Estimation of Key Parameters for CGE Models

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Outline

1. Introduction
2. Estimation of substitution elasticities
   - What is the substitution elasticity?
   - Econometric model and data
   - Estimation results
3. Simulations with estimated parameters
4. Summary

Introduction

- Many literatures on climate policy based on CGE modeling analysis
- The simulation results and conclusions of them depend on the size of some parameters.
  - Substitution elasticities between production factors
- The key parameters in CGE models should have empirical evidence.
  - Too high (low) elasticities lead to under- (over) estimates of the effects of climate policy.
- The empirical foundation for the key parameters is lacking.
  - Based on old studies
  - Borrowing from famous models

Research problem & contribution

Research problem:

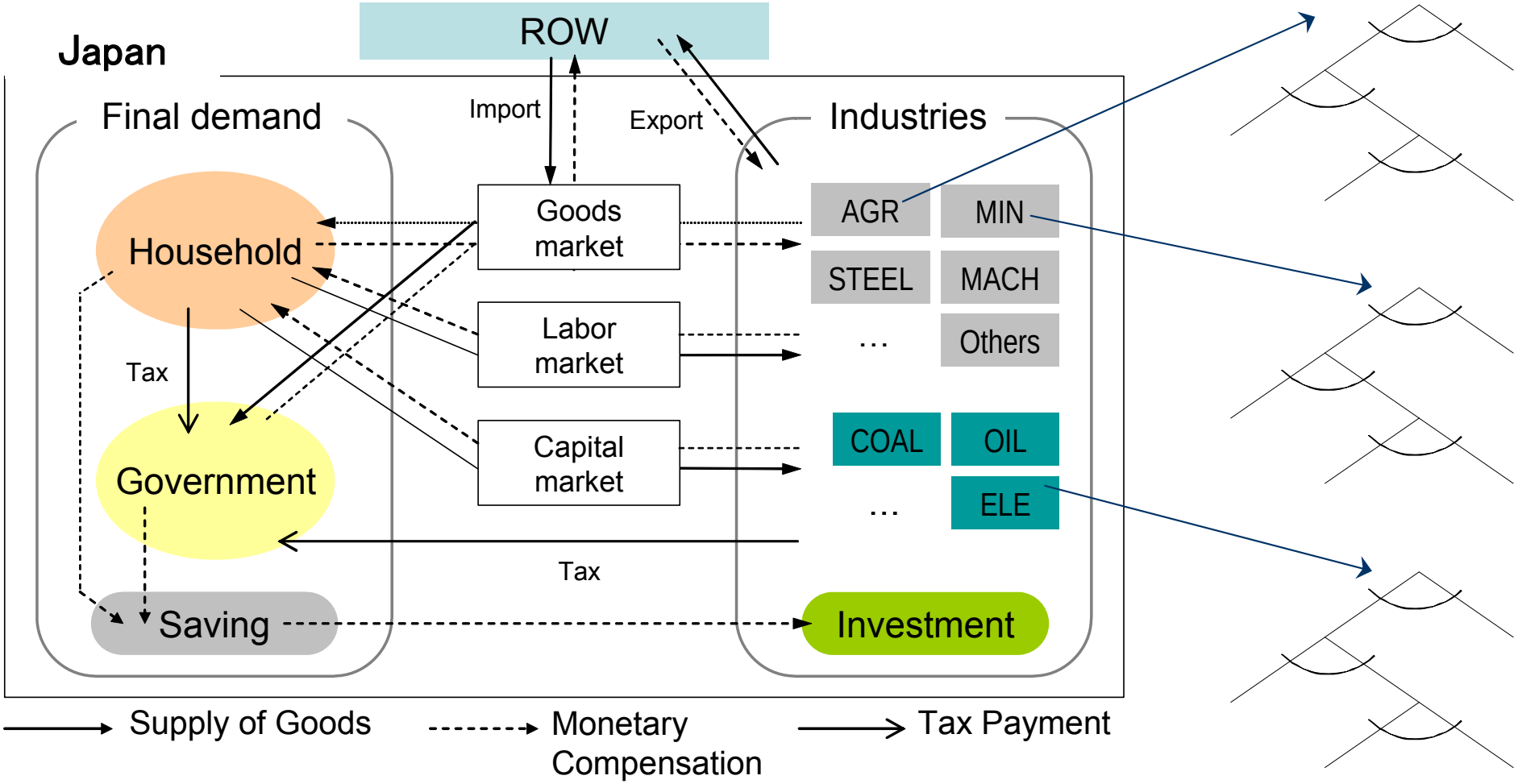
We need more econometric analyses which specify the key parameters of CGE models to get more reliable simulation results.

We estimated nested CES production functions using a panel data for OECD countries.

Contribution:

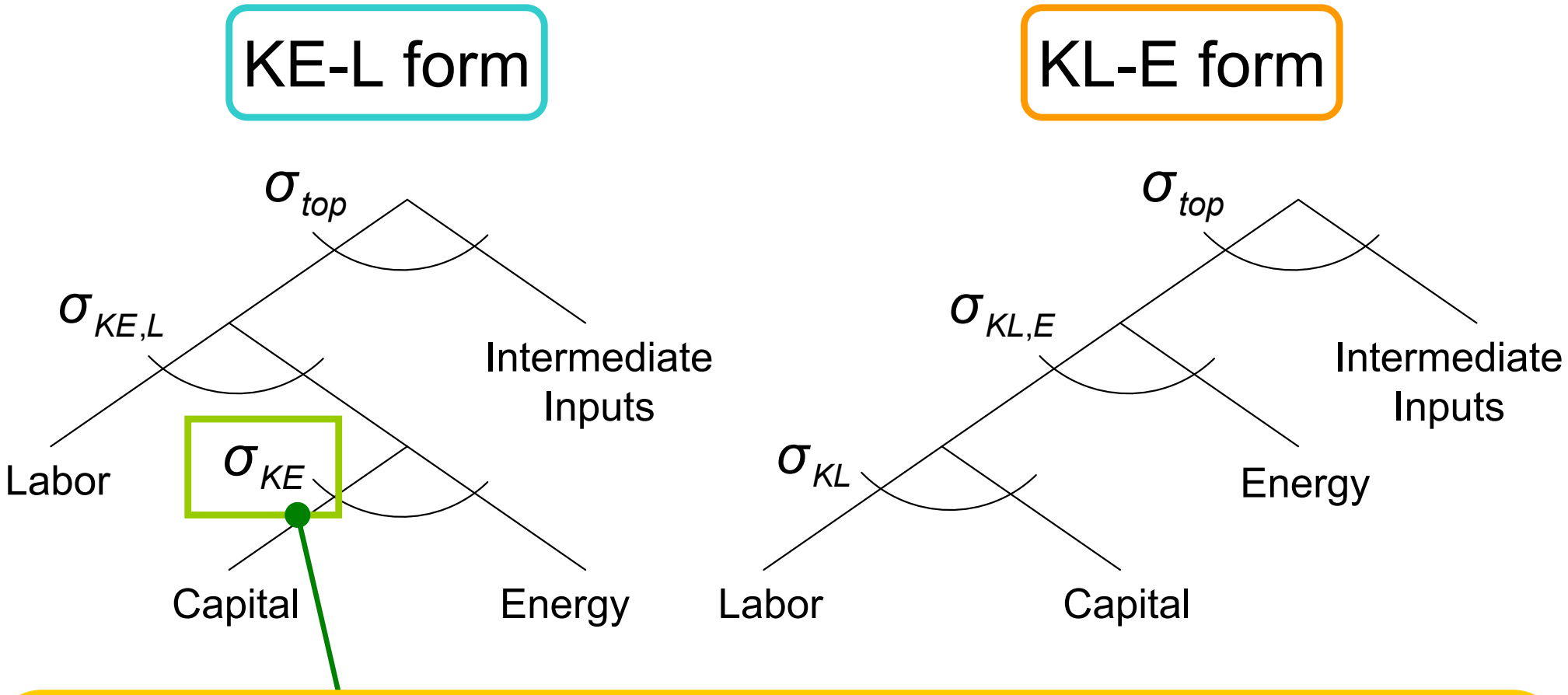
Our study improves the reliability of CGE models for climate policy by estimating nested CES production functions.

What is the substitution elasticity?



In most cases, we assume nested CES functions as production structures.

Production structure & substitution elasticities



Substitution elasticity between capital (K) and Energy (E)

If $\frac{P_E}{P_K}$ changes by 1%, $\frac{Q_K}{Q_E}$ would change by σ_{KE} %.

Econometric model & data

Firm's cost minimization problem

$$\min_{E,K} \quad P_E Q_E + P_K Q_K \quad \text{s.t.} \quad \overline{Q} = \left[\alpha Q_E^{\frac{\sigma_{KE}-1}{\sigma_{KE}}} + (1-\alpha) Q_K^{\frac{\sigma_{KE}-1}{\sigma_{KE}}} \right]^{\frac{\sigma_{KE}}{\sigma_{KE}-1}}$$

CES production function

The model to be estimated

$$\ln\left(\frac{Q_E}{Q_K}\right)_{i,t} = \beta_{0,i} + \sigma_{KE} \ln\left(\frac{P_K}{P_E}\right)_{i,t} + u_{i,t}$$

Data:

Panel data for 19 OECD countries with 18 industries (1970-2004), formed by the EU-KLEM project of the European Commission.

Estimation results

	KE-L			KL-E		
	Conventional		Our estimation	Conventional		Our estimation
	σ top			σ top		
Chemical	0.00	<	0.81	0.00	<	0.85
Other Non-metallic Mineral	0.00	<	0.98	0.00	<	0.31
Iron & Steel	0.00	<	1.05	0.00	<	1.17
Machinery	0.00	<	1.15	0.00	<	0.13
Electrical equipment	0.00	<	0.75	0.00	<	0.88
Transport equipment	0.00	<	1.04	0.00	<	0.55
Transport	0.00	<	1.05	0.00	<	0.35
Construction	0.00	<	0.97	0.00	<	1.26
	σ KE-L			σ KL-E		
Chemical	0.80	>	0.34	0.40	>	0.00
Other Non-metallic Mineral	0.80	>	0.21	0.40	<	0.41
Iron & Steel	0.80	>	0.00	0.40	<	0.64
Machinery	0.80	>	0.08	0.40	>	0.29
Electrical equipment	0.80	>	0.33	0.40	<	0.52
Transport equipment	0.80	>	0.43	0.40	<	0.52
Transport	0.80	>	0.47	0.40	>	0.28
Construction	0.80	<	0.94	0.40	<	0.53
	σ KE			σ KL		
Chemical	0.10	>	0.04	1.00	>	0.33
Other Non-metallic Mineral	0.10	<	0.35	1.00	>	0.36
Iron & Steel	0.10	<	0.29	1.00	>	0.22
Machinery	0.20	>	0.12	1.00	>	0.30
Electrical equipment	0.20	<	0.25	1.00	>	0.16
Transport equipment	0.20	>	0.09	1.00	>	0.14
Transport	0.10	<	0.45	1.00	>	0.31
Construction	0.20	>	0.11	1.00	>	0.07

Simulations by 4 models

- 4 CGE models
  1. KE-L model with conventional parameters
  2. KE-L model with new parameters
  3. KL-E model with conventional parameters
  4. KL-E model with new parameters

The goal of simulations:

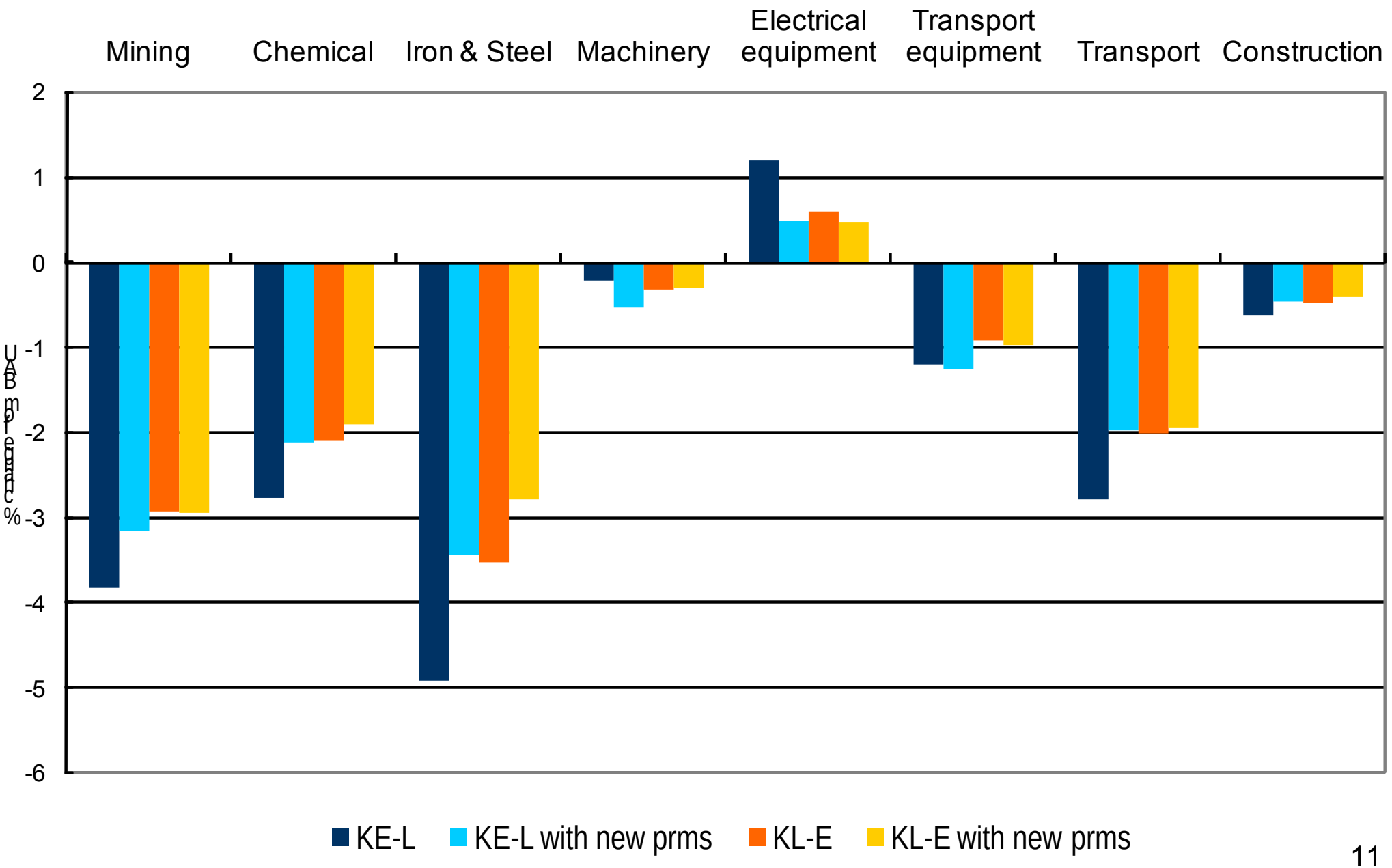
CO_2 reduction by 13% to meet the Kyoto Target

Comparison of simulation results

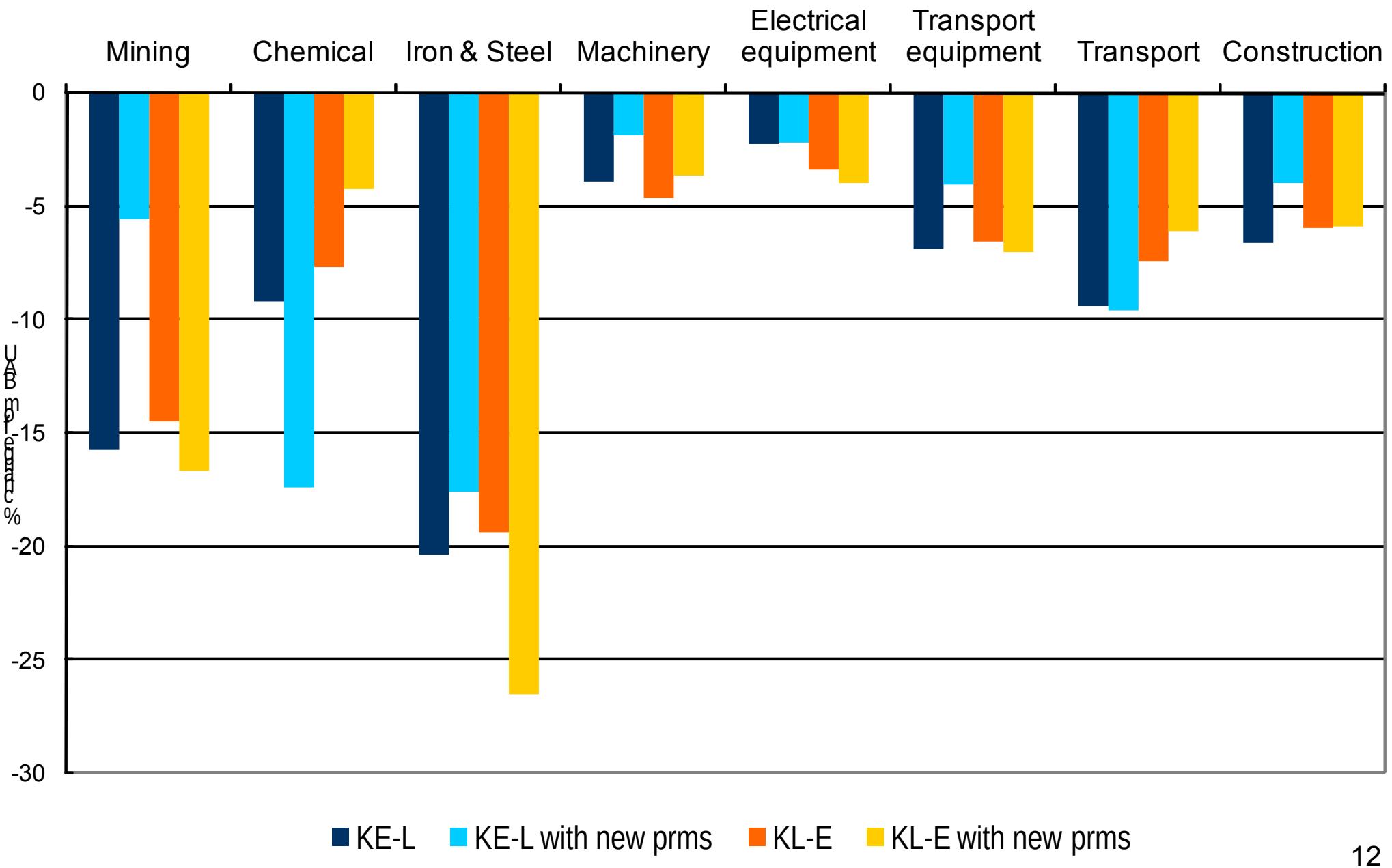
Model	GDP (%)	Equivalent Value (%)	Carbon tax rate (yen/t-C)
KE-L	-1.10	-0.19	18,766
KE-L with new prms	-0.79	-0.16	13,160
KL-E	-0.76	-0.16	12,305
KL-E with new prms	-0.73	-0.15	12,001

We could over-estimate necessary carbon tax rate by 43% more if we use conventional values of key parameters for the KE-L models.

Industrial output (%)



CO_2 emissions (%)



Summary

- We specified key parameters of CGE models by the econometric analysis.
  - Higher elasticities for energy intensive industries
  - Lower elasticities for non-energy intensive industries
- If we use conventional parameters, we could over-estimate the impacts of the climate policy.
  - 43% higher reduction costs for 1t of CO_2 emissions
  - Distribution of reduction costs of CO_2 emissions between industries

Thank you!

Comments are welcome.

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