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The Evaluation of technological progress in Japanese Economy- using JIDEA7

This paper aims at evaluating the contribution of technological progress to Japanese Economic growth for forecasting periods between 2006 and 2020. The growth rate will be decomposed into changes in demands and in technological progress, and synergy effects.

For the projection figures, I will make forecasts by use of our JIDEA7 with different input coefficients calculated within our model. Then, I will try to find out the relationship between input coefficients change and its contribution of technological progress factors to the growth.

1. Introduction

There seem to be two ways in forecasting an economy by use of I-O tables; fixing coefficients constant and varying them. In Japan, many people use the former methods especially for short term projection, assuming that the input structure is stable. Contrary to the case, INFORUM model has a function to vary the input coefficients, which enable us to make long term forecasting effectively.

In this paper, I will explain the methods and suggest how to fix the extended indexes.

1-1. INFORUM methods of changing input coefficients adopted in JIDEA7

1. prepare real input-output table between 1985 and 2006; amr_t
2. calculate the followings;
   $inter_t = amr_t * outr_t - amr_t * I * outr_t$ (1985≦t≦2006)
   $cci_t = amr_{2006} * outr_t - amr_{2006} * I * outr_t$
   $index_t = inter_t / cci_t$
3. applying ols for index projection
   $index_t = f(dum85, dum90, dum95, time)$ (est. 1986-2006)
   Then projecting indexes up to 2020 and adjusting indexes of 2006 as 1.0.
4. estimating the input coefficients for forecasting periods by followings;
   $amr_t = I * index_t * amr_{2006}$ (2006≦t≦2020)

1-2. Table 1 shows indexes figures obtained by using JIDEA7 database.

The colored cells indicate that their growth rates over the previous year are over 10% or less than -10%, meaning that the coefficients are fluctuating much and not so stable.

In Japan, many people assume that the input coefficients are stable enough for some five years. But these data show that the assumption is not necessarily true. [1]

Table 1. INFORUM Methods Applied to Japanese Intermediate Coefficients (2006=1.0)

	OBSERVATION																					
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	1.28	1.24	1.20	1.00	1.18	1.12	1.08	1.02	1.02	0.90	1.01	1.03	1.05	1.02	1.03	1.02	0.96	0.96	0.96	0.96	1.00	1.00
2	1.15	1.12	1.08	2.83	1.09	1.10	1.01	1.12	1.21	1.06	1.14	1.04	1.04	1.03	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00
3	1.25	1.19	1.12	1.02	1.04	0.83	0.87	0.88	0.93	0.83	0.96	0.86	0.85	0.92	0.94	0.93	1.00	1.00	1.00	1.00	1.00	1.00
4	0.89	0.88	0.87	0.33	0.90	0.89	1.07	1.16	1.22	0.89	0.85	0.90	0.90	0.94	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00
5	1.06	1.08	1.12	7.03	1.11	1.08	1.35	1.62	1.08	1.16	0.97	0.87	0.84	0.99	0.97	0.95	1.00	1.00	1.00	1.00	1.00	1.00
6	0.96	0.95	1.02	1.06	0.88	0.91	0.94	0.97	0.89	0.95	0.97	1.00	0.99	1.05	1.08	1.02	1.07	1.08	1.02	1.01	1.01	1.00
7	0.83	0.84	0.87	0.72	0.75	1.03	1.03	1.13	1.06	1.07	1.01	1.16	1.16	1.00	0.99	0.98	1.04	1.04	1.01	1.01	1.00	1.00
8	0.90	0.79	0.81	0.67	0.87	0.95	1.06	1.06	0.94	0.87	0.96	1.02	1.07	1.04	1.05	0.99	0.99	1.00	1.00	0.99	0.97	1.00
9	1.28	1.14	1.10	0.89	0.79	1.44	1.18	1.06	1.12	0.96	1.01	1.14	1.16	1.03	1.01	0.76	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	0.96	0.92	1.10	1.04	1.07	1.20	1.32	1.07	1.13	1.01	1.00	0.99	1.00	1.03	1.02	0.99	0.99	1.02	1.01	1.01	1.00
11	1.03	1.02	1.01	0.97	1.05	1.19	1.14	1.14	1.06	1.00	1.03	0.91	0.86	1.01	1.03	1.01	1.01	1.01	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	0.98	1.00	1.01	0.97	0.93	0.91	0.88	1.01	1.03	1.05	1.01	0.99	0.99	1.03	1.03	1.01	1.02	1.01	1.00
13	1.28	1.25	1.24	1.18	1.12	1.09	1.10	1.11	1.06	1.07	0.97	1.10	1.06	0.98	0.99	1.00	0.99	0.99	1.00	1.00	1.00	1.00
14	1.01	1.01	1.01	1.01	1.05	1.05	0.89	0.87	1.03	1.11	1.06	1.00	0.99	1.02	1.03	1.00	0.98	0.99	1.00	0.99	0.99	1.00
15	0.93	1.04	1.17	1.11	1.15	1.04	1.13	1.39	1.27	1.21	1.01	1.06	1.12	1.05	1.09	1.05	1.01	1.02	1.03	1.03	1.03	1.00
16	0.91	0.91	0.91	0.92	0.94	0.93	0.86	0.87	0.85	0.94	0.93	0.95	0.99	1.02	1.00	1.04	1.04	1.02	1.01	1.02	1.00	1.00
17	0.90	0.91	0.93	0.97	0.96	0.95	0.86	0.80	0.77	0.80	0.97	0.93	0.95	1.02	1.12	1.01	1.00	1.00	1.00	1.00	1.00	1.00
18	0.61	0.63	0.63	0.59	0.68	0.70	0.78	0.79	0.72	0.80	0.91	0.91	0.96	0.97	1.03	1.02	1.00	1.00	1.00	1.00	1.00	1.00
19	0.96	0.90	0.87	0.87	0.90	1.07	0.91	0.89	0.90	0.88	1.06	0.89	0.89	1.06	1.02	1.04	1.07	1.06	1.01	1.04	1.00	1.00
20	0.90	0.89	0.87	0.83	0.80	0.96	0.77	0.72	0.57	0.63	0.94	0.90	0.89	0.94	0.98	0.90	0.99	0.99	1.00	1.00	1.00	1.00
21	0.96	0.94	0.94	0.98	1.04	1.05	1.39	1.59	1.17	1.22	0.99	1.02	1.05	0.97	0.96	0.96	1.00	1.00	1.00	1.00	1.00	1.00
22	0.94	0.92	0.88	0.93	0.87	0.79	0.82	0.86	0.79	0.86	0.81	0.80	0.78	0.90	0.92	0.93	0.94	0.94	0.98	1.00	1.00	1.00
23	1.12	1.13	1.12	1.08	1.11	1.11	1.05	1.06	1.10	1.15	1.14	1.13	1.16	1.05	0.91	0.95	0.89	0.88	0.95	1.02	0.98	1.00
24	1.23	1.22	1.24	1.18	1.21	1.18	1.08	1.09	1.04	1.11	1.09	0.99	1.01	1.04	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
25	1.30	1.31	1.31	1.22	1.25	1.39	1.24	1.30	1.20	1.16	1.32	1.32	1.27	1.24	1.28	1.17	0.96	0.96	0.97	0.97	0.99	1.00
26	1.05	0.92	0.83	0.91	0.93	1.02	1.01	1.08	1.08	1.05	1.02	0.96	0.94	0.92	0.90	0.98	1.01	1.01	1.01	0.99	1.00	1.00
27	1.28	1.19	1.10	1.06	1.16	1.29	0.88	0.86	0.77	0.82	1.21	1.15	1.30	1.28	1.14	1.09	0.95	0.94	1.00	1.00	1.00	1.00
28	1.11	1.01	0.92	0.91	0.96	1.04	0.96	0.92	0.97	0.93	0.99	0.94	0.99	0.97	1.01	1.00	0.99	0.99	1.00	1.00	1.00	1.00
29	0.87	0.89	0.95	0.90	0.96	0.93	1.03	1.16	0.92	0.91	1.01	1.09	1.09	1.15	1.11	1.11	1.06	1.03	1.08	1.01	0.99	1.00
30	0.96	1.00	1.02	1.08	1.04	1.03	1.16	1.40	1.44	1.37	0.96	1.00	0.96	0.88	1.01	0.96	0.95	0.95	0.99	1.00	1.01	1.00
31	0.92	0.84	0.83	0.81	0.85	0.93	0.84	0.86	0.81	0.76	0.93	0.89	1.01	1.00	0.98	0.96	1.00	0.99	0.99	1.00	1.00	1.00
32	1.11	1.14	1.17	1.20	1.18	1.22	1.23	1.34	1.38	1.34	1.20	1.29	1.33	1.06	0.99	1.10	1.00	1.00	1.00	1.00	1.00	1.00
33	1.09	1.06	1.04	1.01	1.05	1.09	1.17	1.16	1.13	1.15	1.01	1.17	1.14	0.93	0.95	0.99	0.98	0.99	1.00	1.00	1.00	1.00
34	1.17	1.21	1.24	0.94	0.97	1.18	0.88	0.75	0.99	0.98	0.80	1.03	1.08	0.92	0.92	0.89	0.86	0.82	0.98	1.00	1.01	1.00
35	2.18	1.80	1.74	0.50	0.53	0.39	0.95	1.43	0.95	1.06	1.50	1.25	1.39	1.68	1.63	1.02	1.65	1.55	1.38	1.38	1.18	1.00
36	1.17	1.13	1.13	1.08	1.08	1.00	0.91	0.90	0.84	0.89	1.00	0.99	1.03	1.05	1.10	0.98	1.07	1.06	1.01	1.01	1.00	1.00
37	1.39	1.48	1.82	0.91	0.81	0.83	0.85	0.84	0.89	0.55	1.10	0.89	1.22	1.19	1.09	1.56	0.89	0.86	0.80	1.15	0.71	1.00
38	0.67	0.88	1.16	0.28	0.86	0.60	0.32	0.12	0.11	−0.31	0.56	1.24	1.34	1.06	1.19	0.61	0.44	0.51	0.83	0.86	0.96	1.00
39	0.51	0.77	0.82	−0.48	−1.48	0.31	2.03	1.89	1.77	1.49	0.07	−0.55	−1.87	0.76	2.43	4.77	4.35	4.27	2.53	1.88	0.42	1.00
40	0.43	0.41	0.40	0.42	0.51	0.48	0.56	0.57	0.54	0.48	0.79	0.65	0.63	0.95	0.99	1.01	1.07	1.05	1.01	0.99	0.99	1.00
41	0.81	0.65	0.65	−0.14	−0.12	0.45	0.48	0.74	0.64	0.71	0.72	1.25	1.16	0.74	0.81	0.93	0.70	0.73	0.94	0.90	0.91	1.00
42	0.31	0.32	0.37	0.44	0.42	0.51	0.53	0.43	0.47	0.42	0.78	0.92	1.21	0.99	1.02	0.91	1.00	1.00	1.00	1.00	1.00	1.00
43	0.65	0.67	0.69	0.61	0.84	0.79	0.83	0.80	0.84	0.82	1.00	0.77	0.81	0.97	0.98	0.99	1.17	1.15	1.19	1.24	1.20	1.00
44	1.28	1.32	1.41	1.08	1.19	1.34	0.76	0.78	0.86	0.71	0.90	1.05	1.06	0.99	1.17	1.04	0.90	0.90	1.00	1.00	1.00	1.00
45	1.12	1.12	1.12	0.82	1.10	1.00	0.75	0.73	0.74	0.78	0.83	0.89	0.92	0.88	0.87	0.91	1.05	1.03	1.04	1.03	1.01	1.00
46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
47	1.12	1.12	1.16	1.05	1.13	1.11	0.92	0.89	0.95	0.99	0.99	1.01	1.06	1.10	1.00	1.02	1.05	1.05	1.01	1.00	0.99	1.00
48	1.49	1.35	1.31	0.99	1.15	1.24	1.31	1.42	1.41	1.49	1.15	1.04	1.08	1.31	0.98	0.98	1.25	1.25	0.95	1.05	1.02	1.00
49	0.73	0.71	0.72	0.43	0.61	0.70	0.65	0.71	0.74	0.79	0.87	0.87	0.90	0.97	0.93	1.05	0.97	0.92	1.05	1.04	1.01	1.00
50	0.60	0.60	0.60	0.58	0.54	0.57	0.59	0.57	0.54	0.58	0.54	0.55	0.54	0.90	0.97	0.92	0.96	0.96	0.98	0.99	0.99	1.00
51	1.11	1.21	1.30	1.25	1.37	1.09	0.96	0.88	0.80	0.74	1.17	0.85	0.82	1.22	1.08	0.99	1.00	1.00	1.00	1.00	1.00	1.00
52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	0.73	0.81	0.84	0.82	0.85	0.85	0.93	0.87	0.85	0.90	0.99	0.87	0.87	0.93	0.92	0.98	0.91	0.91	1.00	1.00	1.00	1.00
55	0.46	0.50	0.54	0.58	0.61	0.79	0.76	0.84	0.83	0.77	0.98	0.80	0.80	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00
56	0.99	0.99	1.00	0.99	0.98	0.96	1.04	1.05	1.08	1.14	0.94	0.93	0.93	1.00	0.99	0.98	1.00	1.00	1.00	1.00	1.00	1.00
57	0.85	0.86	0.89	0.80	0.72	1.02	0.93	0.89	0.82	0.92	1.05	1.06	1.05	0.99	0.99	0.94	1.01	1.01	1.00	1.00	1.01	1.00
58	1.26	1.21	1.19	1.08	1.00	1.06	1.08	0.92	1.07	1.14	0.95	1.04	1.06	1.00	0.99	1.00	0.96	0.97	0.98	0.98	0.99	1.00
59	1.00	1.01	0.99	0.98	0.96	1.06	1.14	1.11	1.11	1.19	1.04	1.15	1.15	1.02	1.01	1.02	1.05	1.05	1.03	1.02	1.02	1.00
60	0.63	0.62	0.60	0.68	0.68	0.71	0.62	0.64	0.53	0.54	1.04	0.83	0.78	1.03	1.03	0.96	1.01	1.03	0.99	1.00	1.01	1.00
61	0.30	0.30	0.31	0.28	0.30	0.52	0.11	0.38	0.56	0.87	1.01	0.53	0.53	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
62	0.97	0.98	1.00	0.98	0.94	0.97	1.15	1.26	1.51	1.54	0.95	0.92	0.89	1.00	0.98	0.97	0.97	0.97	1.00	1.00	1.00	1.00
63	0.58	0.83	1.10	1.00	0.92	0.55	0.54	0.51	0.78	0.83	0.90	0.52	0.52	0.98	1.01	0.99	1.01	1.01	1.00	1.00	1.00	1.00
64	0.91	0.88	0.85	0.83	0.84	0.85	0.78	0.77	0.84	0.80	0.93	0.85	0.84	0.97	1.01	1.01	1.02	1.02	1.01	1.00	1.00	1.00
65	1.36	1.30	1.24	1.25	1.10	0.89	0.78	0.85	0.84	0.85	1.21	0.77	0.76	1.16	1.16	0.92	1.12	1.12	0.96	0.97	1.00	1.00
66	1.39	1.30	1.24	1.11	1.20	1.28	1.22	1.20	1.21	1.18	0.92	1.19	1.21	0.97	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00

Note: [yellow box] indicates that growth rates over the previous year is more/less than 10%
These figures are calculated as followings; (amr*outr-diagonal elements)/(amr[2006]*outr-diagonal elements)
Source: JIDEA7

Table 2 shows estimated results of slopes by changing the estimation periods.

A is the estimated slopes obtained from 1986 to 2006 data and their indexes of year 2020 . The results of B and C are derived from the periods from 1999 to 2006 and from 2002 to 2006 respectively.

D and E are the indexes figures of 2020 obtained by multiplying 0.999 and 1.08 for the baseline indexes respectively.

If we assume that the coefficients are stable for some five years, we can expect that the slopes should be around 0.0. Contrary to this expectation, the case C (est.2002-2006) which reflects the latest trends, has a sector like 39 whose slope is minus 0.864, and this means the figure of 2020 will be minus 11.1, (1-0.864*14). This would not happen in reality.

When we use coefficients of case B (est.1999-2006), the model works but not stable if we change several equations under current baseline fixes.

Therefore, when applying INFORUM method for changing input coefficients, it seems better and practical to modify them to fit for Japanese model instead of just adopting the calculated figures.

In the end, we fixed the indexes for baseline simulation, based on the results of data periods from 1986 to 2006 with some modification, which is shown Table 3.

Table 4 shows the results when a variation of INFORUM methods is applied to. Case A is estimators obtained by not extracting diagonal elements and case B is by original way.

The average of indexes figures in 2020 of case A is 1.011, and the same of B is 1.032. The indexes seem moderate in the case of A. Initially I assume that indexes of case A will clinches more to 1.0 than those of B because the magnitudes of diagonal elements are relatively larger than others. This means if indexes are more than 1.0, the ratios of B/A are expected over 1.0 and if less than 1.0, then below 1.0.

However, when we see the figures sector wise, the ratios of B/A do not always support this assumption. This is partly because the diagonal elements are not necessarily the largest in the row. However, there still exist that the assumption is denied even though the diagonal elements are the biggest in the sector.

Regarding the indexes estimation, we apply the linear function for extending the indexes in our model. But INFORUM seems to have an experience for applying logistic curve. Much more variation of estimating indexes can be explored.

Table 2. The Coefresults Indexes and their figures in 2020 (2006=1.0)

	Baseline	A (est: 86-2006)		B (est: 99-2006)		C (est: 2002-2006)		const	D coef: 0.999	E coef:1.08
	2020	slope	2020	slope	2020	slope	2020	2020	2020	2020
1	0.86	-0.011	0.84	-0.004	0.94	0.013	1.18	1.00	0.85	0.93
2	0.94	-0.022	0.70	-0.002	0.98	0.000	1.00	1.00	0.93	1.01
3	1.14	-0.005	0.93	0.009	1.12	0.000	1.00	1.00	1.13	1.23
4	1.11	0.009	1.13	-0.001	0.98	0.000	1.00	1.00	1.10	1.20
5	1.13	-0.060	0.15	0.006	1.08	0.000	1.00	1.00	1.12	1.22
6	1.08	0.005	1.06	-0.010	0.85	-0.017	0.76	1.00	1.07	1.17
7	0.94	0.009	1.12	0.001	1.02	-0.008	0.89	1.00	0.93	1.02
8	1.00	0.009	1.13	-0.005	0.92	-0.003	0.95	1.00	0.99	1.08
9	1.00	-0.008	0.89	0.014	1.20	0.001	1.01	1.00	1.00	1.00
10	0.96	-0.003	0.96	-0.002	0.97	0.002	1.03	1.00	0.95	1.03
11	0.90	-0.003	0.95	-0.004	0.95	-0.002	0.97	1.00	0.89	0.97
12	0.99	0.002	1.03	0.001	1.01	-0.007	0.91	1.00	0.98	1.07
13	0.91	-0.013	0.82	0.001	1.02	0.002	1.02	1.00	0.90	0.98
14	0.97	-0.001	0.99	-0.003	0.96	0.003	1.04	1.00	0.96	1.05
15	0.98	-0.005	0.93	-0.008	0.88	-0.004	0.94	1.00	0.97	1.06
16	1.09	0.007	1.10	-0.003	0.95	-0.005	0.93	1.00	1.08	1.18
17	1.05	0.007	1.09	-0.010	0.85	-0.000	1.00	1.00	1.04	1.14
18	1.00	0.023	1.32	-0.004	0.95	0.000	1.00	1.00	1.00	1.00
19	0.99	0.007	1.10	-0.005	0.93	-0.013	0.81	1.00	0.98	1.07
20	1.05	0.010	1.14	0.008	1.11	0.002	1.03	1.00	1.04	1.13
21	0.95	-0.004	0.95	0.005	1.08	0.000	1.00	1.00	0.94	1.03
22	1.00	0.006	1.08	0.014	1.19	0.014	1.20	1.00	1.00	1.00
23	1.00	-0.009	0.87	0.015	1.21	0.027	1.38	1.00	1.00	1.00
24	0.86	-0.012	0.83	0.001	1.02	-0.001	0.99	1.00	0.85	0.93
25	1.00	-0.017	0.76	-0.034	0.53	0.010	1.14	1.00	1.00	1.00
26	1.01	0.002	1.02	0.009	1.12	-0.003	0.95	1.00	1.00	1.09
27	1.00	-0.006	0.91	-0.015	0.79	0.011	1.15	1.00	1.00	1.00
28	0.98	0.001	1.01	-0.001	0.99	0.001	1.02	1.00	0.97	1.06
29	1.01	0.007	1.10	-0.018	0.75	-0.015	0.80	1.00	1.00	1.09
30	1.01	-0.006	0.91	0.004	1.06	0.012	1.17	1.00	1.00	1.09
31	1.07	0.009	1.13	0.004	1.06	0.002	1.03	1.00	1.06	1.15
32	0.58	-0.012	0.83	-0.006	0.92	-0.000	0.99	1.00	0.57	0.62
33	0.89	-0.006	0.92	0.006	1.08	0.002	1.03	1.00	0.88	0.96
34	0.88	-0.009	0.88	0.021	1.29	0.040	1.56	1.00	0.87	0.95
35	1.42	0.002	1.03	-0.054	0.24	-0.130	-0.83	1.00	1.41	1.54
36	1.01	-0.003	0.96	-0.010	0.87	-0.013	0.81	1.00	1.00	1.09
37	0.83	-0.013	0.82	-0.049	0.31	0.019	1.27	1.00	0.82	0.90
38	1.01	0.015	1.20	0.023	1.33	0.110	2.54	1.00	1.00	1.09
39	1.18	0.112	2.57	-0.487	-5.81	-0.864	-11.10	1.00	1.17	1.28
40	1.18	0.036	1.51	-0.003	0.96	-0.012	0.83	1.00	1.17	1.28
41	1.18	0.028	1.40	0.024	1.34	0.050	1.69	1.00	1.17	1.28
42	1.18	0.041	1.57	0.004	1.06	0.000	1.01	1.00	1.17	1.28
43	1.18	0.026	1.37	0.018	1.25	-0.028	0.61	1.00	1.17	1.28
44	0.75	-0.012	0.83	-0.012	0.83	0.021	1.29	1.00	0.74	0.80
45	1.10	0.000	1.00	0.016	1.23	-0.010	0.87	1.00	1.09	1.19
46	0.00	0.000	0.00	0.000	0.00	0.000	1.00	0.00	0.00	0.00
47	0.94	-0.004	0.94	-0.004	0.94	-0.012	0.83	1.00	0.93	1.02
48	0.86	-0.016	0.78	-0.007	0.91	-0.043	0.39	1.00	0.85	0.93
49	1.23	0.022	1.31	0.008	1.11	0.011	1.15	1.00	1.22	1.33
50	1.00	0.026	1.36	0.008	1.11	0.008	1.11	1.00	1.00	1.00
51	0.92	-0.010	0.86	-0.006	0.91	-0.000	1.00	1.00	0.91	0.99
52	0.00	0.000	0.00	0.000	0.00	0.000	1.00	0.00	0.00	0.00
53	0.00	0.000	0.00	0.000	0.00	0.000	1.00	0.00	0.00	0.00
54	1.10	0.010	1.14	0.012	1.17	0.017	1.24	1.00	1.09	1.19
55	1.00	0.026	1.36	0.001	1.01	-0.001	0.99	1.00	1.00	1.00
56	1.07	-0.000	1.00	0.002	1.02	0.001	1.02	1.00	1.06	1.15
57	0.95	0.009	1.13	0.005	1.06	-0.001	0.98	1.00	0.94	1.02
58	0.93	-0.010	0.86	0.001	1.02	0.007	1.10	1.00	0.92	1.00
59	0.94	0.000	1.00	-0.002	0.97	-0.012	0.84	1.00	0.93	1.01
60	1.00	0.024	1.34	-0.000	0.99	-0.004	0.94	1.00	1.00	1.00
61	1.00	0.044	1.62	0.001	1.01	0.000	1.00	1.00	1.00	1.00
62	1.08	-0.004	0.95	0.005	1.07	0.006	1.09	1.00	1.07	1.17
63	1.00	0.014	1.19	-0.001	0.99	-0.002	0.97	1.00	1.00	1.00
64	1.15	0.010	1.15	-0.001	0.98	-0.004	0.94	1.00	1.14	1.25
65	1.07	-0.008	0.88	-0.016	0.78	-0.021	0.71	1.00	1.06	1.16
66	1.00	-0.017	0.76	0.003	1.04	-0.000	1.00	1.00	1.00	1.00
AVE =	1.01		1.06		0.88		0.86	1.00	0.968	1.050

Note: slopes are calculated by Index = F (time)
Source: JIDEA7

Table 3. Coefresult of Basline (2006=1.0)

	BASELINE (est. basically 86-2006)													
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86
2	1.00	0.99	0.99	0.98	0.98	0.97	0.97	0.96	0.96	0.96	0.95	0.95	0.94	0.94
3	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14
4	1.01	1.02	1.02	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.09	1.09	1.10	1.11
5	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.07	1.08	1.09	1.10	1.11	1.12	1.13
6	1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07	1.08	1.08
7	1.00	0.99	0.99	0.98	0.98	0.97	0.97	0.97	0.96	0.96	0.95	0.95	0.94	0.94
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.96	0.96	0.96
11	0.99	0.99	0.98	0.97	0.96	0.96	0.95	0.94	0.93	0.93	0.92	0.91	0.90	0.90
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99
13	0.99	0.99	0.98	0.97	0.97	0.96	0.96	0.95	0.94	0.94	0.93	0.92	0.92	0.91
14	1.00	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97
15	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98
16	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.09	1.09
17	1.00	1.01	1.01	1.01	1.02	1.02	1.03	1.03	1.03	1.04	1.04	1.04	1.05	1.05
18	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
19	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99	0.99
20	1.00	1.01	1.01	1.01	1.02	1.02	1.02	1.03	1.03	1.03	1.04	1.04	1.04	1.05
21	1.00	0.99	0.99	0.99	0.98	0.98	0.98	0.97	0.97	0.97	0.96	0.96	0.96	0.95
22	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
23	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
24	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86
25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
26	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01
27	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
28	1.00	1.00	1.00	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98
29	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
30	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
31	1.00	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07
32	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.70	0.67	0.64	0.61	0.58
33	0.99	0.98	0.98	0.97	0.96	0.95	0.95	0.94	0.93	0.92	0.91	0.91	0.90	0.89
34	0.99	0.98	0.97	0.96	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.89	0.88
35	1.03	1.06	1.09	1.12	1.15	1.18	1.21	1.24	1.27	1.30	1.33	1.36	1.39	1.42
36	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
37	0.99	0.98	0.96	0.95	0.94	0.93	0.91	0.90	0.89	0.88	0.87	0.85	0.84	0.83
38	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.01
39	1.01	1.03	1.04	1.05	1.07	1.08	1.09	1.11	1.12	1.13	1.14	1.16	1.17	1.18
40	1.01	1.03	1.04	1.05	1.07	1.08	1.09	1.11	1.12	1.13	1.14	1.16	1.17	1.18
41	1.01	1.03	1.04	1.05	1.07	1.08	1.09	1.11	1.12	1.13	1.14	1.16	1.17	1.18
42	1.01	1.03	1.04	1.05	1.07	1.08	1.09	1.11	1.12	1.13	1.14	1.16	1.17	1.18
43	1.01	1.03	1.04	1.05	1.07	1.08	1.09	1.11	1.12	1.13	1.14	1.16	1.17	1.18
44	0.98	0.96	0.95	0.93	0.91	0.89	0.87	0.85	0.84	0.82	0.80	0.78	0.76	0.75
45	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.07	1.08	1.09	1.09	1.10
46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
47	1.00	0.99	0.99	0.98	0.98	0.97	0.97	0.97	0.96	0.96	0.95	0.95	0.95	0.94
48	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.87	0.86
49	1.02	1.03	1.05	1.07	1.08	1.10	1.12	1.13	1.15	1.16	1.18	1.20	1.21	1.23
50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
51	0.99	0.99	0.98	0.98	0.97	0.97	0.96	0.95	0.95	0.94	0.94	0.93	0.92	0.92
52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.07	1.08	1.09	1.10	1.10
55	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
56	1.00	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07
57	1.00	0.99	0.99	0.98	0.98	0.98	0.97	0.97	0.97	0.96	0.96	0.95	0.95	0.95
58	1.00	0.99	0.99	0.98	0.98	0.97	0.97	0.96	0.96	0.95	0.95	0.94	0.94	0.93
59	1.00	0.99	0.99	0.98	0.98	0.97	0.97	0.96	0.96	0.96	0.95	0.95	0.94	0.94
60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
61	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
62	1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.08
63	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
64	1.01	1.02	1.03	1.04	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15
65	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07	1.07
66	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Note: the indexes for baseline are obtained by the following estimation;
Index = F(dum85, dum90, dum95, time) and different from slopes shown in Table 2.
Source: JIDEA7

Table4. Comparison of the estimated indexes in 2020 with/without diagonal elements

sectors	with(A)	without(B)	B/A	sectors	with(A)	without(B)	B/A
1	0.81021	0.78278	0.9661	34	0.91756	0.92234	1.0052
2	0.92508	0.92508	1.0000	35	1.02768	0.59577	0.5797
3	0.81825	0.81604	0.9973	36	1.02532	0.97366	0.9496
4	1.01702	1.01706	1.0000	37	0.83230	1.14684	1.3779
5	0.93200	0.93201	1.0000	38	0.57087	1.02712	1.7992
6	1.03234	1.05329	1.0203	39	1.21418	1.65093	1.3597
7	1.05623	1.04661	0.9909	40	1.51369	1.53234	1.0123
8	1.03240	1.05053	1.0176	41	0.99647	1.33287	1.3376
9	0.61918	0.60110	0.9708	42	1.67335	1.68121	1.0047
10	0.99089	0.99264	1.0018	43	1.15760	1.23751	1.0690
11	0.87041	0.84977	0.9763	44	0.77639	0.81749	1.0529
12	0.97039	1.01861	1.0497	45	0.92125	0.92136	1.0001
13	0.80594	0.79372	0.9848	46	0.00000	0.00000	–
14	0.99793	1.00339	1.0055	47	0.99717	1.03454	1.0375
15	1.03366	0.98238	0.9504	48	0.89370	0.68682	0.7685
16	1.12429	1.11358	0.9905	49	0.98475	1.08855	1.1054
17	1.12921	1.13376	1.0040	50	1.26836	1.35298	1.0667
18	1.37345	1.37345	1.0000	51	0.92738	0.93768	1.0111
19	0.99113	0.96949	0.9782	52	0.00000	0.00000	–
20	1.07174	1.08614	1.0134	53	0.00000	0.00000	–
21	0.86193	0.86565	1.0043	54	1.20982	1.20521	0.9962
22	1.01904	1.07697	1.0568	55	1.36448	1.36937	1.0036
23	0.87975	0.91043	1.0349	56	1.07437	1.05440	0.9814
24	0.80900	0.80627	0.9966	57	1.07788	1.07422	0.9966
25	0.77579	0.80982	1.0439	58	0.86283	0.89613	1.0386
26	0.83524	0.84516	1.0119	59	0.99641	0.97487	0.9784
27	0.90243	0.94178	1.0436	60	1.38095	1.35955	0.9845
28	0.90917	0.91914	1.0110	61	1.58348	1.58348	1.0000
29	1.03391	1.03448	1.0006	62	0.91980	0.91062	0.9900
30	0.91617	0.96888	1.0575	63	1.40750	1.40040	0.9950
31	1.08472	1.08503	1.0003	64	1.12722	1.12040	0.9940
32	0.80456	0.80355	0.9987	65	1.03715	0.97527	0.9403
33	0.90438	0.90603	1.0018	66	0.63855	0.64226	1.0058
				AVE	1.01137	1.03208	1.0205

Note: Colored cells are the sectors that assumption is not supported.

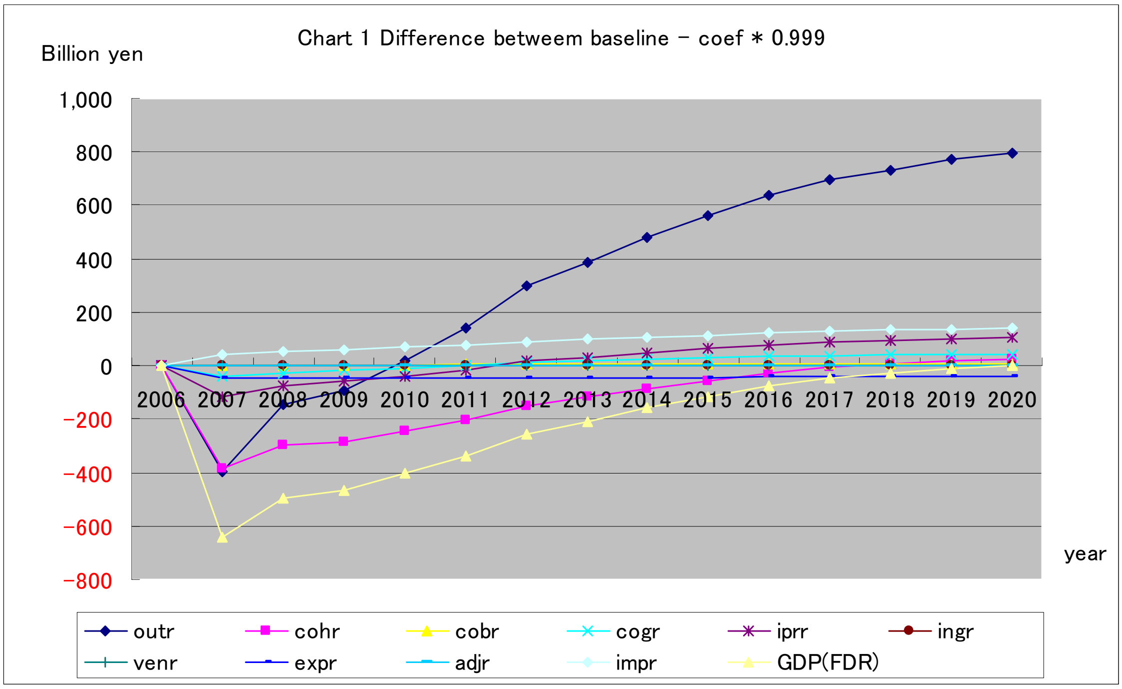
Source; JIDEA7

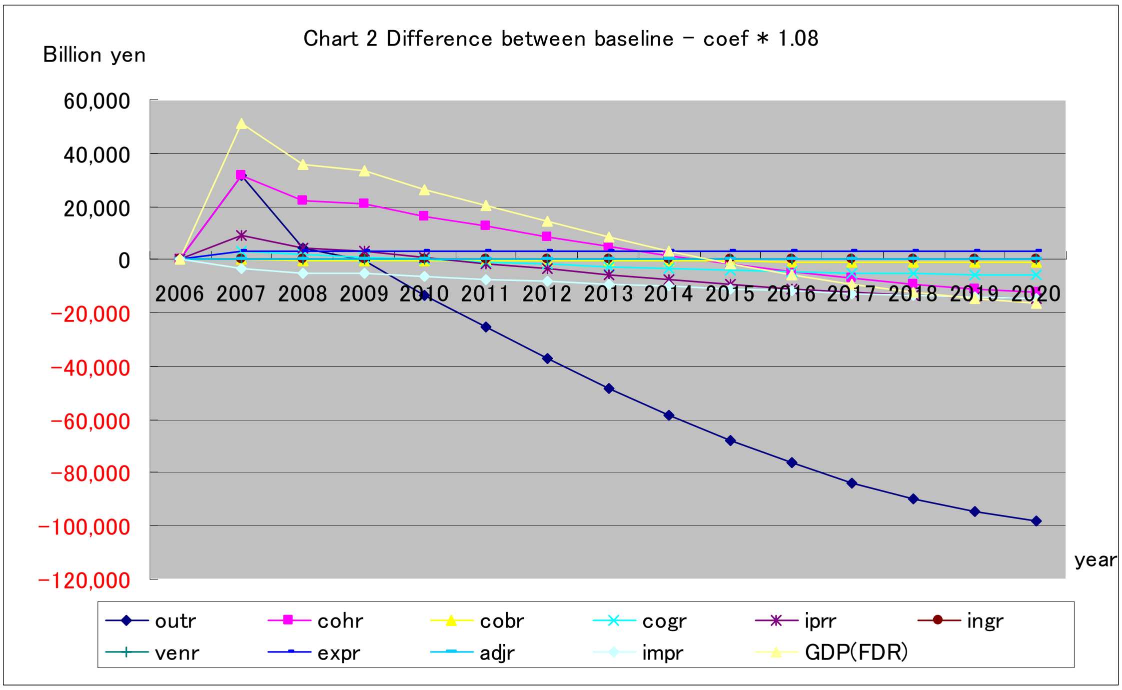
1-3. The effects of expanding/ shrinking input coefficients

Based on the baseline simulation, I intentionally expanded or shrunk the input coefficients in order to find their effects on outputs.

The maximum multiplier and divisor are 1.08 and 0.999 respectively that our model is tolerable.

Chart 1 shows the case when input coefficients are shrunk. The outputs and real gdp expand initially, but they turn reverse direction soon. Chart 2 depicts the opposite simulation.





The averages weighted by real outputs in 2020 become 0.977 in baseline, 0.968 in the case of 0.1% shrinkage and 1.050 by 8% expansion.

Generally the input coefficients become larger, outputs come to larger, I expect. However, as the charts show, my expectation is not fully supported. The output difference increases first, however, it starts decreasing in 2009. Some sectors record decreases in 2007.

At this stage, I can not find the reason why the differences from baseline turn opposite direction as sectors do show various movements.

1-4. Measurement of technological progress

Based on the baseline simulation, I made a decomposition of outputs changes.

There are several variations in treating synergy term.[2] Here, I will adopt the following definition.

X_t: outputs in year t

F_t: final demands in year t

B_t : inverse matrix in year t;$(I-A)^{-1}$

Table 5.	Decomposition of Simulation Results (2006-2020)										(unit:billion yen, %, 2000price)
	Output changes by final demands changes					Output changes by technological progress					Synergy
ΔOutputs	ΔCon	ΔInv	ΔExp	ΔImp	ΔFd	ΔCon	ΔInv	ΔExp	ΔImp	ΔFd	
74,587	22,626	28,258	68,985	60,260	59,609	9,284	6,634	6,765	7,255	15,428	-452
100.0	30.3	37.9	92.5	80.8	79.9	12.4	8.9	9.1	9.7	20.7	-0.6

$\Delta X = X_{2020} - X_{2006}$

$= B_{2020}\{F_{2020} - F_{2006}\} + \{B_{2020} - B_{2006}\} F_{2006}$

$= B_{2006}\{F_{2020} - F_{2006}\} + \{B_{2020} - B_{2006}\} F_{2006} + \{B_{2020} - B_{2006}\}\{F_{2020} - F_{2006}\}$

Table 6.	Decomposition of Simulation Results (2006-2013)										(unit:billion yen, %, 2000price)
	Output changes by final demands changes					Output changes by technological progress					Synergy
ΔOutputs	ΔCon	ΔInv	ΔExp	ΔImp	ΔFd	ΔCon	ΔInv	ΔExp	ΔImp	ΔFd	
24,552	6,229	8,621	32,821	29,864	17,808	3,468	2,554	2,990	3,156	5,857	-467
100.0	25.4	35.1	133.7	121.6	72.5	14.1	10.4	12.2	12.9	23.9	-1.9

$\Delta X = X_{2013} - X_{2006}$

$= B_{2013}\{F_{2013} - F_{2006}\} + \{B_{2013} - B_{2006}\} F_{2006}$

$= B_{2006}\{F_{2013} - F_{2006}\} + \{B_{2013} - B_{2006}\} F_{2006} + \{B_{2013} - B_{2006}\}\{F_{2013} - F_{2006}\}$

Table 7.	Decomposition of Simulation Results (2013-2020)										(unit:billion yen, %, 2000price)
	Output changes by final demands changes					Output changes by technological progress					Synergy
ΔOutputs	ΔCon	ΔInv	ΔExp	ΔImp	ΔFd	ΔCon	ΔInv	ΔExp	ΔImp	ΔFd	
50,035	16,570	20,092	36,805	31,494	41,973	5,936	3,971	4,371	5,136	9,142	272
100.0	33.1	40.2	73.6	62.9	83.9	11.9	7.9	8.7	10.3	18.3	0.5

$\Delta X = X_{2020} - X_{2013}$

$= B_{2020}\{F_{2020} - F_{2013}\} + \{B_{2020} - B_{2013}\} F_{2013}$

$= B_{2013}\{F_{2020} - F_{2013}\} + \{B_{2020} - B_{2013}\} F_{2013} + \{B_{2020} - B_{2013}\}\{F_{2020} - F_{2013}\}$

Table 8.	Decomposition of Simulation Results by fixing coefficients (2006-2020)			
			(unit:billion yen, %, 2000price)	
ΔOutputs	ΔIntermediates by technological progress	ΔIntermediates by output changes	Final demands changes	Synergy
74,587	6,625	38,197	29,025	740
100.0	8.9	51.2	38.9	1.0

$\Delta X = (A^v X_{2020} + F_{2020}) - (A^c X_{2006} + F_{2006})$

$= (A^v X_{2020} - A^c X_{2006}) + (F_{2020} - F_{2006})$

$= (A^v - A^c) X_{2006} + A^c (X_{2020} - X_{2006}) + (F_{2020} - F_{2006}) + (A^v - A^c)(X_{2020} - X_{2006})$

A^v : amr_{2020} input-output coefficient matrix of year 2020

A^c : amr_{2006} input-output coefficient matrix of year 2006

F_i : final demand of year i

X_i : real output of year i

From these tables, we find that approximately 20 % of Japanese output expansion is measured by the technological factor during 2006 and 2020. When divide the period into two, its contribution rate of 23.9% of the first part of forecasting period is larger than that of 18.3% of the latter parts of projection periods; namely 2013-2020.

Anyway, the output expansions are led by the increases of final demands, mainly investments and consumptions.

When I measure the same directly in the model, the contribution of technological factor for the whole period is 8.9%, much smaller than the outcomes derived from using leontief inverse.

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[1] Kiji says it is natural to assume that input coefficients are changing incessantly because the relative price and the ratio of imported goods usage are not necessarily constant even though their values are expressed by constant price.

[2] Fujikawa shows extensively the variations of the decomposition methods. Ogawa et al. made a decomposition analysis using Japanese 1980 and 1990 I-O tables.

References

[1] Kiji Takayuki, Introduction to I-O, chapter5-1, input-coefficients http://www.sanken.keio.ac.jp/user/kiji/lecture/index.html

[2] Ogawa Kazuo, Tokutsu Ichirou, Japanese Economy, Japan: Yuuhikaku, 2002. pp.273-280

[3] Kujikawa kiyoshi, Introduction to I-O analysis, Japan: Nippon Hyoron-sha, 2005 pp166-174

The remaining problems unsolved.

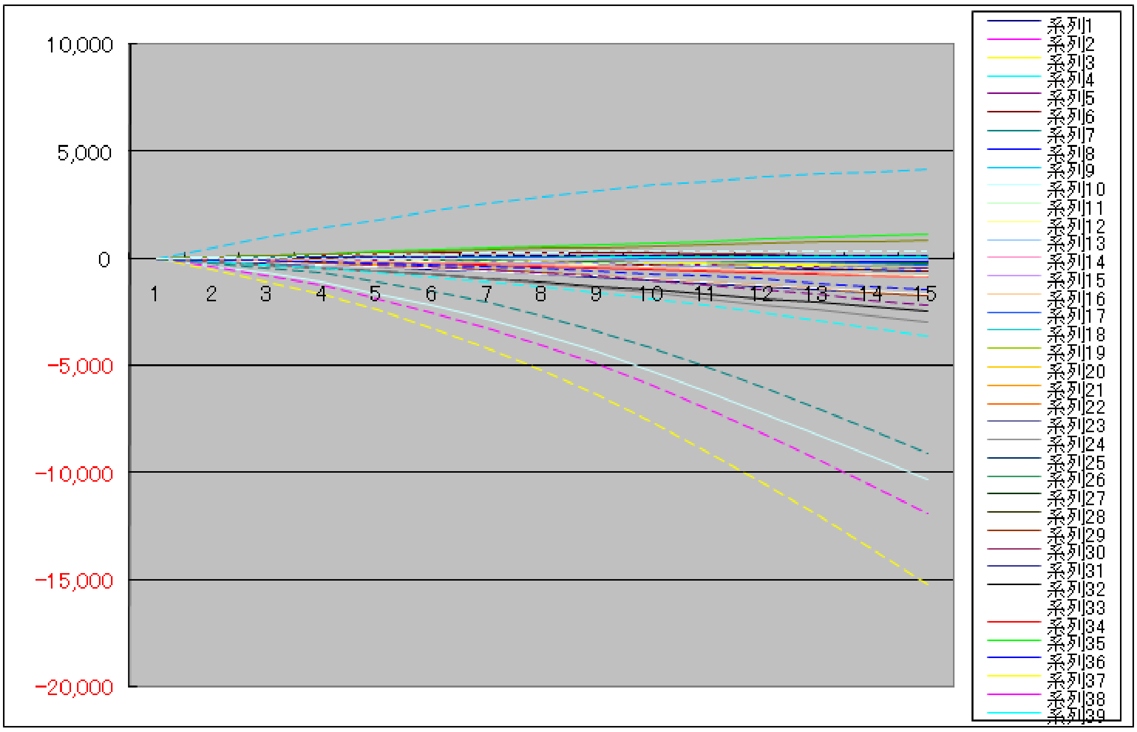
1. Balancing errors for the forecasting period; when measured in real output total, maximum 0.0004% gap exist and when we see sectorwise, sector 4 shows 3.9% gap.

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1		−0.0000	0.0000	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0002	0.0002	0.0002
2		−0.0004	−0.0006	0.3433	0.3959	0.4543	0.3676	0.3116	0.2869	0.2567	0.2254	0.1987	0.1841	0.1719	0.0444	0.0416	0.0391
3		−0.0000	−0.0000	0.0022	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0022	0.0022	0.0022	0.0022	0.0006	0.0006	0.0006
4		−0.0001	0.0001	2.5601	2.5275	2.9609	3.1283	3.5637	3.6707	3.4585	3.4800	3.6278	3.7380	3.8964	1.1092	1.1526	1.1826
5		−0.0001	0.0003	1.5979	1.5784	1.6032	1.5903	1.6027	1.5652	1.4859	1.4563	1.4280	1.4024	1.3782	0.3094	0.3061	0.3002
6		0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
7		−0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8		0.0000	0.0000	0.0017	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0017	0.0017	0.0017	0.0008	0.0007	0.0007
9		0.0000	0.0000	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0002	0.0002	0.0002
10		0.0000	0.0000	0.0023	0.0024	0.0025	0.0025	0.0025	0.0025	0.0025	0.0026	0.0026	0.0026	0.0026	0.0008	0.0008	0.0008
11		0.0000	−0.0000	0.0008	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0002	0.0003	0.0002
12		−0.0000	0.0000	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0004	0.0004	0.0005
13		0.0000	0.0000	0.0009	0.0009	0.0009	0.0009	0.0010	0.0010	0.0009	0.0010	0.0010	0.0010	0.0010	0.0003	0.0003	0.0003
14		0.0000	0.0000	0.0045	0.0045	0.0045	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0046	0.0047	0.0011	0.0011	0.0012
15		−0.0000	−0.0000	0.0123	0.0123	0.0123	0.0122	0.0122	0.0121	0.0120	0.0120	0.0119	0.0118	0.0118	0.0028	0.0028	0.0028
16		0.0000	0.0000	0.0035	0.0034	0.0034	0.0035	0.0036	0.0036	0.0035	0.0035	0.0035	0.0037	0.0037	0.0016	0.0012	0.0012
17		−0.0000	−0.0000	0.0025	0.0025	0.0024	0.0025	0.0025	0.0025	0.0024	0.0024	0.0024	0.0025	0.0025	0.0011	0.0008	0.0009
18		0.0000	−0.0000	0.0006	0.0010	0.0009	0.0009	0.0007	0.0006	0.0007	0.0006	0.0010	0.0010	0.0010	0.0008	0.0007	0.0007
19		0.0000	−0.0000	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0001	0.0001	0.0001
20		−0.0000	0.0000	0.0004	0.0004	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0001	0.0001	0.0001
21		−0.0000	−0.0000	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0003	0.0003	0.0003
22		0.0000	0.0000	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0029	0.0008	0.0008	0.0008
23		−0.0000	0.0000	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0002	0.0002	0.0002
24		−0.0000	0.0000	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0002	0.0002	0.0002
25		−0.0000	0.0000	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0001	0.0001	0.0001
26		0.0000	−0.0000	0.0004	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0001	0.0001	0.0001
27		0.0000	−0.0000	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0002	0.0002	0.0002
28		0.0000	0.0000	0.0011	0.0011	0.0011	0.0011	0.0012	0.0012	0.0011	0.0011	0.0011	0.0011	0.0011	0.0003	0.0003	0.0003
29		−0.0000	0.0000	0.0002	0.0005	0.0006	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0002	0.0002	0.0002
30		0.0000	−0.0000	0.0043	0.0043	0.0042	0.0041	0.0039	0.0038	0.0037	0.0037	0.0036	0.0035	0.0034	0.0010	0.0010	0.0010
31		0.0000	−0.0000	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0009	0.0009	0.0009	0.0009	0.0009	0.0003	0.0003	0.0003
32		−0.0000	0.0000	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007	0.0007	0.0002	0.0002	0.0002
33		−0.0000	0.0000	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0001	0.0002	0.0002
34		0.0000	−0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0000	0.0000	0.0000
35		−0.0000	−0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
36		0.0000	−0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001
37		−0.0000	−0.0000	−0.0000	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
38		0.0000	0.0000	0.0000	−0.0001	−0.0001	−0.0001	−0.0000	−0.0000	−0.0000	0.0000	−0.0001	−0.0001	−0.0001	−0.0001	−0.0001	−0.0001
39		−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0000	−0.0000	−0.0000
40		−0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
41		−0.0000	−0.0000	−0.0002	−0.0005	−0.0002	−0.0002	−0.0001	−0.0001	−0.0001	−0.0001	−0.0001	−0.0002	−0.0002	−0.0002	−0.0002	−0.0002
42		0.0000	−0.0000	0.0006	−0.0001	0.0000	0.0000	0.0001	0.0002	0.0001	0.0002	0.0003	0.0003	0.0003	0.0000	−0.0000	−0.0000
43		0.0000	0.0000	0.0002	−0.0000	0.0000	−0.0000	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	−0.0001	−0.0001	−0.0001
44		0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000
45		0.0000	0.0000	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0002	0.0001	0.0000	0.0000	0.0000
46		0.0000	0.0000	−0.0002	0.0002	0.0003	0.0005	0.0001	0.0001	0.0001	0.0001	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004
47		−0.0000	−0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
48		−0.0000	−0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
49		−0.0000	−0.0000	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0000	0.0001	0.0001	−0.0000	−0.0000	−0.0000
50		0.0000	0.0000	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0002	0.0002	0.0002
51		0.0000	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001
52		−0.0000	0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0000	−0.0000
53		−0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
54		0.0000	0.0000	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0001	0.0001	0.0001
55		0.0000	−0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
56		0.0000	0.0000	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0001	0.0001	0.0001
57		−0.0000	−0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
58		0.0000	0.0000	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001
59		−0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
60		−0.0000	0.0000	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0001	0.0001	0.0001
61		0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
62		−0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0000
63		−0.0000	−0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	−0.0000	−0.0000	0.0000
64		−0.0000	−0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	−0.0000	−0.0000	−0.0000
65		0.0000	0.0000	0.0000	0.0000	0.0000	−0.0000	−0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
66		0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000	−0.0000
Sum		−0.0000	−0.0000	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0001	0.0001	0.0001

2. Dealing with naughty sectors in this model such as sector 2, 4 whose output levels are very small. Possible solution might be that we treat them as a non-competitive type. But how?

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1		12,757	12,387	12,438	12,363	12,204	12,161	12,147	12,112	12,071	12,014	11,952	11,895	11,842	11,786	11,735	11,683
2		12	9	33	29	25	31	36	39	44	50	56	61	65	69	73	77
3		961	969	1,027	1,028	1,026	1,035	1,050	1,066	1,082	1,098	1,113	1,128	1,143	1,158	1,173	1,188
4		13	14	3	3	2	2	2	2	2	2	2	2	2	2	2	2
5		111	117	50	51	51	52	53	55	58	60	62	64	66	67	69	71
6		28,379	27,995	28,260	28,283	28,158	28,289	28,428	28,521	28,606	28,643	28,671	28,707	28,760	28,798	28,850	28,902

3. Huge outcome gaps are observed when we make a forecast with input coefficient fixed and varied. This may be partly attributed to adopting non-linear function in our investment functions. Even though will it be justified?



Yellow: sector 58 (finance) mainly by cohr

```
r cohrpop58 =  dum85y, dum90y, dum95y, pcdisincr
```

Purple: 57 (trade) mainly by cohr

```
r cohrpop57 = dum85y, dum90y, dum95y, ctaxdumy, pcdisincr
```

Pale blue: 51 (construction) mainly by iprr

```
r linvr = dum85y, dum90y, dum95y, lgdpr, timet
```

Blue: 62 (other public: Education, research & Medical service) mainly by cohr

```
r cohrpop62 = dum85y, dum90y, dum95y, pcdisincr, relpri62
```

Top blue:64 (business services) because of expansion of totintr64