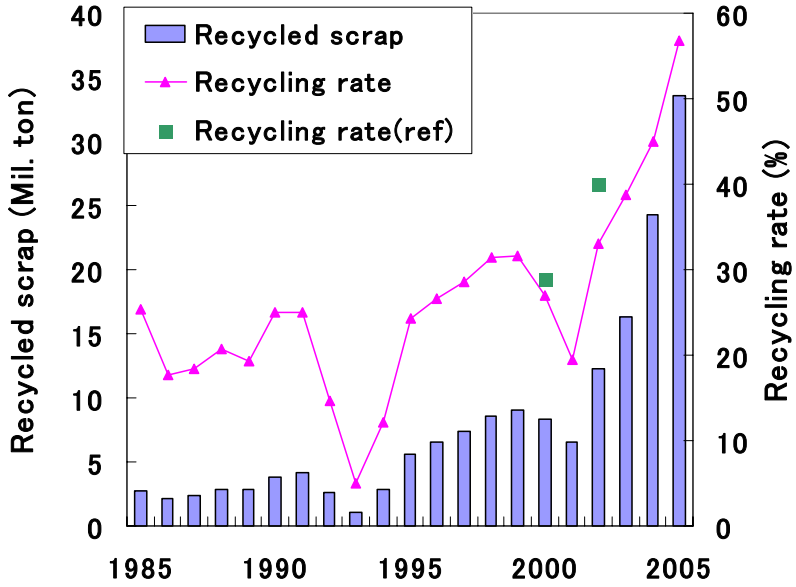


Fig. Iron scrap recycling

Up to 2004, the supply and demand of iron scrap was balances.

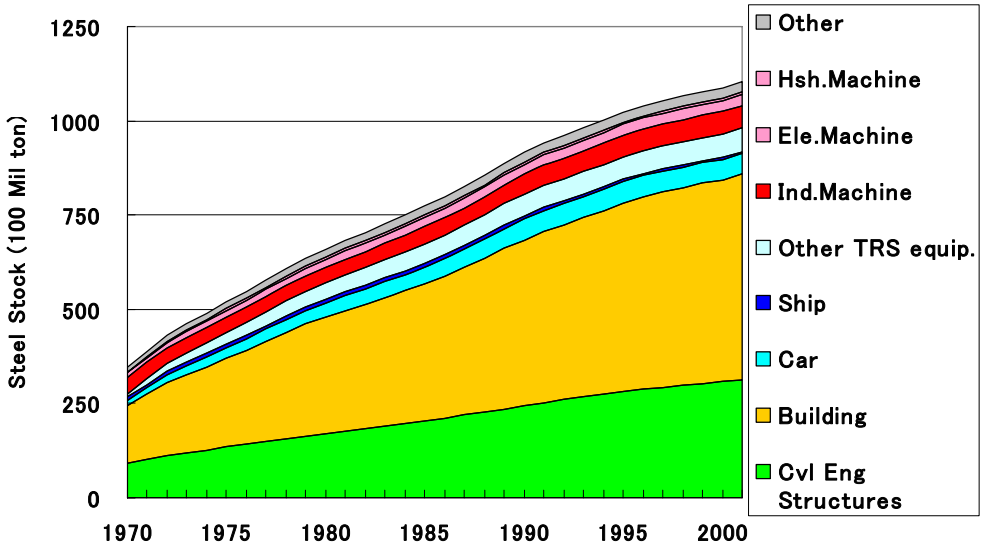
→ Recycling rate was not 100% = > Shortfall were met with Imports.

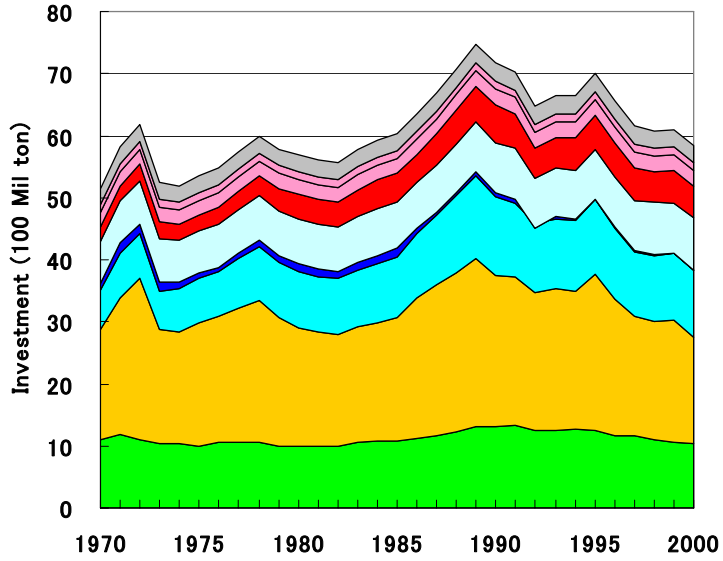
Recycled depreciation scrap = Consumption − Net Import − Home scrap

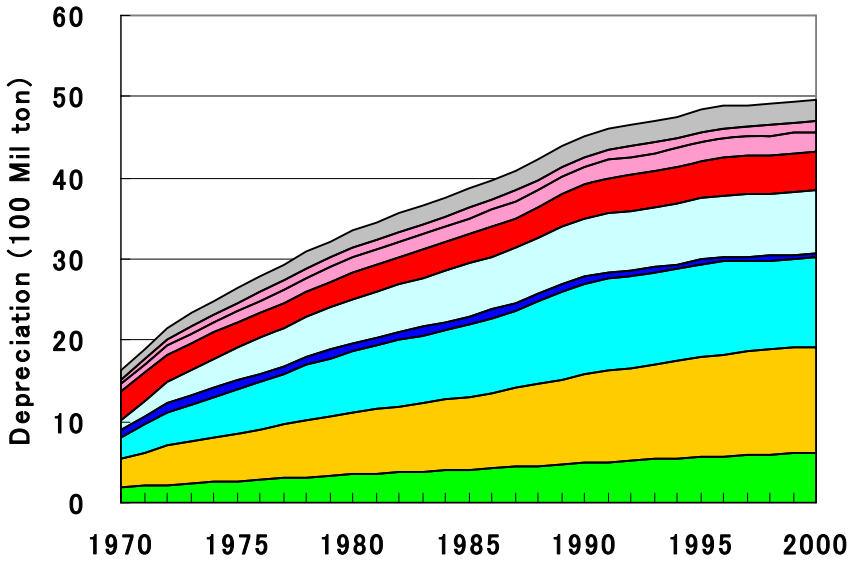
→ The recycling rate of depreciation scrap is increasing, reaching 57% in 2005

(Including Home scrap; 65 %)

Steel Stock and Investment in Japan







Cvl.Eng. Str. : 28.2 %

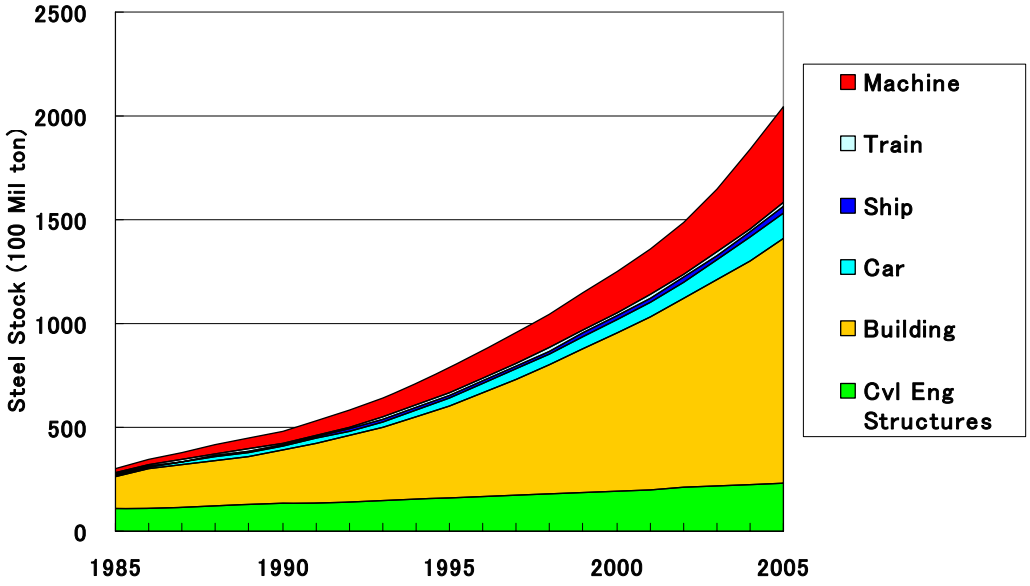
Building: 49.7%

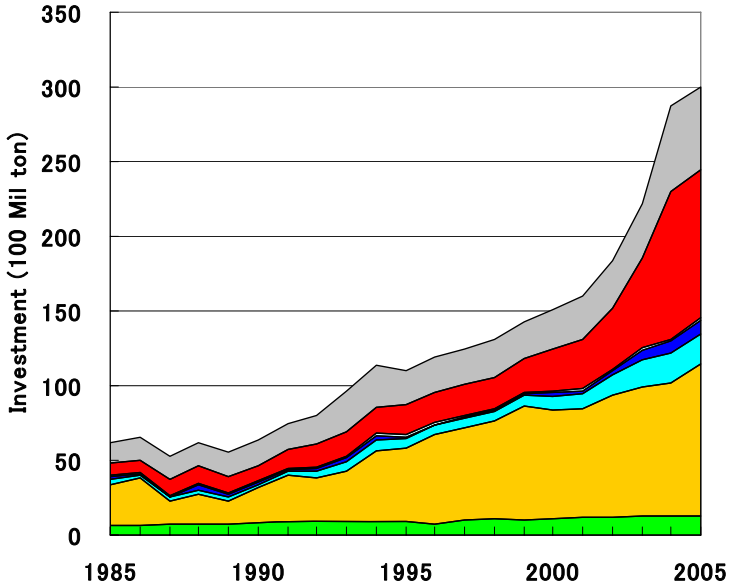
Transport: 10.9% (Car:4.9, Oth:5.8)

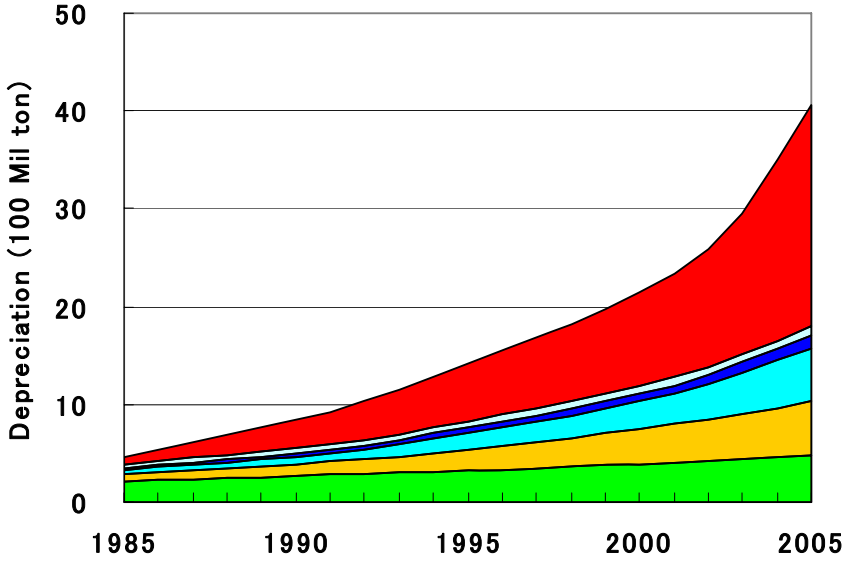
Machine: 8.6% (Ind; 5.4, E.le2.6)

The share of the Stock, Investment and Scrap are different → Lifetime

Steel Stock and Investment in China







Cvl.Eng. Structures. : 11.4 %

Building: 57.4%

Transport: 8.5% (Car:6.2, Ship:1.4)

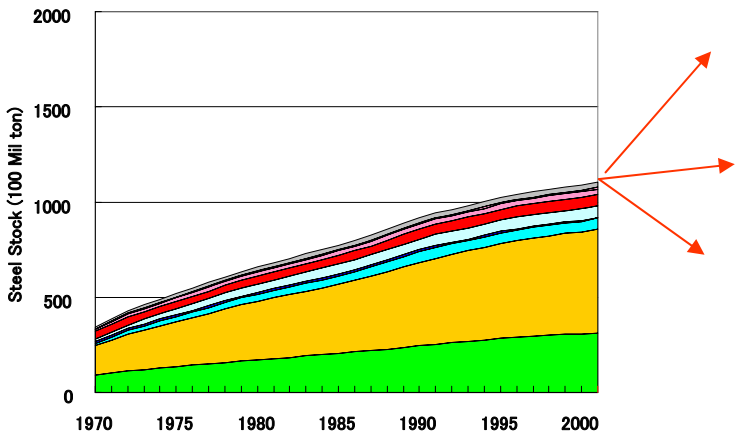
Machine: 22.7%

Question for future steel use

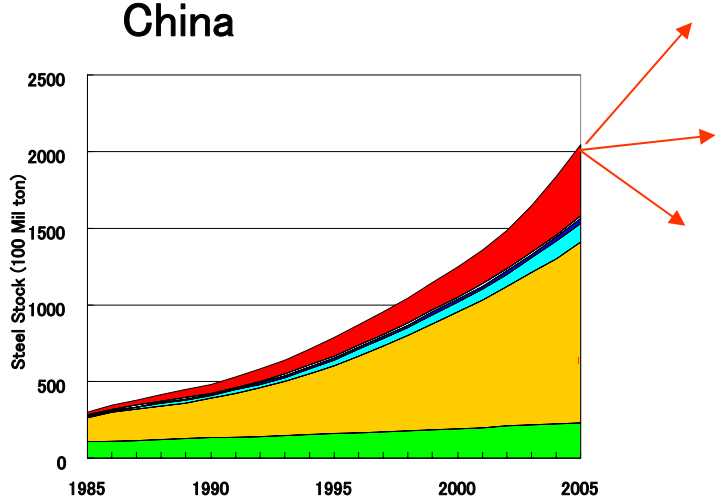
Domestic investment is done to meet “STOCK DEMAND”

→How will the stock demand change?
→How much steel is required?

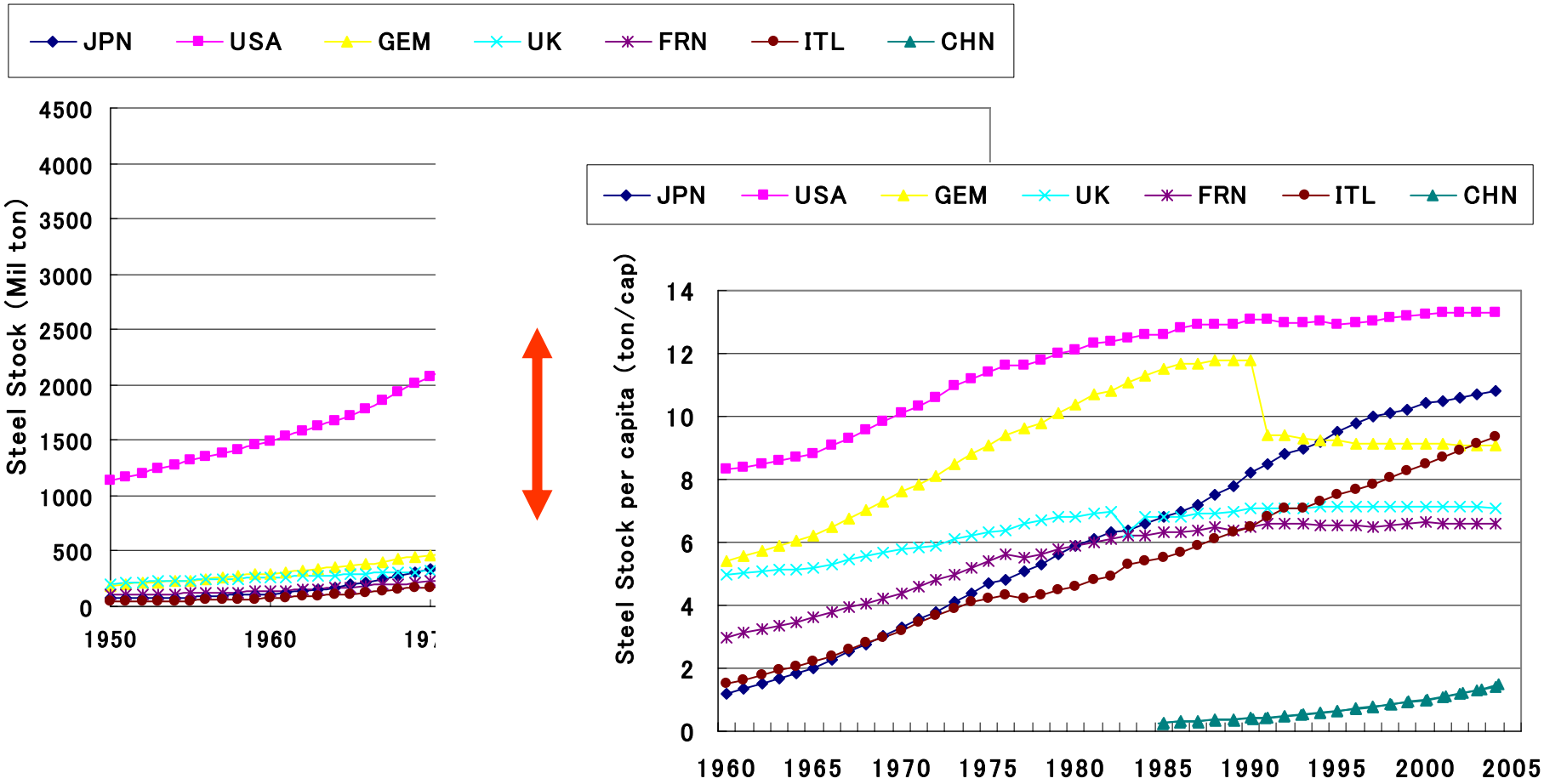
Japan



China



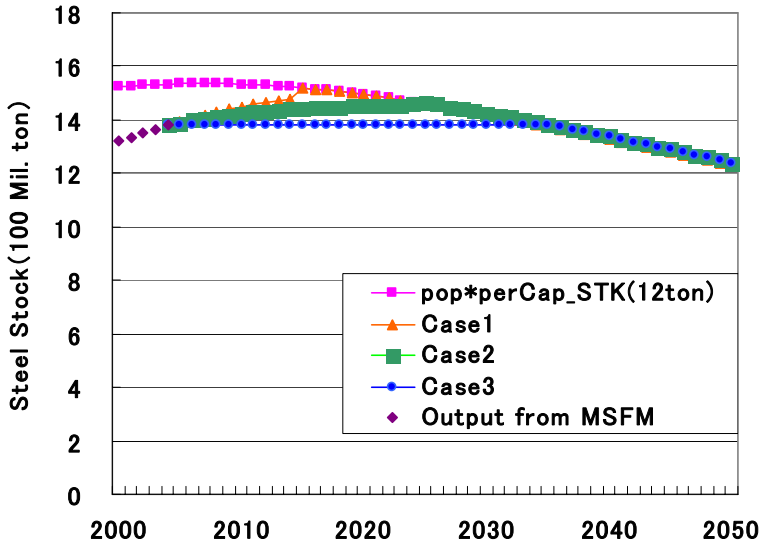
Steel stocks of main steel production countries

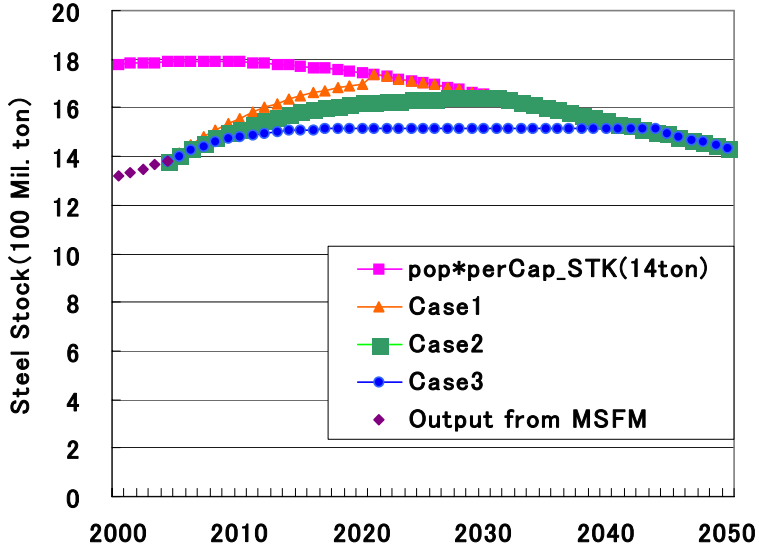


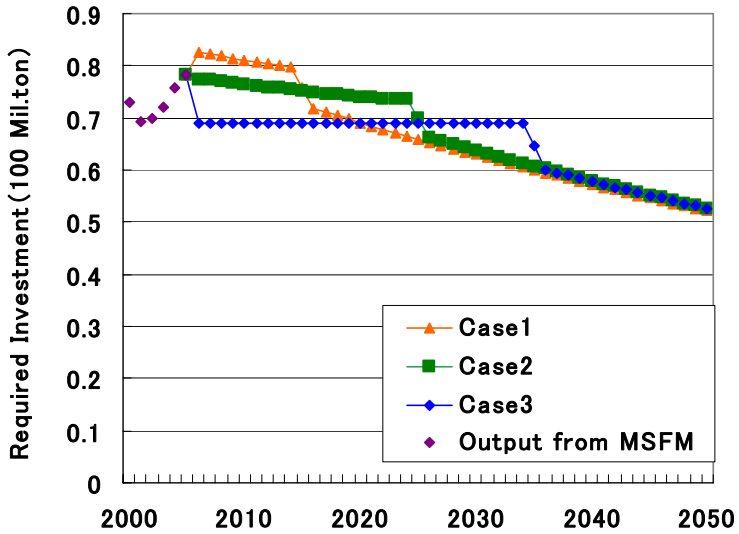
The steel stock per capita will be saturated at a certain level.

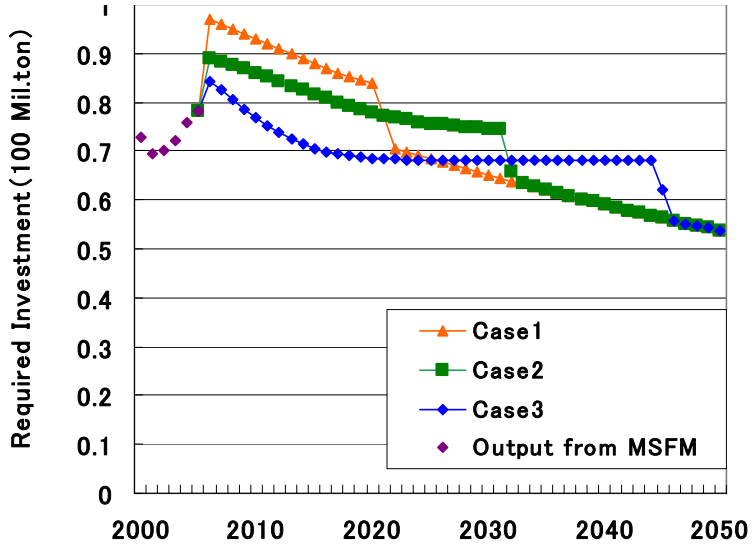
The level is different depending on countries.

Future steel stock and steel investment in Japan

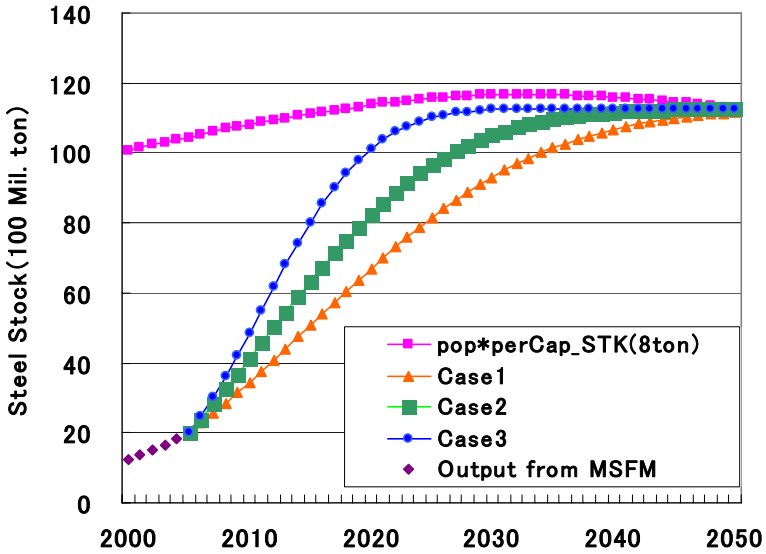


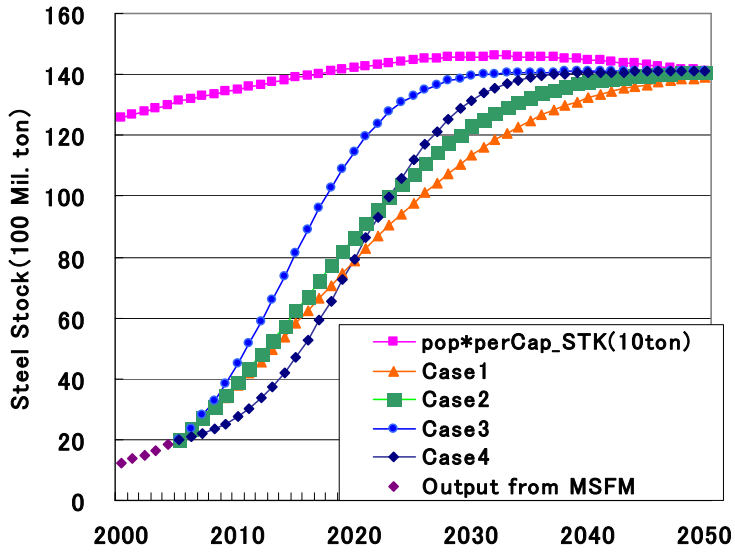


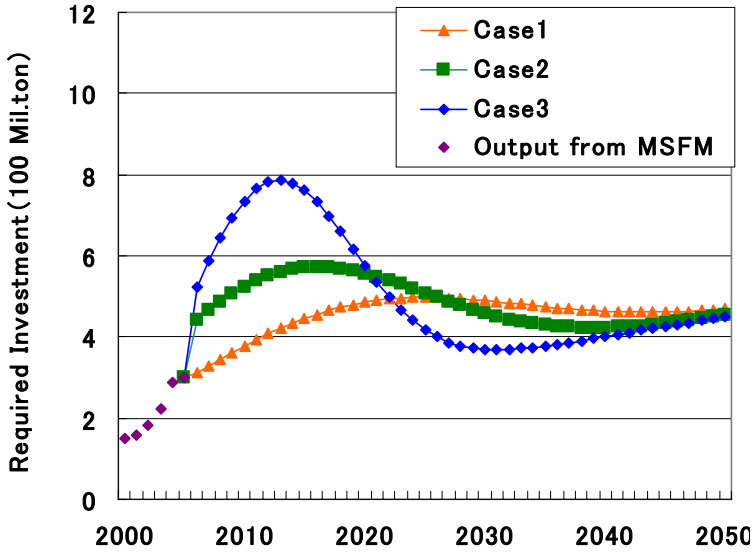


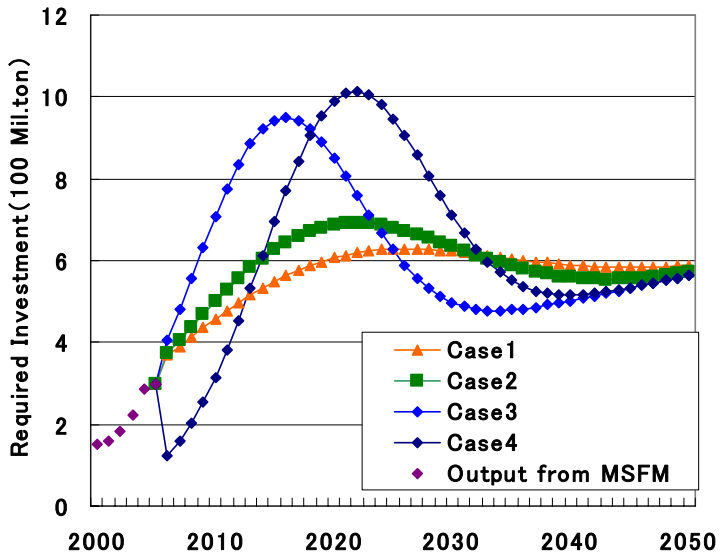


Future steel stock and steel production in China









Future task

Why is the steel stock per capita different?

→ The shares of the stock of goods are different.

$$Steel\_STK_t = \sum_i a_i \cdot DF\_STK_{i,t}$$

Why is the component of the stock different?

→ The social situation is different ???

① $DF\_STK_i = f(Z_{i,j})$

② $DF\_STK_i = POP \cdot DF\_STK\_CAP_i$

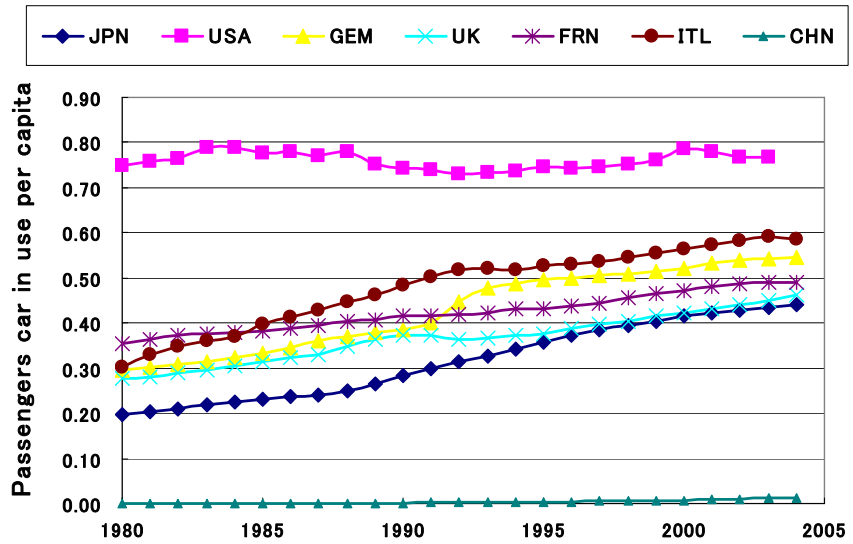
$= POP \cdot f(Z_{i,j})$

Population density

The level of compact city

Size of household

Preference,,,,,,,



Thank you

Supplement

1. Preparing Data:steel input to sectors

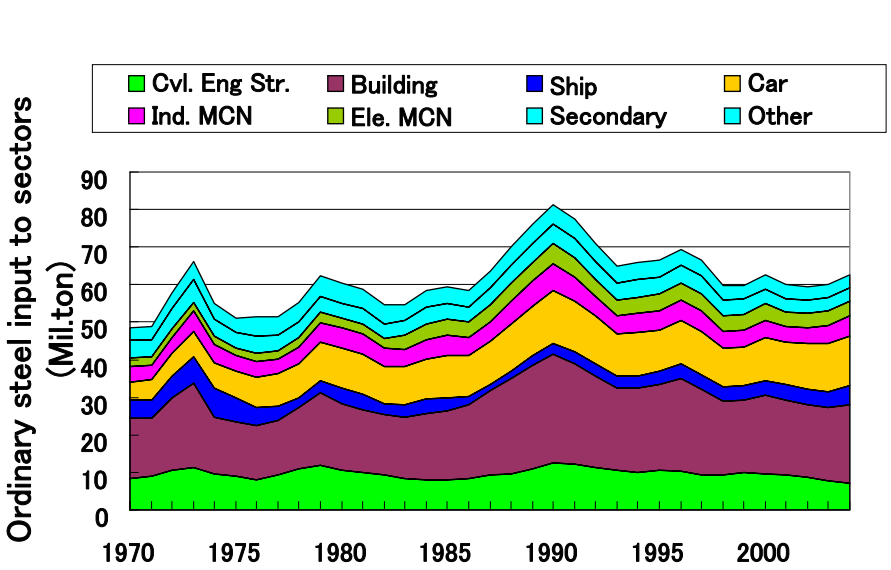


Fig. Ordinary steel input to sectors

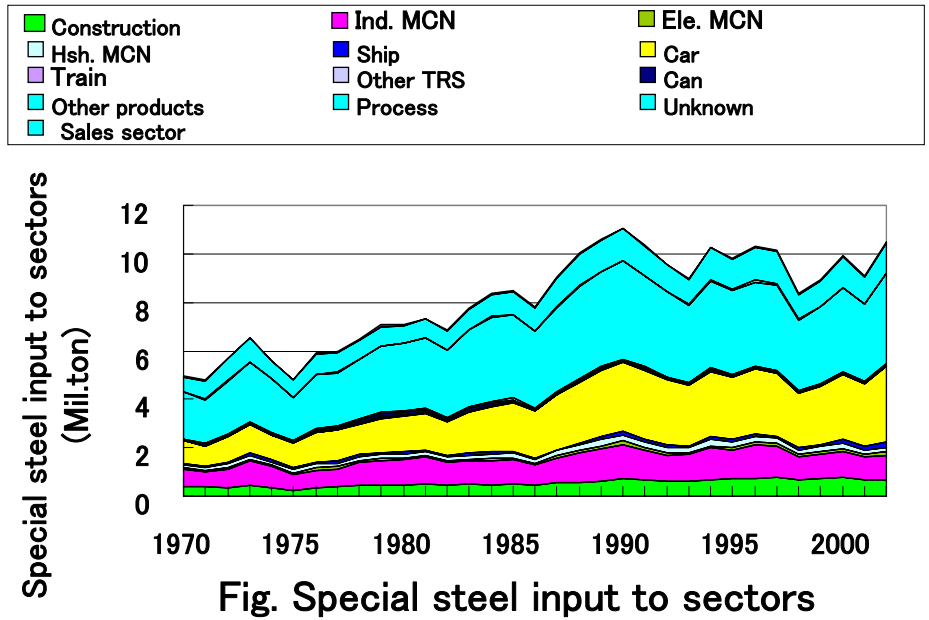


Fig. Special steel input to sectors