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INFORTW:

AN INTER-INDUSTRY FORECASTING MODEL

OF THE TAIWANESE ECONOMY

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Abstract

The Interindustry Forecasting Model of Taiwan (INFORTW) is presented in this paper. Based on the considerable foundation of data, the INFORTW describes the structure of 47 industries. The real side and price-income sides of the model are described in this paper, as well as the connection between the two. To resolve inconsistent data, the RAS method is employed.

Keywords: INFORUM, input-output analysis, multisectoral model

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1 INTRODUCTION

The Inter-industry Forecasting Model of Taiwan (INFORTW) illustrates the interaction between 47 industries and the macroeconomic environment in Taiwan. In current society, production has become more efficient with specialization, and the connections between industries have been strengthened. Inter-industry models enable economic activities to be forecasted and simulated, and allow the relationships between industries to be elucidated. Using ample time series data ensures that highly accurate, reliable estimation results are yielded. In addition, accurate simulated result could assist policy formulation. Because of the need for a policy analysis tool, INFORTW was developed based on a considerable foundation of data with the assistance of the Taiwanese government.

INFORUM-type models have been widely used in numerous countries over the past 30 years. Historical data are analyzed in these models, and most parameters are obtained by estimation. Although using a large dataset ensures comprehensive, reliable estimated results, the use of a large dataset complicates the estimation process, because amassing and maintaining a large dataset is difficult. However, this problem has been resolved by computational progress. Models developed on the basis of the INFORUM model include the FuturCanada Model of Canada, the Multisectoral Development Analysis (MUDAN) model of China (Yu, 1997), the Interindustry Forecasting Project (INFORGE) of Germany (Ahlert, 2001; Bach et al., 2002; Lutz et al., 2005, 2007; Meyer et al., 2007a, 2007b; Giljum et al., 2008; Lehr et al., 2008; Wiebe et al., 2012), the Interindustry Italian Model (ITIMO) of Italy (Bardazzi et al., 1991; Bardazzi and Barnabani, 2001), the Japan Interindustry Dynamic Economic Analysis (JIDEA) model of Japan, the INFORUM Model of the Polish Economy (IMPEC) of Poland (Orlowski and Tomaszewicz, 1991), the Macroeconomico Industrial de Espana model of Spain (Werling, 1992), and the Long-term Interindustry Forecasting Tool (LIFT)of the United States (McCarthy, 1991; Dowd et al., 1998). Moreover, some of these models involve an extended module for studying additional specific topics. PANTA RHEI, for

example, is an environmental extension of the INFORGE model of Germany[1]. The Interindustry Large Scale Integrated and Dynamic Model (ILIAD) is an extension of the LIFT of the United States for assessing industries in greater detail.

In 2013, the Taiwanese government began developing an interindustry model to portray the economic interaction between industries in Taiwan, particularly energy-consuming industries, such as the iron, steel, and chemical industries. INFORTW is a local extension of the INFORUM model. This model efficiently estimates and forecasts annual productions and price indices for 47 industries in Taiwan, as well as consumption demands, investment demands, government expenditures, net exports, wages, depreciation expenses, operating profits, and indirect taxes for each industry. Aggregated economic variables, such as the gross domestic production (GDP) and the employed population, can also be obtained using this model. To resolve inconsistent data, the RAS method is used. Generally, this model is dedicated to interindustry planning, government policy analysis, and contributes to a general understanding of the economic environment.

2 THE INTERINDUSTRY FORECASTING MODEL OF TAIWAN

2.1 Real side

The real side of INFORTW estimates the final demand and output for 47 industries in Taiwan. The first central equation of INFORTW is

$$\mathbf{y} \; = \; \mathbf{A} \; \mathbf{y} \; + \; \mathbf{f} \tag{1}$$

where $\mathbf{y}$ is the output vector (1×47), $\mathbf{f}$ is the final demand vector (1×47), and $\mathbf{A}$ is the input

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[1] PANTA RHEI is not an abbreviation; it cites a reflection of the Greek philosopher Heraklit and means all things flow.

coefficient matrix (47×47). This equation represents the equivalence of the supply and demand for each industry. In other words, the output equals the intermediate demand (**A y**) plus the final demand. Throughout this paper, the boldface type represents matrices (denoted in upper case) and vectors (denoted in lowercase), and the italics represent variables.

The final demand is composed of five sectors: the consumption demand (**c**), investment demand (**i**), government expenditures (**g**), exports (**x**), and imports (**m**). These five sectors are all vectors (1× 47). For each industry, the final demand is the summation of its consumption, investment, government expenditure, and net export, expressed as

$$\mathbf{f} = \mathbf{c} + \mathbf{i} + \mathbf{g} + \mathbf{x} - \mathbf{m} \tag{2}$$

The behavior equation of sector demand for each industry is obtained using estimation. The five sectors are introduced as follows.

The consumption demand of an industry i at time t ($c_{i,t}$) could be explained by itself in previous year ($c_{i,t-1}$), because consumption patterns are fairly regular and do not change dramatically in the short-term. Based on demand theory, the consumption demand for industry i is also a function of the price index for industry i ($p_{i,t}$) and total income (y_t). A time variable (t) was also incorporated to represent long-term trends. The consumption demand of industry i at time t is expressed in the following behavioral equation

$$c_{i,t} = C(c_{i,t-1}, \; p_{i,t}, \; y_t, \; t) \;, \; i = 1, \; \dots 13. \tag{3}$$

The investment demand of an industry i at time t ($i_{i,t}$) is determined based on the investment demand in the previous year ($i_{i,t-1}$) and the output of industry i ($y_{i,t}$). In macroeconomics, investment demand is typically considered affected by interest rates (r_t), and the time trend (t) must also be considered. The investment demand for industry i at time t is expressed by the following behavioral equation

$$i_{i,t} = I(i_{i,t-1},\ y_{i,t},\ r_t,\ t)\ ,\ i = 1,\ \dots 19. \tag{4}$$

In practice, data categories are not matched to industries. For example, the consumption demand is calculated based on a dataset comprising 13 categories and these 13 categories are not matched to the 47 industries considered in INFORTW. Moreover, the investment demand is calculated on the basis of a dataset containing 19 categories, which are also not matched to the 47 industries. The consumption and investment demands according to category are converted to the final consumption and investment demands by industry by using a bridge matrix. These conversions are expressed as

$$\mathbf{c} = \mathbf{B_C} \cdot \widetilde{\mathbf{c}} \tag{5}$$

where $\widetilde{\mathbf{c}}$ is the consumption demand vector by category and $\mathbf{B_C}$ is the consumption bridge matrix, and

$$\mathbf{i} = \mathbf{B_I} \cdot \widetilde{\mathbf{i}} \tag{6}$$

where $\widetilde{\mathbf{i}}$ is the investment demand vector by category and $\mathbf{B_I}$ is the investment bridge matrix. Thus, the final demand by industry is obtained by multiplying the final demand by category by the bridge matrix.

The government expenditure of an industry i at time t ($g_{i,t}$) is expressed as an exogenous variable. To calculate the government expenditures of the 46th industry, public administration services, annual government expenditure data collected before 2012 were directly analyzed. Government expenditures for public administration services after 2012 were calculated based on the average growth rate of the preceding 10 years. Government expenditures of the other industries were all set to zero. Moreover, based on trade theory, exports were considered influenced by the export price ($p^e_{i,t}$) of industry i, the foreign price (p^f_t), and foreign income (y^f_t). The exports of industry i ($e_{i,t}$) were also derived from the historical patterns of the previous year ($e_{i,t-1}$). The same logic was applied to imports. Imports ($m_{i,t}$) are affected by the import price ($p^m_{i,t}$), the local price ($p_{i,t}$), the local income

(y_t), and its lagged term ($m_{i,t-1}$). Thus, the exports and imports of industry i at time t are expressed in the following behavioral equations:

$$e_{i,t} = E(e_{i,t-1}, \ p^e_{i,t}, \ p^f_t, \ y^f_t) \ , \ i = 1, \ \ldots 47. \tag{7}$$

$$m_{i,t} = M(m_{i,t-1}, \ p^m_{i,t}, \ p_{i,t}, \ y_t) \ , \ i = 1, \ \ldots 47. \tag{8}$$

After the final demand was estimated using Equations 2 to 8, the output ($y_{i,t}$) for each industry on the real side is obtained by solving Equation 1, which can be rewritten as

$$\mathbf{y} = (\mathbf{I_0} - \mathbf{A})^{-1} \ \mathbf{f} \tag{9}$$

where $\mathbf{I_0}$ is an identity matrix (47×47) and $(\mathbf{I_0} - \mathbf{A})^{-1}$ is a Leontief inverse matrix. The solution for the output is interactive. Because current output, consumption, investment, government expenditures, and net exports are mutually dependent, these six sets of equations are solved simultaneously in the model.

2.2 Price-Income side

The price-income side of INFORTW estimates the value added and unit prices for 47 industries in Taiwan. The second central equation of INFORTW is:

$$\mathbf{p} = \mathbf{A'} \ \mathbf{p} + \mathbf{v} \tag{10}$$

where $\mathbf{p}$ is the unit price vector (1×47), $\mathbf{v}$ is the unit value-added vector (1×47), and $\mathbf{A'}$ is the transposition of the input coefficient matrix (47×47). As this equation shows, the unit price is equal to the sum of the unit material cost ($\mathbf{A'p}$) and the unit value-added cost. The unit value-added cost ($v_{i,t}$) is derived from the total value-added cost ($va_{i,t}$) divided by the output, expressed as:

$$v_{i,t} = \frac{va_{i,t}}{y_{i,t}}, \ i = 1, \ \ldots 47. \tag{11}$$

According to the national accounts, the total value added (**va**) is composed of four components: wages (**w**), depreciation expenses (**d**), operating profit (**pr**), and indirect taxes (**t**). Thus, the total value added is calculated by

$$\textbf{va} \; = \; \textbf{w} \; + \; \textbf{d} \; + \; \textbf{pr} \; + \; \textbf{tax} \tag{12}$$

Each component of the value added is estimated for each industry. The wages of industry i at time t ($w_{i,t}$), which constitutes the principal component of value added in Taiwan, are a function of that industry's lagged term ($w_{i,t-1}$), average wages (w_t), and labor productivity ($prl_{i,t}$). Generally, wages in a specific industry gradually change over time; thus, the lagged term represents the pattern of its autocorrelation. In addition to industry-specific factors, the economic environment influences wages. Thus, the average wage of all industries is considered. The wages of industry i at time t are expressed in the behavioral equation

$$w_{i,t} \; = \; W(w_{i,t-1}, \; w_t, \; prl_{i,t}) \; , \; i \; = \; 1, \; ...47. \tag{13}$$

In addition, wage levels depend on industry-specific labor productivity, which is estimated as a function of changes in output ($\Delta y_{i,t}$), investment in the previous year ($i_{i,t-1}$) and the time trend (t). Changes in output and lagged investment are derived from the estimated results of the real side of INFORTW. The function of the labor productivity of industry i at time t is expressed as:

$$prl_{i,t} \; = \; PRL(\Delta y_{i,t}, \; i_{i,t-1}, \; t) \; , \; i \; = \; 1, \; ...47. \tag{14}$$

After the fitted labor productivity is obtained using Equation 14, the wage behavior equation is estimated by regarding labor productivity as an explanatory variable. Furthermore, the labor demand of industry i at time t ($l_{i,t}$) is obtained from the output divided by the labor productivity, expressed as

$$l_{i,t} \; = \; \frac{y_{i,t}}{prl_{i,t}}, \; i \; = \; 1, \; ...47. \tag{15}$$

The depreciation expenses of industry i at time t ($d_{i,t}$) are estimated according to the industry's

lagged term ($d_{i,t-1}$), the proxy variable of the capital stock for industry i at time t ($k_{i,t}$), and the time

trend (t). Because actual capital stock data for each industry are unavailable, a proxy variable is

employed. The proxy variable used for the capital stock is the cumulative investment, which is also

obtained from the real side of INFORTW. The depreciation expenses of industry i at time t are

expressed in the following behavior equation

$$d_{i,t} = D(d_{i,t-1},\ k_{i,t},\ t)\ ,\ i = 1,\ \ldots 47. \tag{16}$$

The operating profits of industry i at time t ($pr_{i,t}$) are a function of the industry's lagged term

($pr_{i,t-1}$), changes in output ($\Delta y_{i,t}$), and the price index for industry i in the previous year ($p_{i,t-1}$). Based

on production theory, prices affect revenue directly, which in turn affects profits. The operating

profits of industry i at time t are expressed in the following behavior equation

$$pr_{i,t} = PR(pr_{i,t-1},\ \Delta y_{i,t},\ p_{i,t-1})\ ,\ i = 1,\ \ldots 47. \tag{17}$$

Finally, a behavior equation is used to estimate the indirect taxes of industry i at time t ($tax_{i,t}$),

which are simply a function of the value added of industry i ($va_{i,t}$) and the time trend (t). As the linear

function indicates, taxes are a proportion of the total value added, excluding the time trend, and

expressed as:

$$tax_{i,t} = TAX(va_{i,t},\ t)\ ,\ i = 1,\ \ldots 47. \tag{18}$$

After estimating the value added using Equations 11 to 18, the price index ($p_{i,t}$) for each

industry in the price-income side is obtained by solving Equation 10, which can be rewritten as

$$\mathbf{p} = (\mathbf{I_0} - \mathbf{A}')^{-1}\ \mathbf{v}. \tag{19}$$

Similarly, the solution for the price is interactive. Because the current price, value added, and its four

components are all mutually dependent, these sets of equations on the price-income side of

INFORTW are solved simultaneously.

2.3 Connection between the real and price-income side

Figure 1 shows a detailed flow chart of the real and price-income sides of INFORTW. INFORTW was programmed using Stata statistical software (version 12).

[FIGURE 1]

2.4 RAS method

In this study, a data mismatch occurred because the data were acquired from various sources. In particular, the output for each industry differed between I-O tables and national accounts, causing unstable estimated results when simultaneously using the industrial structure from the I-O tables and the time series data from national accounts. Thus, one of the datasets had to be reasonably adjusted to synchronize the I-O table with the national account. In addition, I-O tables are updated every five years, but industrial structures can change substantially within five years, rendering the industrial structure outdated. However, national accounts are revised annually. Integrating the I-O table into the national account can allow the latest annual I-O coefficient and data to be obtained. Thus, to solve these problems, the RAS method (Bacharach, 1970) was employed before the INFORTW was used for estimation.

Beginning with an I-O table (matrix **A**, 47×47), which represents the interindustry structure, two constrained conditions from the national account were set, including the output minus final demand (vector **u**, 1×47) and the output minus value added (vector **v**, 1×47) for each industry. Using recursive estimation, the RAS method was used to adjust each element of the I-O table, and making the row-sum and column-sum equal to the vector **u** and **v**, respectively, by industry. After the revised I-O coefficients (matrix **B**, 47×47) were obtained, the INFORTW could be estimated.

2.5 Data

INFORTW is not the only econometric model involving I-O techniques, but it is distinguished from numerous models used to model the Taiwanese economy by its data foundation. This data foundation is composed of I-O tables updated every five years, and time series data regarding outputs, prices, five sectors of final demand, and four components of value added. All data are collected for 47 industries of INFORTW. The substantial foundation of data used in this model contributes to both the estimation of behavioral equations and its forecasting ability.

Time series data were obtained from various sources. Taiwanese economic data, such as the national account or the I-O table, were primarily acquired from the Directorate General of Budget, Accounting and Statistics (DGBAS) of Taiwan. The I-O table has been updated every 5 years since 1981, and the latest I-O table was updated in 2006. Other economic data are updated annually and range between 1981 and 2011. Data regarding Taiwan's annual government expenditures, exports, and imports were acquired from the Ministry of Finance of Taiwan. To consider the international economic situation when estimating net exports, the global production and price data from the World Development Indicators of the World Bank were used. Historical data between 1981 and 2012 were used to estimate the model. To avoid over-extrapolation, the forecasting interval of the INFORTW was set to 2013–2025. When future data is available, the forecasting period can be lengthened accordingly.

In addition, the original data was not exactly sorted according to 47 industries. Thus, data were merged or divided as necessary. The 47 industries described by the INFORTW were classified as presented in Appendix 1.

3 SCENARIOS

According to the IEA (2010), energy efficiency has been emphasized by governments worldwide in recent years. Based on a 2012 survey conducted by the Energy Bureau of Taiwan, the iron and steel industries annually invest approximately USD$43.6 million (TWD$1.29 billion) in energy saving, and primarily (71.8%) invest in maintaining and improving their production processes. This survey collected primary data from major energy-consuming companies in Taiwan. In addition, a policy target for improving energy efficiency by 2% per year has been implemented since 2008, by the Ministry of Economic Affairs of Taiwan. Moreover, technical feasibility was considered based on the FORECAST model which is a Germen model and the extension application of Taiwan is under developing. FORECAST is a bottom-up technical model for measuring energy use (Fleiter et al., 2011, 2012). The bottom-up model is used because of its engineering base, which is neglected in top-down economic models, including INFORTW. The FORECAST model involves using productions in the base scenario of the INFORTW as exogenous variables and is used to estimate the technically feasible amount of energy saving in the future. This energy saving is then set as exogenous variables into the INFORTW to simulate economic impacts in different scenarios of energy efficiency improvement. Incorporating a bottom-up model into INFORTW would increase the reliability of the exogenous energy saving rate set by INFORTW.

To model energy efficiency improvements in the iron and steel industries, technical feasibility, investment amount, and energy saving targets were considered in modeling "weak" and "strong" energy efficiency scenario. In the weak scenario, the electricity and gas inputs were decreased by 3% and 0.5%, respectively, and this energy efficiency improvement was considered financially supported by USD$50.7 million (TWD$1.5 billion) of investment after 2015. The strong scenario was modeled in two stages. At the first stage, the electricity and gas inputs were decreased by 4% and 0.7%, respectively, and annual investment was set at USD$67.6 million (TWD$2 billion) after 2015. The

production process was expected to have progressed by 2020, implying greater improvements in energy efficiency. Thus, at the second stage of the strong scenario, the electricity and gas inputs were considered to decrease further, by 8% and 2%, respectively, and annual investment was further increased by USD$67.6 million (TWD$2 billion). These two scenarios were considered technically feasible after referring to the MURE model and consulting specialists' opinions. Thus, three scenarios modeled for the iron and steel industries in Taiwan were specified as follows:

Scenario 2-1: Base scenario.

Scenario 2-2: Weak scenario:

Electricity input decreases by 3% and gas input decreases by 0.5% after 2015.

Annual investment increases by USD$50.7 million after 2015.

Scenario 2-3: Strong scenario:

Stage 1: Electricity input decreases by 4% and gas input decreases by 0.7% after 2015.

Annual investment increases by USD$67.6 million after 2015.

Stage 2: Electricity input decreases by 8% and gas input decreases by 2% after 2020.

Annual investment further increases by USD$67.6 million after 2020.

4 ESTIMATED RESULTS

4.1 Base scenarios

Figure 2 shows the estimated results of the economic environment in Taiwan from 1981 to 2025 obtained using INFORTW; the values after 2012 were forecasted. As shown in Figure 2 (A), the fitted value of Taiwan's GDP was remarkably similar to the actual value, particularly in the last 15 years. An upward trend was also observed. Moreover, some of Taiwan's recent economic shocks, such as the global financial crisis in 2009, the SARS epidemic in 2003, and the Asian financial crisis

in 1998, were indicated by drops in GDP. These results indicated that the estimation ability of the

INFORTW was satisfactory, which implied that the forecast values were reliable. The GDP was

predicted to be USD$479.7 billion at an economic growth rate of 2.05% in 2013, and USD$577.8

billion at a 1.98% growth rate in 2020.

The fitted value was markedly accurate around 2006, because the I-O table of the 2006 version

was used. Further from 2006, the estimated error was more substantial because the industry structure

had changed. For forecasting purposes, the latest industrial structure should be used to ensure that the

most accurate forecasting values were obtained. The 2011 version of the I-O table is expected to be

released in late 2014, at which time the input coefficients can be updated.

[FIGURE 2]

The iron and steel industries were modeled to demonstrate the industrial explanatory ability of

INFORTW. Figure 3 shows the estimated results of the base scenario between 1981 and 2025, in

which values after 2011 were predicted. A slow upward trend was observed. The production (or

value added) of the iron and steel industry in Taiwan was predicted to be USD$6.75 billion and

USD$7.04 billion in 2015 and 2020, respectively, at an average annual growth rate of approximately

1%.

[FIGURE 3]

4.2 Economic Impact simulation

Three scenarios (Section 3.2) were simulated: the base scenario, the weak scenario, and the

strong scenario. Table 1 lists the estimated results for the iron and steel industries in particular, and

Table 2 lists the overall estimated results for the general Taiwanese economy. The values for the

weak and strong scenarios listed in Tables 1 and 2 represent the difference between these scenarios

and base scenario. Policy influences caused by improving energy efficiency were thus be captured by

changes in production and job opportunities.

[TABLE 1]
[TABLE 2]

As shown in Table 1, the production of the iron and steel industry exhibited a slow growth in the base scenario. Based on this slight upward trend, production changes immediately decreased when the investments in energy efficiency were input. Because of increasing investment, the value added of the iron and steel industry was immediately crowded out. In the weak scenario, production decreased by USD$525 million in 2015. In the strong scenario, productions dropped by USD$699 million in 2015 and decreased by USD$1362 million in 2020. However, this negative effect was compensated for progressively by improvements in energy efficiency. This improvement rendered the production process more efficient, causing a subsequent increase in production after investing. According to the INFORTW results, the recovery period was approximately six years. Production changes caused by the investment and recovery processes are shown in Figure 4(A). After the immediate drop in the first years of investment (in 2015 and 2020), the negative production change gradually decreased and then became positive approximately six years later. This pattern was similar in both the weak and strong scenarios, but the degree of influence on production was higher for the strong scenario.

In addition, this energy efficiency improvement produced a strong linkage effect throughout the Taiwanese economy. The changes in Taiwan's GDP caused by energy efficiency improvements in the iron and steel industries are shown in Figure 4(B). The improvements undertaken in the weak scenario, which involved annual investment amounts of $50.7 million, were estimated to increase Taiwan's GDP by USD$198.1 million until 2025. The strong scenario, which involved annual investment amounts of USD$67.6 million and USD$135.2 million in Stage 1 and Stage 2, was estimated to increase the GDP by USD$264.2 million at Stage 1 until 2020 and by USD535.7 million at Stage 2 until 2025. Thus, the multiplier was approximately four times, suggesting that the iron and

steel industries exert a strong linkage effect on Taiwan's current economic situation. This positive effect was almost permanent except for a small glide in later years, which could be ignored within a decade.

[FIGURE 4]

The production results indicated that the iron and steel industries are an appropriate target industry for improving energy efficiency and promoting the economy. Because of the industry's strong linkage effect on the general economy, the positive influence of such improvements on Taiwan's economy would be substantial. However, because of the long recovery period (approximately six years), enterprises in the iron and steel industries, particularly small and medium-sized enterprises that hold limited assets, have little incentive to invest in energy efficiency. Thus, the authorities must intervene in increasing energy efficiency investment incentives, which spur the more efficient use of energy and boost the economy. Soft incentives, such as subsidies and tax deductions, or hard incentives, such as regulations, could be employed.

5 CONCLUSION

In this paper, a multisectoral economic model of Taiwan, INFORTW, is presented. This model belongs to the INFORUM family of models, which were originally developed by Almon (1966, 1974, 1988, and 1991) and then developed in several other countries worldwide. INFORTW contains two sides—the real side and the price-income side—and each side incorporates different sectors to describe 47 industries in Taiwan. The real side estimates consumption demands, investment demands, government expenditures, net exports, final demands, and total outputs. The price-income side estimates wages, labor productivity, labor demands, depreciation expenses, operating profits, indirect taxes, value added, and price indices. In addition, the RAS method is used to resolve inconsistent data , caused by the discrepancy in data sources between the I-O table and the national account. In addition to the 47 industries, the overall economic environment can also be analyzed using

INFORTW. Similar to other models in the INFORUM family, INFORTW can be employed to simulate various economic impacts when formulating policies. In other words, INFORTW can be used to answer the "what if" economic questions.

To evaluate INFORTW, fitted values were compared with actual values for each industry and for the general Taiwanese economy. The estimated results for the fitted values were extremely similar to the actual values. Thus, the estimation ability of the INFORTW was satisfactory, which suggests that its forecasting values are reliable.

Investment in improvements in energy efficiency in the iron and steel industries exerted a multiplier effect of approximately four times on Taiwan's GDP. However, because such investment would crowd out part of production and the recovery period was estimated at approximately six years, enterprises in the iron and steel industries have less of an incentive to invest. Thus, the authorities should provide incentives to induce this "positive externality."

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APPENDIX

APPENDIX 1. The classification for INFORTW 47 industries

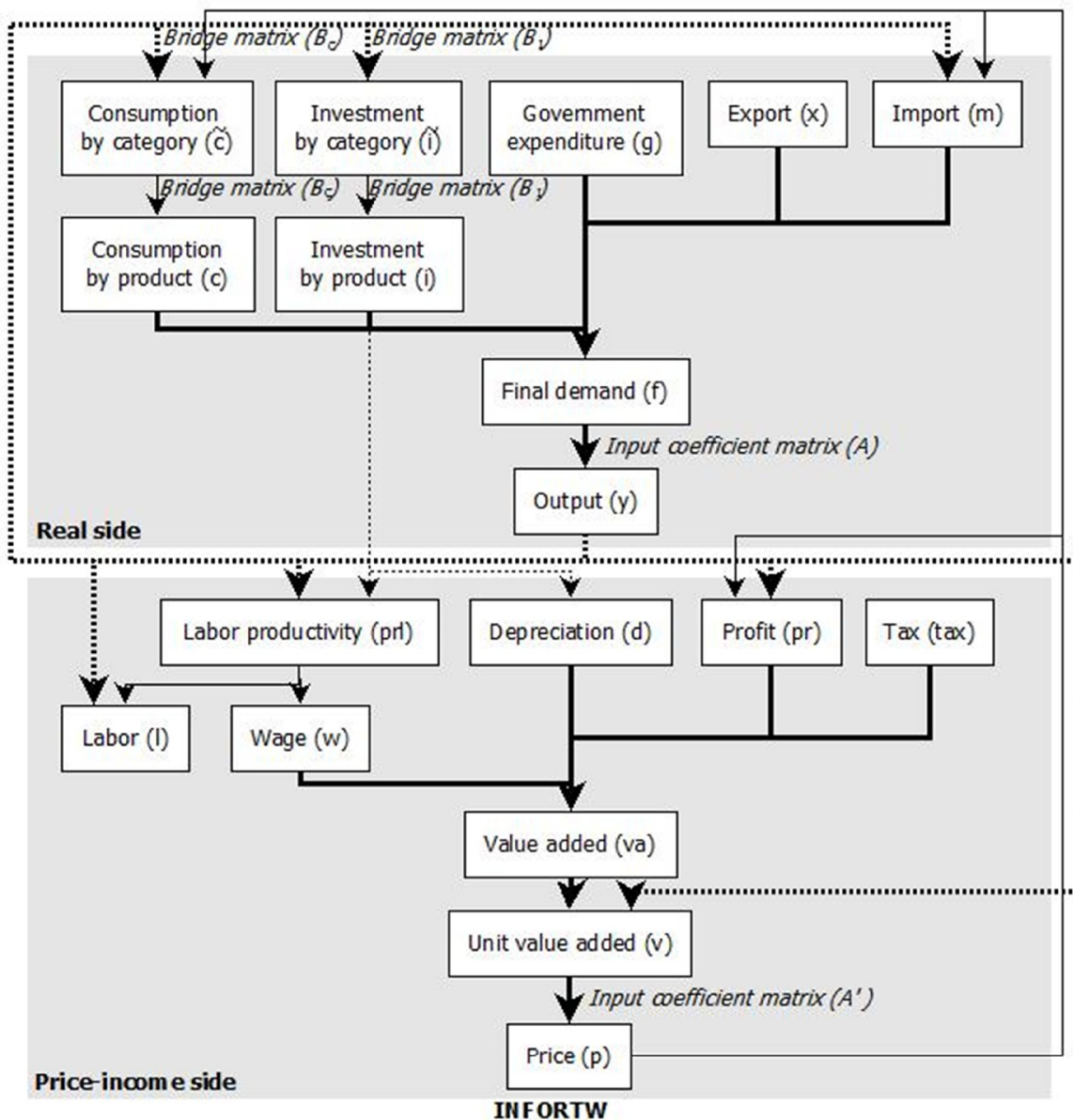| No.	Industry	No.	Industry
The primary sector		24	Lighting equipment
1	Agriculture, livestock, forestry & fishing	25	Domestic appliances
The secondary sector		26	Other electrical materials
2	Minerals	27	Mechanical equipment
3	Process foods, beverages & tobacco	28	Motor vehicles & Transport equipment
4	Textiles & wearing apparel	29	Other manufactures
5	Leather, fur & related products	30	Electricity supply
6	Wood & related products	31	Gas supply
7	Pulp, paper & paper products	32	Water supply & remediation Services
8	Printing	33	Construction
9	Petroleum products	**The tertiary sector**	
10	Coal products	34	Wholesale & retail trade
11	Chemical materials	35	Land transportation
12	Chemical products & medicines	36	Water transportation
13	Rubber & plastic products	37	Air transportation
14	Non-metallic mineral products	38	Supporting services of transportation
15	Iron & steel products	39	Warehousing & storage
16	Other metals	40	Postal & courier services
17	Semi-conductors	41	Accommodation & food services
18	Optoelectronic materials & components	42	Communication, telecommunication & information services
19	Printed circuit assembly	43	Finance, insurance & real estate services
20	Other electronic components & parts	44	Professional, scientific & technical services
21	Computers, electronic & optical products	45	Education, health, social work & entertainment services
22	Power generation, transmission & distribution machinery	46	Public administration services
23	Wires, cables & wiring devices	47	Other services

FIGURE

FIGURE 1. Connection of real and price-income sides of INFORTW
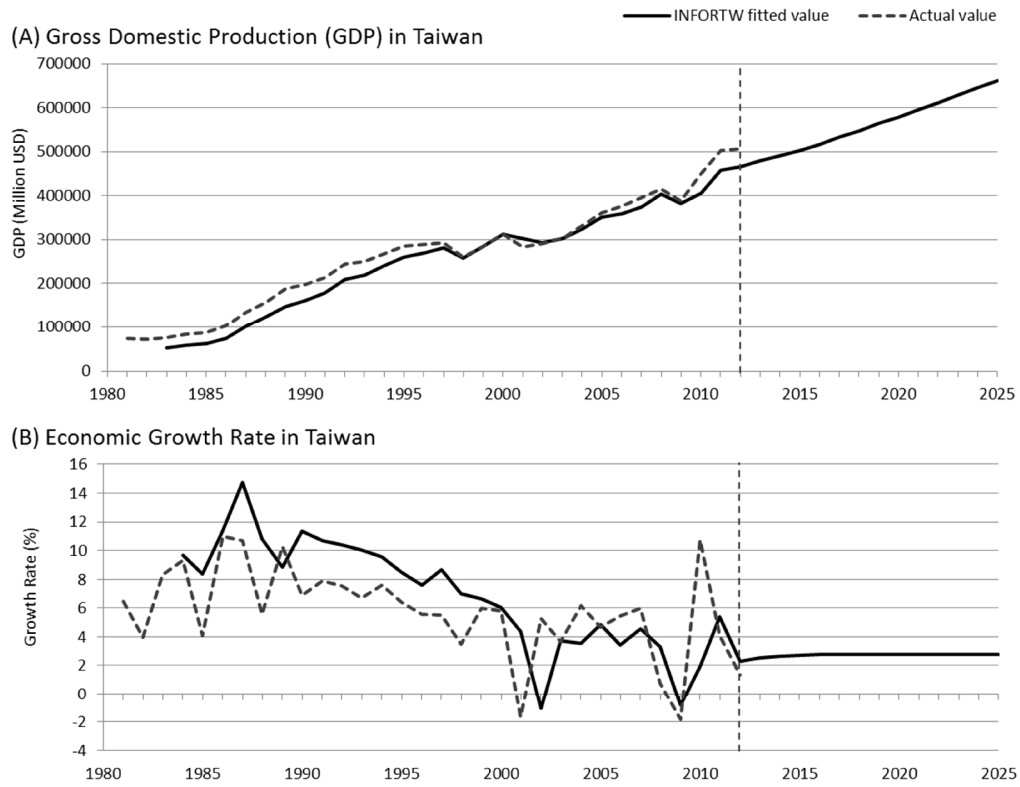
(A) Gross Domestic Production (GDP) in Taiwan

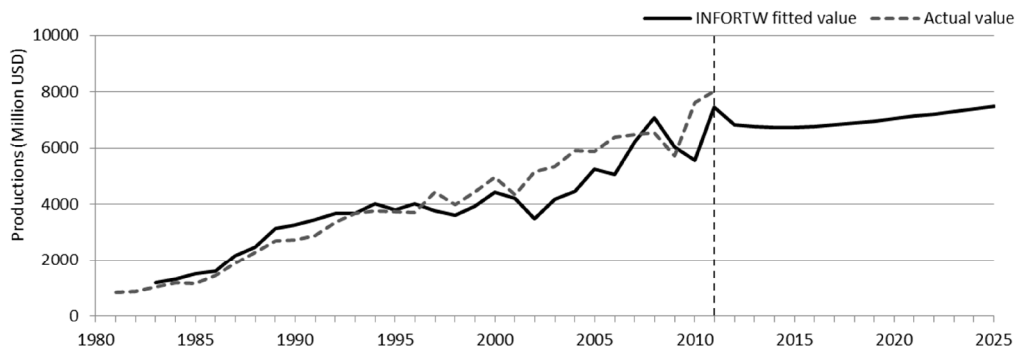FIGURE 2. INFORTW estimated results of macroeconomic variables (1981 – 2025)

FIGURE 3. INFORTW estimated results for productions of the iron and steel industry (1981 – 2025)
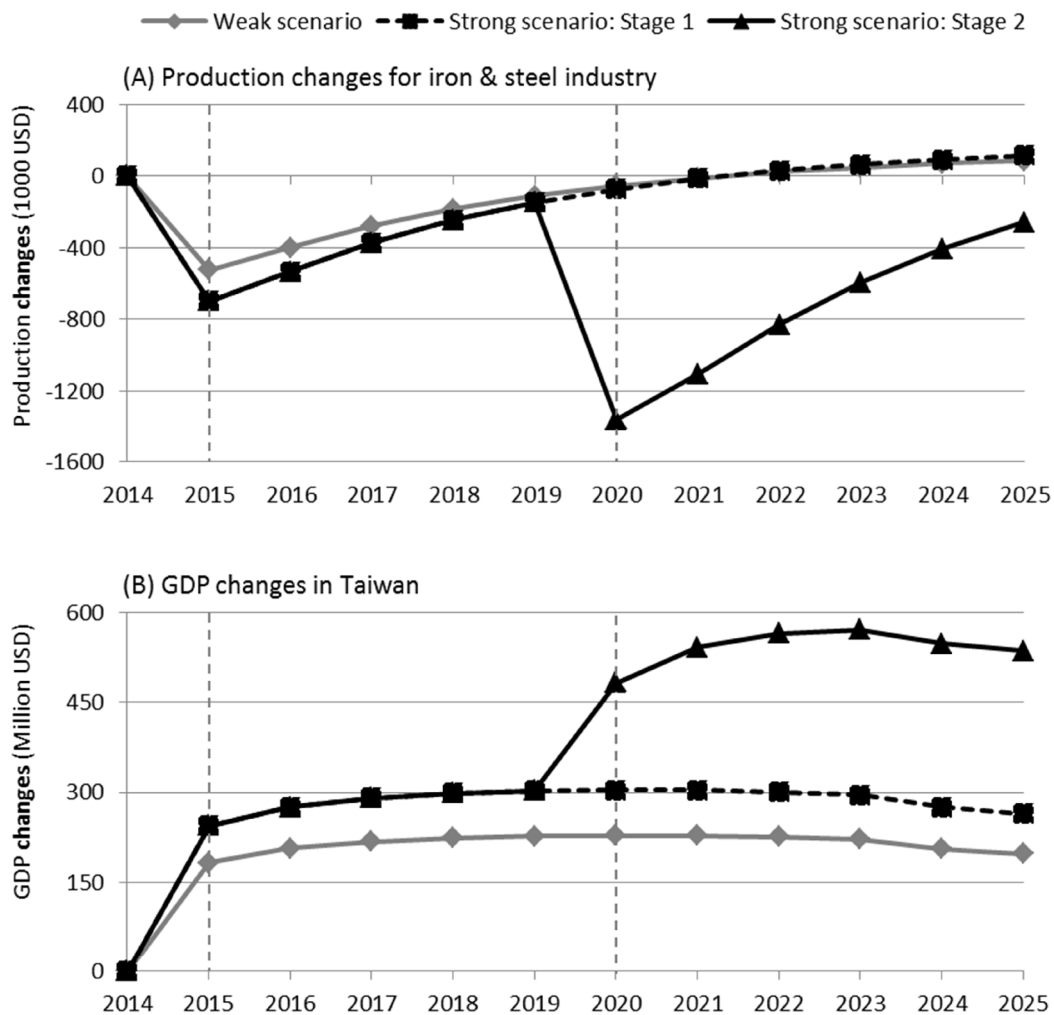
FIGURE 4. Production changes due to energy efficiency improvement in iron and steel industry

TABLE

TABLE 1. INFORTW estimated results for iron and steel industry in Taiwan

Year	Scenario 2-1: Base scenario		Scenario 2-2: Weak scenario		Scenario 2-3: Strong scenario			
	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.

TABLE 2. INFORTW estimated results for Taiwan

Year	Scenario 2-1: Base scenario		Scenario 2-2: Weak scenario		Scenario 2-3: Strong scenario			
	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.