

INFORTW: An Inter-industry Forecasting Model of the Taiwanese Economy

Yu-Wen Su (蘇鈺雯)

Industrial Economics and Knowledge Center (IEK),
Industrial Technology Research Institute (ITRI)

yuwensu@itri.org.tw

sophieywsu@gmail.com

Introduction

- **INFORTW**

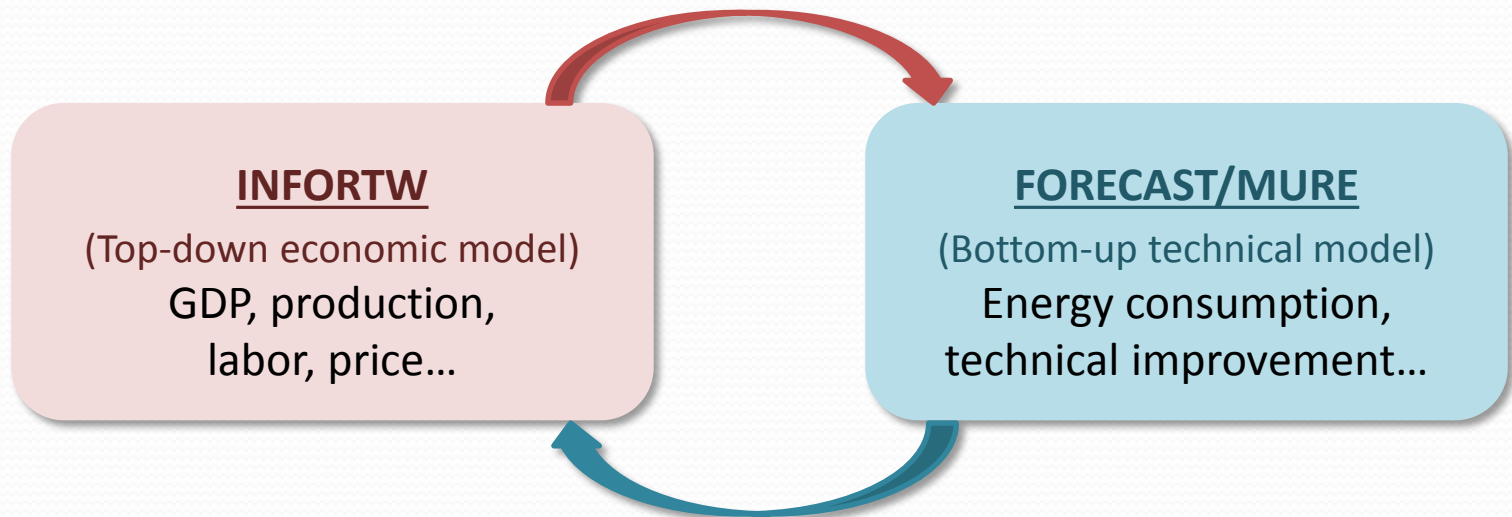
- Inter-industry Forecasting Model of Taiwan
- 47 industries, 1981 – 2012 – 2025

- **Outline**

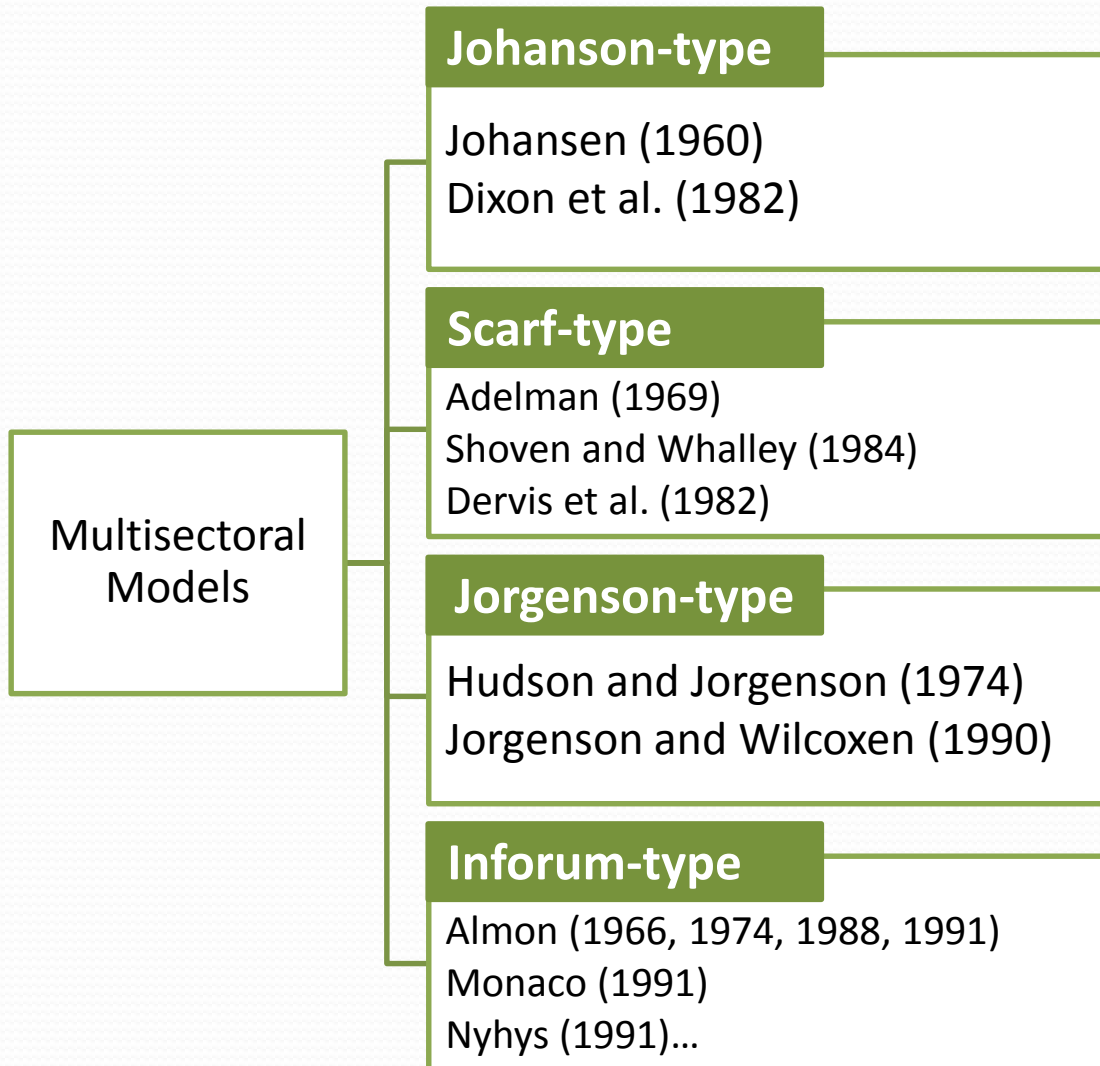
- Research motivation and literature reviews
- INFORTW model development
- Scenarios and estimated results
- Conclusions and suggestions

Research Motivation

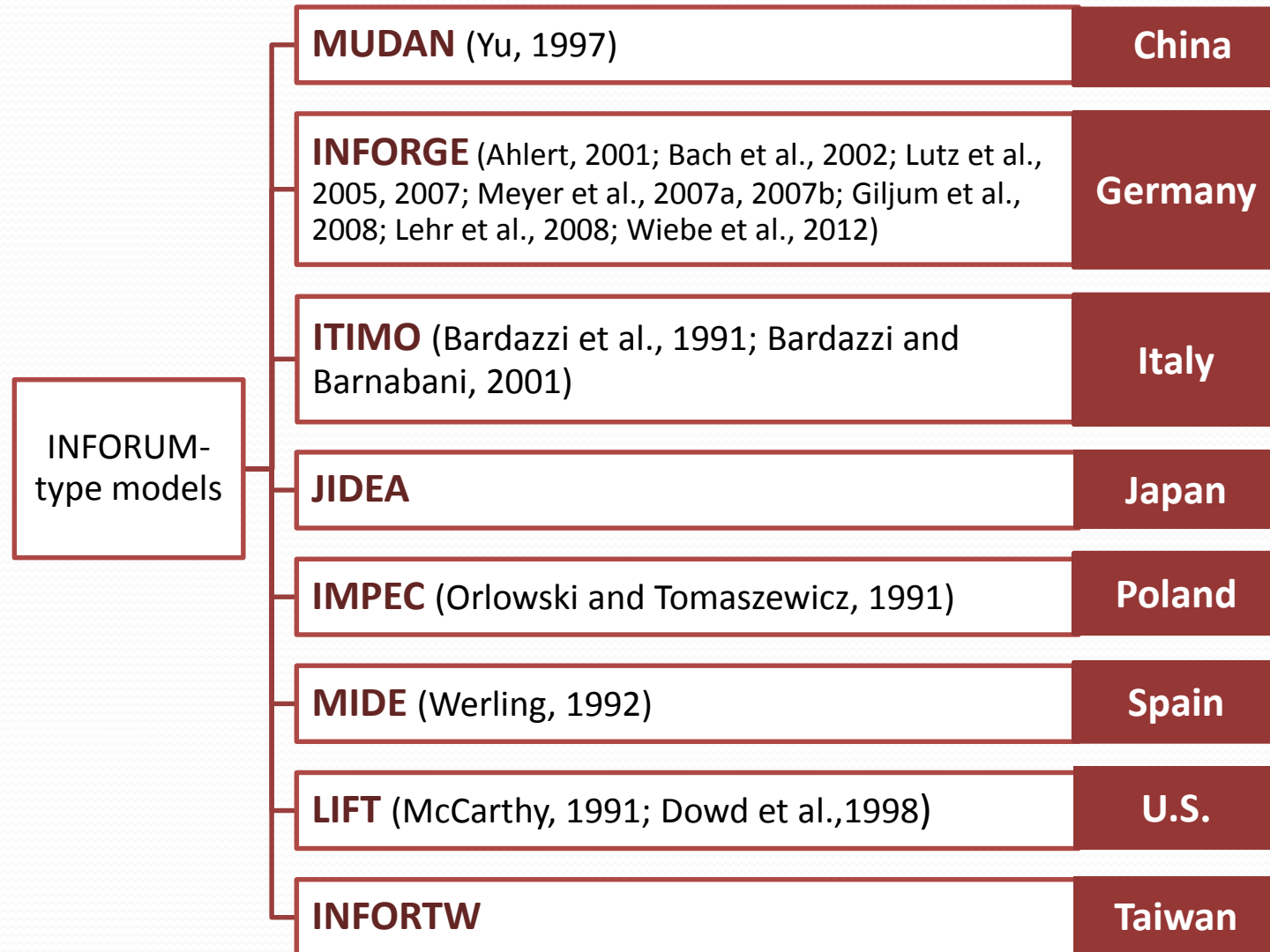
- To use the survey and data foundation of the Industrial Economic and Knowledge (IEK) Center
- To systematize the industrial analysis
- To develop a national economic (top-down) model and cooperate to the FORECAST/MURE (bottom-up) model



Literature Reviews (1/2)



Literature Reviews (2/2)



Model INFORTW (1/6)

Price-Income Side

Real Side

	p	#1	#2	#3	f					y
					c	i	g	x	m	
#1	p_1	y_{11}	y_{12}	y_{13}	c_1	i_1	g_1	x_1	m_1	y_1
#2	p_2	y_{21}	y_{22}	y_{23}	c_2	i_2	g_2	x_2	m_2	y_2
#3	p_3	y_{31}	y_{32}	y_{33}	c_3	i_3	g_3	x_3	m_3	y_3
va	w	w_1	w_2	w_3						
	d	d_1	d_2	d_3						
	pr	pr_1	pr_2	pr_3						
	tax	tax_1	tax_2	tax_3						
y p		y_1	y_2	y_3						

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

$$y = \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} \quad f = \begin{bmatrix} f_1 \\ f_2 \\ f_3 \end{bmatrix} \quad c = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \end{bmatrix}$$

$$f = c + i + g + x - m$$

$$va = w + d + pr + tax$$

$$v = \frac{va}{y}$$

$$y = A y + f$$

$$\rightarrow y = (I_o - A)^{-1} f$$

$$p = A' p + v$$

$$\rightarrow p = (I_o - A')^{-1} v$$

Model INFORTW (2/6)

■ Estimation of final demands (Real side)

■ Consumption demand

$$c_{i,t} = C(c_{i,t-1}, p_{i,p}, y_p, t), i = 1, \dots, 13$$

Consumption Bridge Matrix (Bc)

■ Investment demand

$$i_{i,t} = I(i_{i,t-1}, y_{i,p}, r_p, t), i = 1, \dots, 19$$

Investment Bridge Matrix (Bi)

■ Government expenditure

given as an exogenous variable

Public Administration
Service Industry

■ Export

$$e_{i,t} = E(e_{i,t-1}, p_{i,p}^e, p_p^f, y_t^f), i = 1, \dots, 47$$

■ Import

$$m_{i,t} = M(m_{i,t-1}, p_{i,p}^m, p_{i,p}, y_t), i = 1, \dots, 47$$

Model INFORTW (3/6)

- Estimation of value added (Price-income side)

- Wage, Labor productivity & Labor demand

$$w_{i,t} = W(w_{i,t-1}, w_p, prl_{i,t}), i = 1, \dots, 47$$

$$prl_{i,t} = PRL(\Delta y_{i,p}, i_{i,t-1}, t), i = 1, \dots, 47 \quad l_{i,t} = \frac{y_{i,t}}{prl_{i,t}}, i = 1, \dots, 47$$

- Depreciation expense

$$d_{i,t} = D(d_{i,t-1}, k_{i,p}, t), i = 1, \dots, 47$$

- Operating profit

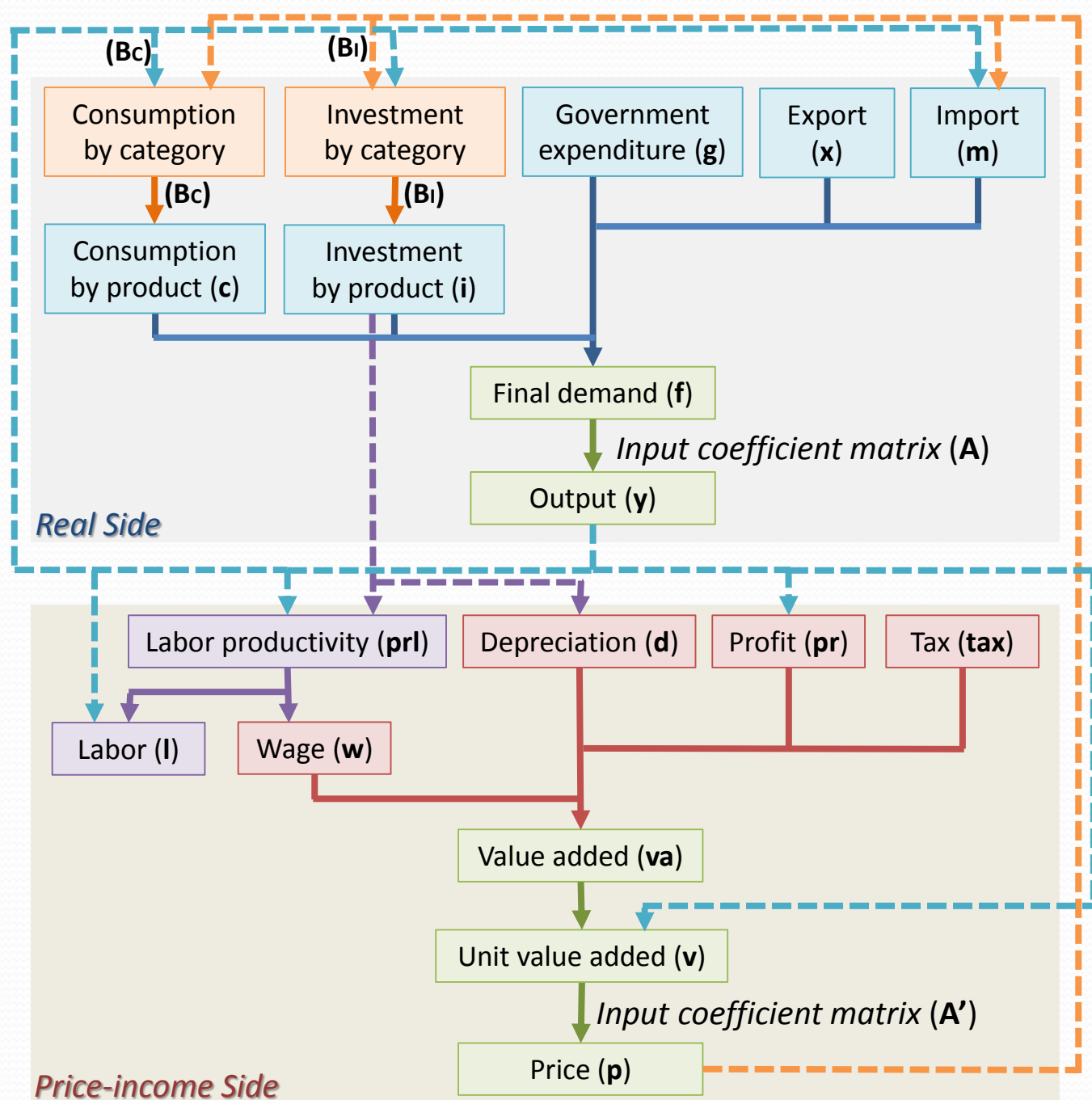
$$pr_{i,t} = PR(pr_{i,t-1}, \Delta y_{i,p}, p_{i,t-1}), i = 1, \dots, 47$$

- Indirect tax

$$tax_{i,t} = TAX(va_{i,p}, t), i = 1, \dots, 47$$

Model INFORTW (4/6)

- **Connection & Equilibrium**
(Stata v.13)



Model INFORTW (5/6)

■ Data source

- Directorate General of Budget, Accounting and Statistics (DGBAS) of Taiwan

- Annual national account
- 5-year updated input–output table

Data mismatch problem
→ RAS method

- Ministry of Finance of Taiwan

- Export & import (price & quantity)

- World Development Indicators (WDI) of the World Bank

- World production and price

Model INFORTW (6/6)

■ RAS method*

- Solve *biproportional constrained matrix problem*
 - Data mismatch between I–O tables and national accounts
 - I–O tables update every five years

B	row sum of B = $\mathbf{y} - \mathbf{f}(\mathbf{u})$	f	y
column sum of B = $\mathbf{y} - \mathbf{v}\mathbf{a}(\mathbf{v})$			
va			
y			

*RAS method

Given a nonnegative matrix \mathbf{A} ($m \times n$) and positive vectors \mathbf{u} , \mathbf{v} , then the biproportional constrained matrix problem is to find a nonnegative matrix \mathbf{B} ($m \times n$) such that $\mathbf{B} = \text{diag}(\mathbf{r}) \mathbf{A} \text{diag}(\mathbf{s})$ holds for vectors $\mathbf{r} \in \mathbb{R}^m$ and $\mathbf{s} \in \mathbb{R}^n$, and the row (column) sums of \mathbf{B} equal to u_i (v_j), $i = 1, \dots, m$ ($j = 1, \dots, n$).

(Bacharach, 1970)

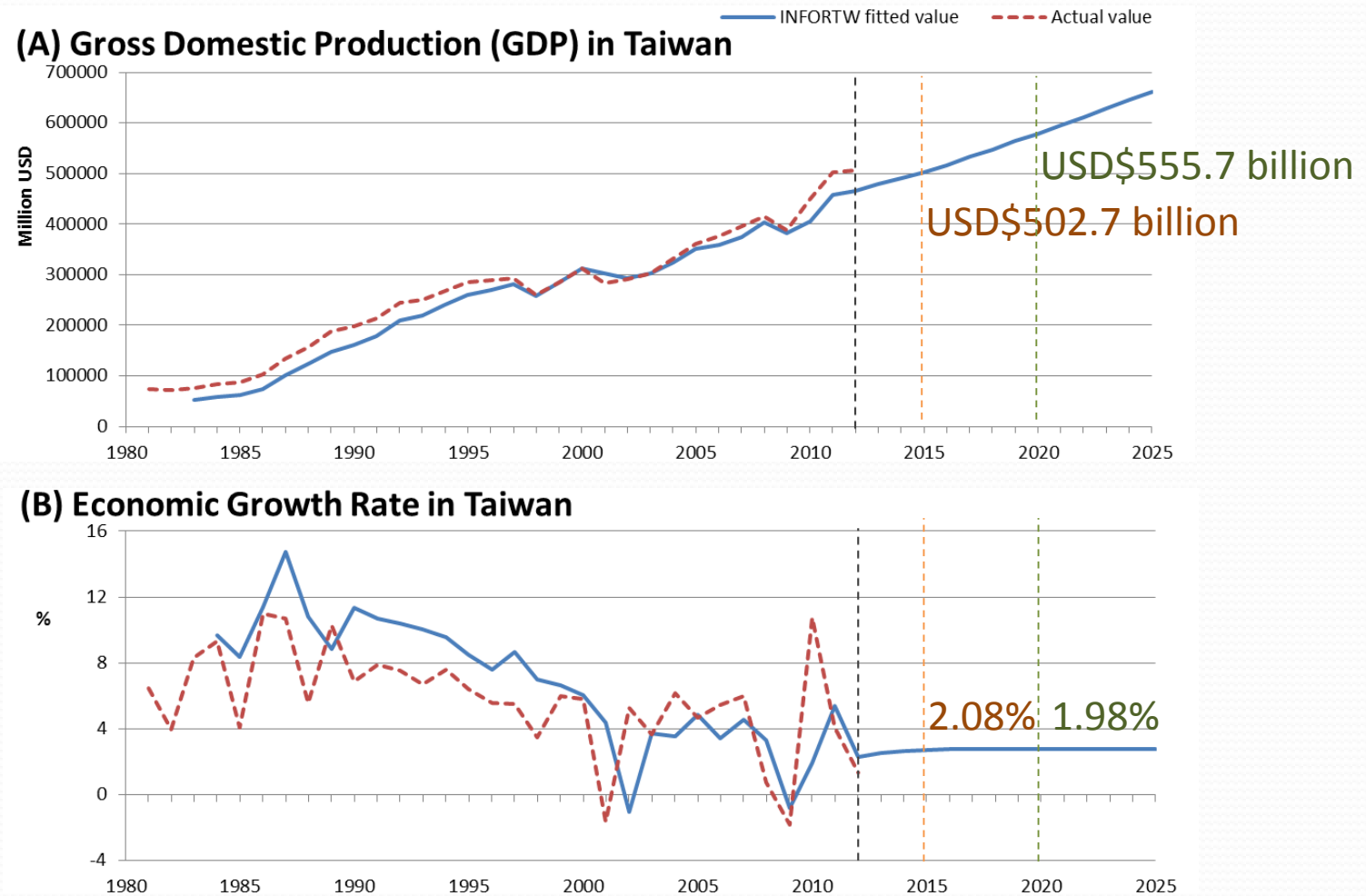
Scenarios

- Energy efficiency improvement for iron & steel industry

	Scenario 1	Scenario 2	Scenario 3	
	Base scenario	Weak scenario	Strong scenario (Stage 1)	Strong scenario (Stage 2)
Electricity input decrease (%)	0	3	4	8
Gas input decrease (%)	0	0.5	0.7	2
Investment increase (USD)	0	50.7 mil.	67.6 mil.	135.2 mil.
Implement time	-	2015	2015	2020

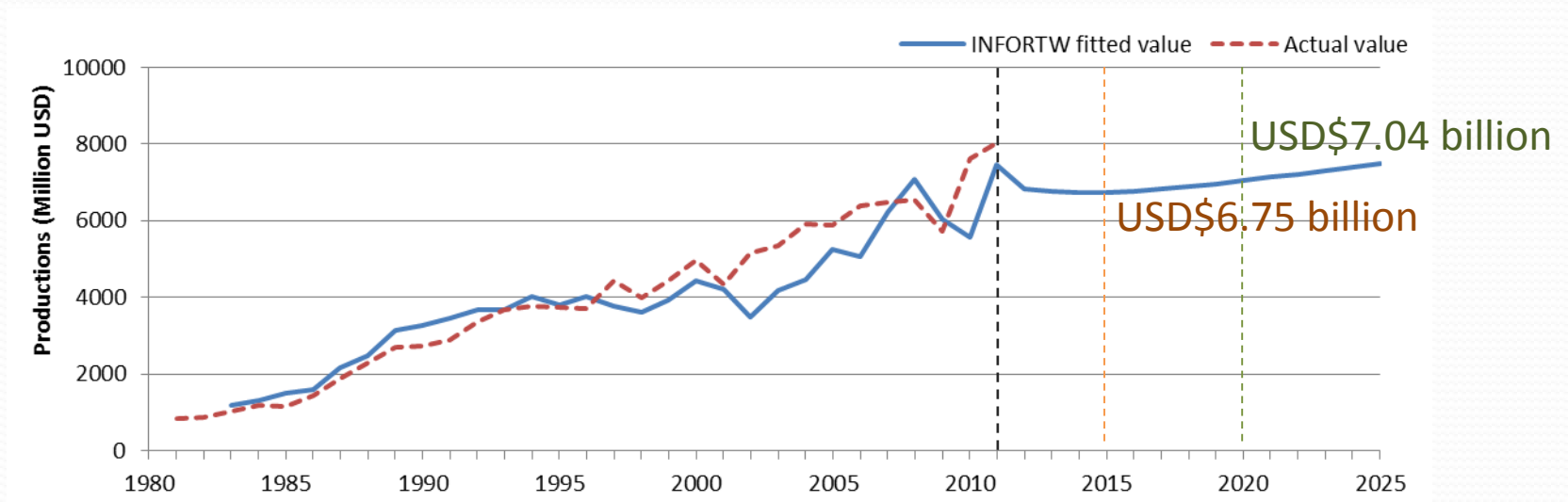
Scenarios are provided by the technical model **FORECAST/MURE** (Forecasting Energy Consumption Analysis and Simulation Tool / Mesures d'Utilisation Rationnelle de l'Energie; Fleiter et al., 2011, 2012).

Estimated Results (1/7, base scenario)



- INFORTW estimated results of macroeconomic variables (1981 - 2025)

Estimated Results (2/7, base scenario)



- INFORTW estimated results for productions of iron & steel industry (1981 - 2025)

Estimated Results (3/7, impact scenario)

Energy efficiency improvement for iron & steel industry

■ INFORTW estimated results for iron & steel industry

Year	<i>Scenario 2-1: Base scenario</i>		<i>Scenario 2-2: Weak scenario</i>		<i>Scenario 2-3: Strong scenario</i>			
	Production	Employee	Production changes	Employee changes	Production changes (1000 USD)		Employee changes (People)	
	(Million USD)	(People)	(1000 USD)	(People)	Stage1	Stage2	Stage1	Stage2
2013	6770.1	96047	-	-	-	-	-	-
2014	6742.8	94776	-	-	-	-	-	-
2015	6749.3	93674	-524.7	18	-699.4	-699.4	24	24
2016	6780.3	92627	-400.1	13	-533.2	-533.2	17	17
2017	6829.4	91635	-279.2	12	-373.2	-373.2	17	17
2018	6891.8	90691	-184.2	12	-244.9	-244.9	16	16
2019	6964.3	89790	-110.3	12	-147.3	-147.3	16	16
2020	7044.3	88927	-54.4	12	-72.8	-1361.9	15	41
2021	7129.8	88099	-11.1	11	-14.3	-1106.4	15	30
2022	7219.2	87309	23.2	11	30.6	-828.8	14	29
2023	7310.6	86564	49.1	10	65.5	-595.4	14	29
2024	7405.1	85805	70.2	10	92.9	-407.0	13	28
2025	7501.2	85043	85.0	10	113.5	-256.5	13	27

Note: The currency exchange rate (TWD/USD) is fixed at 29.6 of the 2013 value.

Estimated Results (4/7, impact scenario)

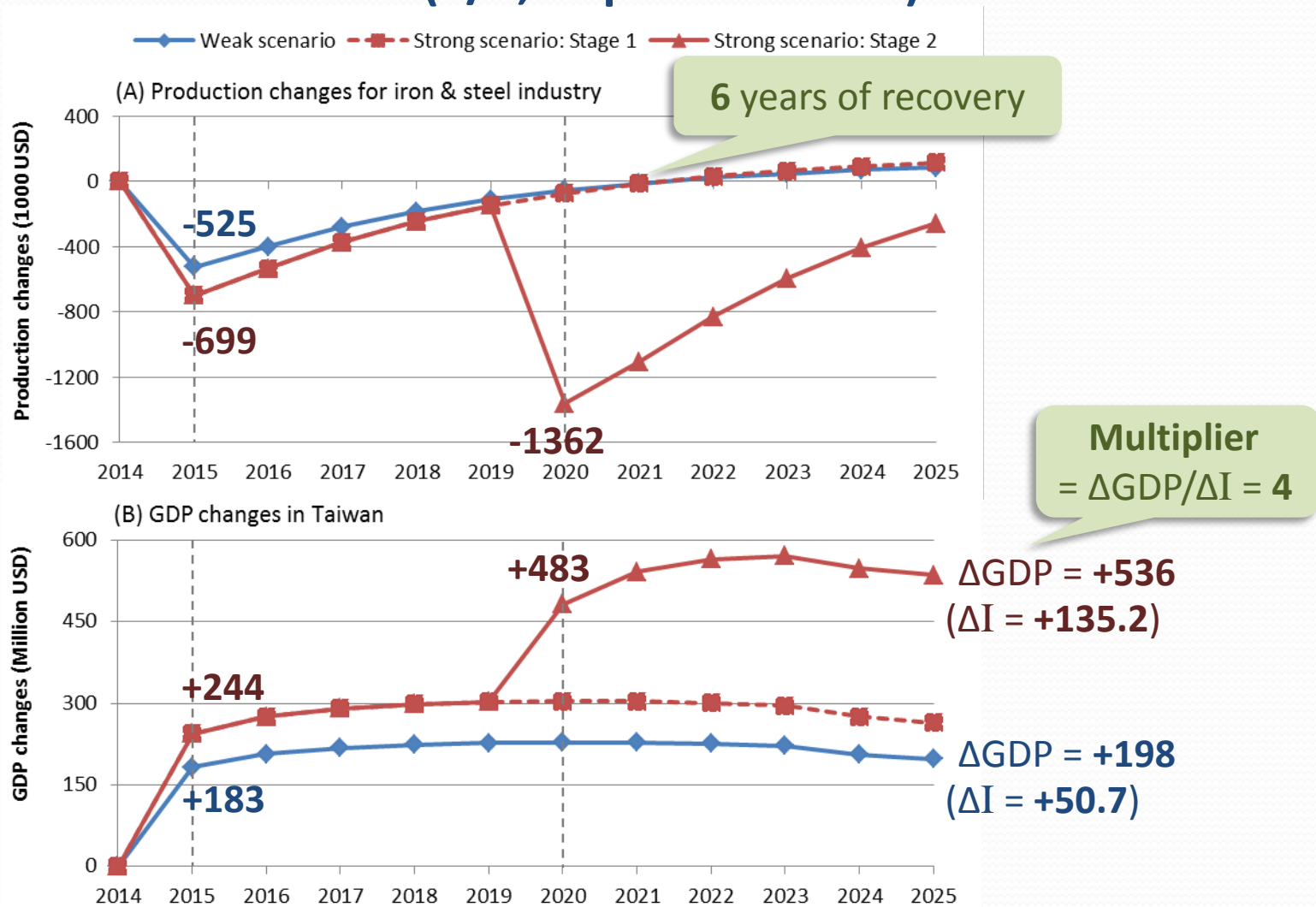
Energy efficiency improvement for iron & steel industry

INFORTW estimated results for Taiwan

Year	<i>Scenario 2-1: Base scenario</i>		<i>Scenario 2-2: Weak scenario</i>		<i>Scenario 2-3: Strong scenario</i>			
	GDP	Growth rate	GDP changes	Employee changes	GDP changes (Million USD)		Employee changes (People)	
	(Million USD)	(%)	(Million USD)	(People)	Stage1	Stage2	Stage1	Stage2
2013	482303.7	2.05	-	-	-	-	-	-
2014	492473.0	2.11	-	-	-	-	-	-
2015	502732.4	2.08	182.83	1387	243.83	243.83	1849	1849
2016	513113.3	2.06	207.01	1613	275.93	275.93	2150	2150
2017	523604.5	2.04	218.05	1667	290.70	290.70	2222	2222
2018	534195.1	2.02	223.96	1700	298.54	298.54	2266	2266
2019	544886.1	2.00	227.00	1719	302.65	302.65	2292	2292
2020	555693.1	1.98	227.80	1723	303.75	482.73	2298	3704
2021	566650.8	1.97	227.72	1719	303.54	541.78	2292	3939
2022	577798.1	1.97	225.71	1696	300.95	564.84	2263	4039
2023	589213.0	1.98	221.61	1641	295.49	571.13	2190	4005
2024	600898.1	1.98	206.18	1556	275.02	548.22	2074	3872
2025	612940.7	2.00	198.13	1514	264.24	535.65	2024	3816

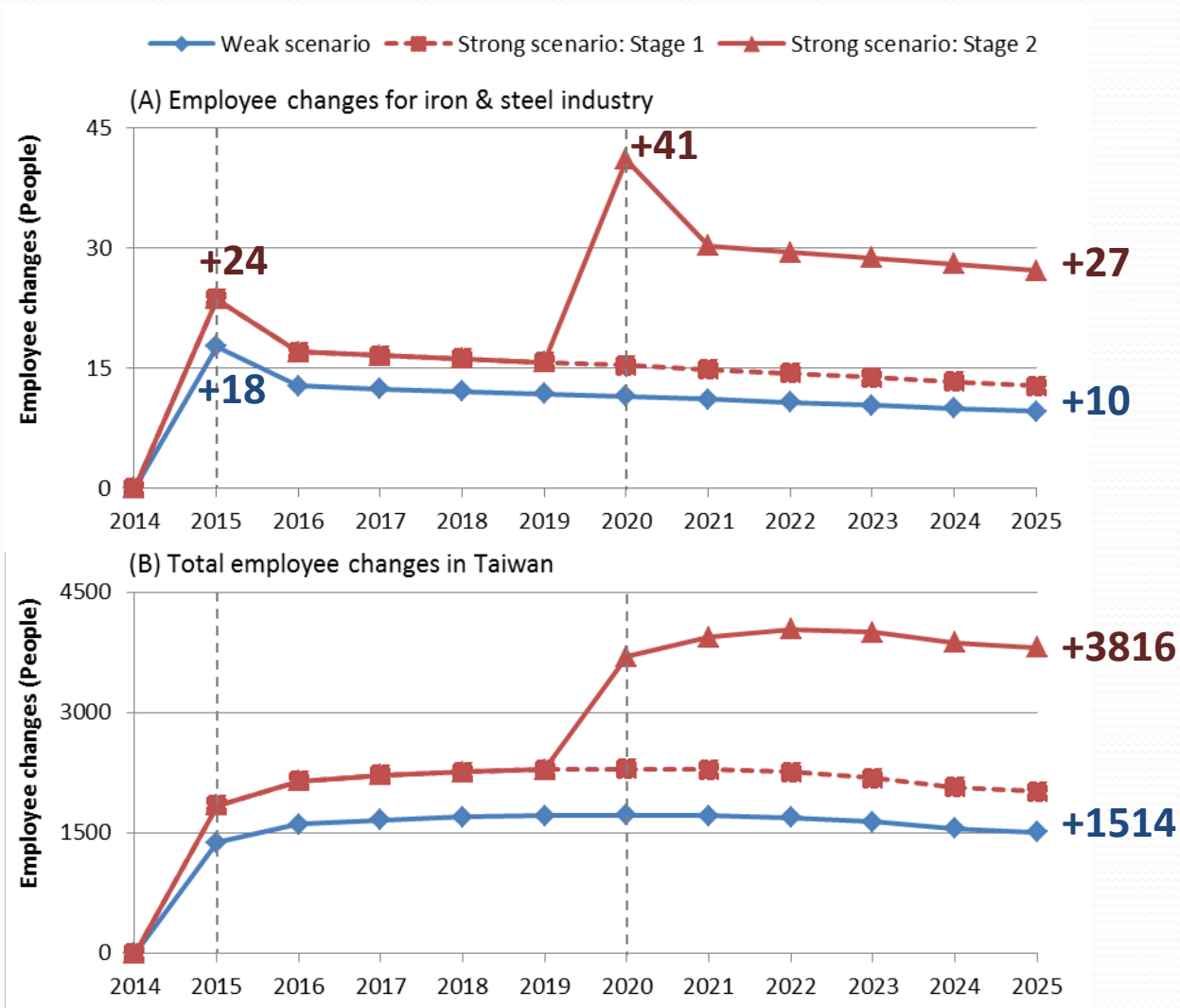
Note: The currency exchange rate (TWD/USD) is fixed at 29.6 of the 2013 value.

Estimated Results (5/7, impact scenario)



- Production changes due to energy efficiency improvement in iron & steel industry

Estimated Results (6/7, impact scenario)



- Employee changes due to energy efficiency improvement in iron & steel industry

Estimated Results (7/7, results review)

- Investments in the energy efficiency improvement for the iron and steel industry
 - Has positive effects on Taiwan's GDP & labor market
 - The multiplier of the investment is nearly 4 times
 - Due to the 6 years recovery period, the iron and steel industry has less incentive to invest in the short term

Conclusion (1/2)

- **Develops the model INFORTW**
 - 47 industries, 1981 – 2012 – 2025
 - Contains real side & price-income side
 - Employs I–O tables, national accounts & RAS method
- **Impact simulations**
 - Energy efficiency improvement for iron & steel industry

Conclusion (2/2)

- **Further research**

- **Maintaining**

- 2011 I–O table updates (released in mid-2014)
 - Further annual data collected

- **Extending**

- Energy module
 - ‘Green’ industry module
 - Detailed industry module

Thank you 😊

Yu-Wen Su (蘇鈺雯)

Industrial Economics and Knowledge Center (IEK),

Industrial Technology Research Institute (ITRI)

yuwensu@itri.org.tw

sophieywsu@gmail.com