Economy-wide Impacts of consumer responses to environmental information disclosure in Tokyo and the other parts of Japan

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Abstract

Environmental problems such as global warming due to GHG emissions have necessitated some constraint in our economic activities, as many countries and many people around the world are concerned about these issues. Environmental and economic policies such as carbon tax are one such constraint.

A tax policy can be interpreted as a desirable method that can lead the economy, which has to pay the social cost of false economic activity or market failure, to a more optimal path. However, this policy will surely raise prices of goods. On the one hand, this price rise will benefit the public sector, but on the other hand, consumers demand will decline. The magnitude of the reduction usually depends on the price elasticity of demand, and the increase in government gain depends on the necessity of the goods for the people.

Therefore, it is not necessarily trivial to ask whether the total effect of rising energy prices will be negative. In addition, nowadays, many people are concerned about environmental problems, and there are indications that consumers tend to change their purchasing behavior regarding certain goods to take environmental concerns into account even if this necessitates paying a higher price.

This paper will empirically prove how the rise in oil and gas prices due to environmental policies like carbon tax affects the total production/consumption when we take into account the change in consumer behavior reflecting their attitudes toward preventing global warming. The main result of the analysis using an input-output model and price elasticity of demand in several sectors will show that most of sectors do not experience a decline in production after a price rise except the biggest sector, real estate. In Japan, real estate might be the main target to support for consumer's purchasing from the viewpoint of economic policy.

1. Introduction

How would a soar in energy prices due to aggressive environmental policies by the government and private companies' impact economic growth? As economics textbooks say, this rise in prices must be equivalent to the influence of a price rise due to a lack of energy or growing energy demand. This would usually lead to a decline in energy consumption to a certain level where the strength of the demand meets the price.

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However, what if consumer behavior and consciousness regarding environmental issues has changed? This might mean that even though prices would be higher than before, consumers would tend to buy eco-friendly goods more than ever.

Generally speaking, an active environmental policy can raise the price of goods because it might increase the cost of energy-related goods due to specific taxes such as carbon tax, and because it might facilitate the development and usage of energy-saving technology and production methods to reduce CO2 emissions more effectively. Such a policy will have two effects: a decline in demand owing to a rise in price, and the creation of new demand for a developing industry. Therefore, the resulting effect is not trivial.

Moreover, if the purchasing behavior changes with a rise in awareness of environmental issues, the situation could become more complicated. Expenditure on normal goods will decline as the price rises, but, on the other hand, expenditure on "eco" goods or "green procurement" might increase despite the price rises[2]. In that case, these kinds of goods might be interpreted as "Giffen goods."

It is not easy to measure the influence of price changes caused by environmental economic policies. This paper endeavors to estimate the total repercussion effect by the change in the price of energy commodities such as oil and gas, and the change in consumer behavior regarding environmental concerns using an empirical economic model.

In the second section, we review the results of a survey on Japanese consumer behavior regarding certain goods that have witnessed a price rise owing to environmental policies such as carbon tax. We also show the estimation results about the price elasticity of the demand for those goods. In section three, to measure the degree of the impact of a price change in the oil and gas sectors, the scenario for our calculation using the input-output (IO) model will be explained. Discussion of the result and interpretation of the cause is mentioned in section four, and political implications are considered briefly in the final section.

2. Changes in consumer behavior and price elasticity of demand for each good

As white papers and surveys by the Ministry of Environment, Japan point out repeatedly, we can often observe changes in consumers' purchasing behavior with growing environmental concerns[3]. This tendency was observed in Europe earlier. For example, Ministry of Environment (1998) mentioned an example of comparative survey conducted in 1998 which around 80 % of German have strong concern about whether the goods are good for the environment or not and the degree of consciousness was higher than Japanese one.

However, Komatsu (2011) analyzed survey data in Japan, which researched the situation between booming environmental concerns and changing of consumer behavior recently.

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[2] Varnäs et al (2009) mentions the practice of green procurement in the Swedish construction industry. For a similar practice in Norway, see Fet et al (2011) and Michelsen et al (2009), and for the Asian region, see Ho (2020)

[3] See Ministry of Environment (2004) and Yamada (2004).

Table 1 shows the difference in purchasing behaviors by the level of disclosure of environmental information for each eco-friendly good by region (Tokyo and Japan other than Tokyo). We see that, at first, some consumers seem to tend to buy goods regardless of the disclosed information about environmental damage even if the prices increase, and later, consumers tend to purchase all kinds of goods listed even more except shampoo in Tokyo if the information about environmental damage is disclosed.

Table1 : Influence on purchasing behavior by the level of disclosure of information about environmental damage

			JOTT			Tokyo		
			No.	%	increment by disclosure	No.	%	increment by disclosure
real estate	disclosing CO2 emission from usage	purchase even if the price is higher	319	16.5	10.0	48	21.6	9.5
		purchase if the price is still same	1,069	55.3		130	58.6	
	hiding that information	purchase even if the price is higher	125	6.5		27	12.2	
		purchase if the price is still same	1,175	60.8		140	63.1	
home appliances	disclosing CO2 emission from usage	purchase even if the price is higher	220	11.4	5.5	36	16.2	8.1
		purchase if the price is still same	1,114	57.6		127	57.2	
	hiding that information	purchase even if the price is higher	113	5.8		18	8.1	
		purchase if the price is still same	1,174	60.7		141	63.5	
PC & audio – video	disclosing CO2 emission from usage	purchase even if the price is higher	166	8.6	4.4	32	14.4	7.7
		purchase if the price is still same	1,068	55.3		122	55.0	
	hiding that information	purchase even if the price is higher	81	4.2		15	6.8	
		purchase if the price is still same	1,121	58.0		129	58.1	
cars	disclosing CO2 emission from usage	purchase even if the price is higher	327	16.9	5.2	47	21.2	6.8
		purchase if the price is still same	1,038	53.7		119	53.6	
	hiding that information	purchase even if the price is higher	226	11.7		32	14.4	
		purchase if the price is still same	1,107	57.3		132	59.5	
clothing	disclosing CO2 emission from usage	purchase even if the price is higher	99	5.1	1.5	16	7.2	0.9
		purchase if the price is still same	806	41.7		102	45.9	
	hiding that information	purchase even if the price is higher	70	3.6		14	6.3	
		purchase if the price is still same	887	45.9		105	47.3	
process foods	disclosing chemical emission from producing	purchase even if the price is higher	184	9.5	1.9	30	13.5	3.2
		purchase if the price is still same	885	45.8		115	51.8	
	hiding that information	purchase even if the price is higher	148	7.7		23	10.4	
		purchase if the price is still same	988	51.1		128	57.7	
shampoos	disclosing CO2 emission from usage	purchase even if the price is higher	213	11.0	3.4	31	14.0	−0.9
		purchase if the price is still same	902	46.7		119	53.6	
	hiding that information	purchase even if the price is higher	147	7.6		33	14.9	
		purchase if the price is still same	967	50.0		120	54.1	

Source: Komatsu (2010)

Further, it shows that the rates after information disclosure are relatively high for more expensive commodities such as real estate and cars. The rate for cars is especially higher than others even if the information about environmental damage is not disclosed[4], because consumers might be aware that progress in automobile technology has done much to reduce CO2 emissions year by year.

These results are consistent with other studies. The consumers' concerns regarding the environment seem to affect their purchasing behavior, signifying that consumers' consciousness has been steadily changing in recent years.

However, more than 40% of the respondents in any good in both areas did not buy the goods until the price dropped to its original level. This means that many consumers behave as the textbooks of economics suggest they would: when the price rises, the demand decreases.

[4] The rate for car purchases even when no information about CO2 emissions was disclosed is 12%; this level is the same as the rate of home appliance purchases even when information about the environmental burden is disclosed: 11.9%.

To confirm this point with our data, let us estimate the price elasticity of demand of each good. Here, we estimated the same type of simple demand function in each sector as follows:

$$\ln Q_{ij} = \alpha_i + \beta_i \ln P_{ij} + \varepsilon_i \quad i = 1,2,\ldots,5, \quad j = 1,2,\cdots,m, \qquad (1)$$

where Q_{ij} denotes the sales of good j in sector i, P_{ij} is the price of good j in sector i, and ln represents a natural logarithm. α is a constant term and ε is a residual term used as disturbance. The five sectors here are cars, home appliances, chemical detergents, clothing, and real estate. β_i is a coefficient that can be interpreted as the elasticity of each sector.

The data used here are from a survey conducted by a private research institute, and contain information about car sales and the range of prices. The data for real estate were calculated from the data on the real estate sales and unit price per square meter provided by the Real Estate Economic Institute Co., Ltd. The rest of the data are from the "Current Survey of Production" by the Ministry of Economy, Trade and Industry, Japan.

Table 2 shows the result of the coefficient on equation (1) with the OLS method.

It is quite obvious that the elasticity demand for real estate is very elastic. This is consistent with economic theory as real estate is expected to be more sensitive to price changes because it is the most expensive good and can be multiple times ones income in general.

On the other hand, the elastic of demand for cars, another expensive good, is the lowest among the 5 categories. Thus, it can be inferred that consumers tend to purchase a car according to their own preferences such as brand, engine displacement, and so on, and that this tendency might result in the abovementioned non-elastic characteristics.

The high elasticity of clothing can be interpreted as the consumers' tendency to react to price signal more than non-price signals, such as brand, unlike for car consumption.

As we mentioned in Table 1, consumer behavior seems to have altered somewhat nowadays owing to popular concern regarding environmental issues. Some prefer to buy eco-friendly or "green" products. However, more than 40% of the consumers in any good still believe that the most important information to consider when purchasing in any sector is the price. Therefore, we can observe that most of them would reduce their consumption according to the price elasticity of demand if each good were to see a rise in price, and its tendency is also shown in Table 2.

Both, the positive effect of an increase in purchase of eco-friendly goods and the

negative effect of declining good consumption may yield complicated results for the whole economy. Hence, as a trial to identify the result, we would like to calculate the repercussion effect of the direct and indirect impacts of both sides using the IO model next.

Table2 : Estimation of the price elasticity of demand for each good

	Coefficent		S.E.	t	P − v
cars	−0.497	*	0.257	−1.931	0.064
home appliances	−0.827	***	0.167	−4.955	0.000
chemical detergents	−0.735	**	0.345	−2.132	0.039
clothing	−1.269	***	0.335	−3.786	0.000
real estate	−4.372	***	0.642	−6.811	0.000

(Note) The asterisks show the significance levels for each estimate as 10% for *, 5% for **, and 1% for ***. The data sources are as follows: the data for cars are from the "information of new cars registered and the unit price on "MiCle's site." The data for real estate is from the "New Apartment Market Trend in Urban Area" by the Real Estate Economic Institute Co., Ltd., and the data for home appliances, chemical detergents, and clothing are from the "Current Survey of Production" by the Ministry of Economy, Trade and Industry.

3. Interregional input-output model and the scenario of calculation

The model we employed here is the interregional IO model with the data from the Tokyo IO table 2005.

$$\begin{pmatrix} \mathbf{X}_T \\ \mathbf{X}_O \end{pmatrix} = \begin{bmatrix} \mathbf{A}_{TT} & \mathbf{A}_{TO} \\ \mathbf{A}_{OT} & \mathbf{A}_{OO} \end{bmatrix} \begin{pmatrix} \mathbf{X}_T \\ \mathbf{X}_O \end{pmatrix} + \begin{pmatrix} \mathbf{F}_T \\ \mathbf{F}_O \end{pmatrix}, \qquad (2)$$

where $\begin{pmatrix} \mathbf{X}_T \\ \mathbf{X}_O \end{pmatrix}$ is total out vector of Tokyo (T) and Japan other than Tokyo (JOTT, O) and

$\begin{bmatrix} \mathbf{A}_{TT} & \mathbf{A}_{TO} \\ \mathbf{A}_{OT} & \mathbf{A}_{OO} \end{bmatrix}$ is the divided input coefficient matrix. The non-diagonal elements in this matrix give us the interregional intermediate input (trading between two areas).

$\begin{pmatrix} \mathbf{F}_T \\ \mathbf{F}_O \end{pmatrix}$ represents the final demand vector for each area.

Fig. 1 shows the outline of Tokyo IO Table 2005, sector 7 provided by the Tokyo metropolitan government. According to this, the total output in Tokyo 2005 is 174.31

trillion yen (about USD 1.58 trillion[5]), and JOTT's total output is 857.01 trillion yen (about USD 7.78 trillion), and the total Japanese output is 1,031.32 trillion yen (about USD 9.37 trillion).

The value-added sum of the is 97.84 trillion yen (about USD 0.89 trillion) in Tokyo, 408.03 trillion yen (about USD 3.71 trillion) in JOTT, and 505.87 trillion yen (about USD 4.60 trillion) in all. These numbers indicate that the magnitude of economics in Tokyo is about one-fifth of JOTT's economic activities.

Additionally, the reason we employed the interregional IO table in this study is that Tokyo IO Table 2005 covers the whole country and can capture the interregional transactions between Tokyo and JOTT, for it is already divided into two areas using the Isard type of non-competitive import IO table. Tokyo IO Table 2005 has features that show even intermediate transactions between two regions as well as inflow and outflow in final demand. Later, we will see the different influences of price and demand changes in two regions.

However, for our purposes, we must rearrange this table because this table usually sets the column of "headquarter" as a provisional sector[6]. In this study, we integrated all sectors—originally 482 by 597 sectors—into 40 but each headquarter was also allocated a sector.

The contents of these sectors are shown in Table 3. Most the results mainly focus on the energy-related sectors such as coal, petroleum, and electricity, and energy-consuming sectors such as transportation as we can easily analyze them in the context of environmental issues.

Now, excluding the import ratio from equation (2) as mentioned above, we can derive the revised equation for induced output, which is adjusted by the Leontief inverse with self-sufficient rate as follows:

$$\begin{pmatrix} \mathbf{X_T} \\ \mathbf{X_O} \end{pmatrix} = \begin{bmatrix} \mathbf{B_{TT}} & \mathbf{B_{TO}} \\ \mathbf{B_{OT}} & \mathbf{B_{OO}} \end{bmatrix} \begin{pmatrix} \mathbf{F_T} \\ \mathbf{F_O} \end{pmatrix}, \qquad (3)$$

where $\mathbf{B_{ij}} = \left[\mathbf{I_{ij}} - (\mathbf{I_{ij}} - \hat{\mathbf{M}}_{\mathbf{ij}})\mathbf{A_{ij}}\right]^{-1}$, $i, j = T, O.$ B_{ij} represents the Leontief inverse within the region and between regions. $\hat{\mathbf{M}}_{\mathbf{ij}}$ is a diagonal matrix derived from the

[5] Here, we assumed that the average exchange rate in 2005 was 110.1 yen per dollar.
[6] This headquarter sector is a type of dummy sector that is treated as if Tokyo is producing goods and services even though the actual product line does not exist within Tokyo to ascertain how the functioning of a headquarter for each company impacts JOTT.

Fig.1 : Frame of Tokyo Input-Output Table(2005, sector 7)

平成17年(2005年)東京都産業連関表(生産者価格表(7部門×2地域))

(単位：億円)

中間需要

	東京都 農林水産・鉱業	東京都 製造業・建設	東京都 電力・ガス・水道	東京都 商業・金融・不動産	東京都 運輸・情報通信	東京都 公務・教育医療・サービス	東京都 本社	東京都中間需要計	その他地域 農林水産・鉱業	その他地域 製造業・建設	その他地域 電力・ガス・水道	その他地域 商業・金融・不動産	その他地域 運輸・情報通信	その他地域 公務・教育医療・サービス	その他地域 本社	その他地域中間需要計	中間需要計
中間投入 東京都 財・サービス 農林水産・鉱業	12	593	3651	1	1	453	0	4710	5	134	0	0	0	24	0	164	4874
中間投入 東京都 財・サービス 製造業・建設	41	17053	2095	10987	9720	18268	2633	60798	89	21469	227	1296	765	5137	29	29011	89808
中間投入 東京都 財・サービス 電力・ガス・水道	4	996	1589	2893	2293	7616	1625	17016	0	0	0	0	0	0	0	0	17016
中間投入 東京都 財・サービス 商業・金融・不動産	47	7632	1061	31871	13389	23969	34635	112603	1063	43599	2454	29620	6239	22556	6963	112494	225098
中間投入 東京都 財・サービス 運輸・情報通信	53	4277	1075	17048	25585	43329	14389	105756	381	17243	3007	21252	11843	28130	3087	84944	190700
中間投入 東京都 財・サービス 公務・教育医療・ｻｰﾋﾞｽ	40	13101	1862	28104	39302	38693	23530	144632	394	38419	3692	18542	9326	22017	7483	99872	244504
中間投入 東京都 本社	3	5472	233	28707	26820	19231		80465	306	60505	2303	80645	29274	28160		201192	281657
東京都中間投入計	199	49124	11566	119610	117111	151559	76812	525981	2238	181369	11682	151354	57446	106024	17562	527676	1053656
中間投入 その他地域 財・サービス 農林水産・鉱業	24	2445	1	8	3	1649	0	4130	16427	202854	29418	85	16	11043	0	259843	263973
中間投入 その他地域 財・サービス 製造業・建設	147	45965	1451	4270	21351	32399	462	106046	26393	1435768	28128	69021	69703	254369	3719	1887101	1993147
中間投入 その他地域 財・サービス 電力・ガス・水道	2	345	517	944	1061	2448	612	5929	1364	56964	14550	19753	10240	54174	2799	159845	165774
中間投入 その他地域 財・サービス 商業・金融・不動産	20	5325	333	954	3899	6197	345	17073	6929	201080	9677	101834	34976	117747	31048	503291	520364
中間投入 その他地域 財・サービス 運輸・情報通信	13	3564	588	2400	5859	9759	1253	23436	7680	116802	8711	78816	74769	77998	13377	378153	401589
中間投入 その他地域 財・サービス 公務・教育医療・ｻｰﾋﾞｽ	7	1631	774	3905	7002	9050	2248	24618	3687	203461	20324	72869	76809	123779	19011	519940	544558
中間投入 その他地域 本社	7	7007	1014	23903	14667	10896		57494	1271	92398	9023	71925	30636	48620		253872	311367
その他地域中間投入計	219	66283	4678	36386	53842	72399	4920	238727	63750	2309328	119831	414304	297149	687729	69954	3962046	4200773
中間投入計	418	115407	16243	155996	170953	223958	81732	764708	65989	2490697	131514	565658	354594	793753	87516	4489721	5254429
粗付加価値 家計外消費支出	27	2518	438	9435	7059	8598	11445	39521	773	41943	3827	19869	19695	29026	13373	128506	168027
粗付加価値 雇用者所得	243	53577	4771	103936	53815	160460	124212	501015	13896	564589	37813	371072	169367	787316	143108	2087161	2588175
粗付加価値 営業余剰	247	5543	1690	114512	18918	27992	35921	204823	37358	125132	18571	417952	47014	109697	35298	791022	995846
粗付加価値 資本減耗引当	63	7557	3896	64731	30443	56287	12283	175260	13732	157203	38798	248586	64188	255312	13369	791188	966448
粗付加価値 間接税	56	4661	1353	19051	8326	12561	16063	62070	5901	144484	13509	62483	24295	43867	18702	313241	375311
粗付加価値 経常補助金	-5	-947	-307	-1708	-172	-1137	0	-4276	-1402	-4947	-2281	-10902	-1692	-9567	0	-30791	-35067
粗付加価値計	630	72909	11842	309959	118389	264761	199925	978414	70258	1028404	110237	1109060	322868	1215650	223850	4080327	5058741
生産額	1048	188316	28086	465955	289342	488719	281657	1743122	136246	3519101	241751	1674718	677462	2009403	311367	8570048	10313170

最終需要・生産額

	東京都 家計外消費支出	東京都 都民家計消費	東京都 他県民都内消費	東京都 政府消費支出	東京都 固定資本形成	東京都 在庫増	東京都 輸出	東京都 輸入	その他地域 消費支出	その他地域 投資	その他地域 輸出	その他地域 輸入	生産額
中間投入 東京都 財・サービス 農林水産・鉱業	27	967	95	0	-10	-64	5	-4873	27	0	0	0	1048
中間投入 東京都 財・サービス 製造業・建設	1888	18471	2689	214	81073	219	17079	-46539	10332	13002	81	0	188316
中間投入 東京都 財・サービス 電力・ガス・水道	18	9089	0	1885	0	0	83	-5	0	0	0	0	28086
中間投入 東京都 財・サービス 商業・金融・不動産	3398	152016	13258	57	11530	120	6121	-2194	28630	15191	12729	0	465955
中間投入 東京都 財・サービス 運輸・情報通信	1681	26595	5592	-13	19329	-102	9463	-9510	12300	32510	799	0	289342
中間投入 東京都 財・サービス 公務・教育医療・ｻｰﾋﾞｽ	28206	74901	33294	109927	2230	0	6876	-11219	0	0	0	0	488719
中間投入 東京都 本社													281657
東京都中間投入計	35217	282039	54928	112069	114152	173	39626	-74340	51288	60702	13609	0	1743122
中間投入 その他地域 財・サービス 農林水産・鉱業	165	2988	160	0	3	10	1	0	31054	8029	888	-171024	136246
中間投入 その他地域 財・サービス 製造業・建設	6102	40344	5370	1	32080	273	485	0	516773	773577	544886	-393937	3519101
中間投入 その他地域 財・サービス 電力・ガス・水道	3	1625	0	0	0	0	39	0	74011	0	322	-24	241751
中間投入 その他地域 財・サービス 商業・金融・不動産	784	9628	1268	1	7252	121	1352	0	975605	95458	72742	-9859	1674718
中間投入 その他地域 財・サービス 運輸・情報通信	302	4494	461	4	4557	41	594	0	214140	36412	49172	-34304	677462
中間投入 その他地域 財・サービス 公務・教育医療・ｻｰﾋﾞｽ	0	596	70	0	0	0	0	0	1465683	25870	13970	-41344	2009403
中間投入 その他地域 本社													311367
その他地域中間投入計	7357	59675	7329	6	43892	445	2470	0	3277267	939345	681982	-650492	8570048
中間投入計	42574	341714	62256	112076	158045	618	42096	-74340	3328555	1000047	695590	-650492	10313170

注1　全国生産額　＝　全国;財・サービス生産額　＋　全国;本社生産額
(10,313,170)　(9,720,146)　(593,023)
(内訳)(1) 全国;財・サービス生産額 = 東京都;財・サービス生産額 + その他地域;財・サービス生産額
(9,720,146)　(1,461,465)　(8,258,681)
(2) 全国;本社生産額 = 東京都;本社生産額 + その他地域;本社生産額
(593,023)　(281,657)　(311,367)

注2　各部門の内容は以下のとおりである。
(1)農林水産・鉱業:農林水産業、鉱業
(2)製造業・建設:製造業、建設
(3)電力・ガス・水道:電力・ガス・熱供給・水道・廃棄物処理
(4)商業・金融・不動産:商業、金融・保険、不動産
(5)運輸・情報通信:運輸、情報通信
(6)公務・教育医療・サービス:公務、教育・研究・医療・保健・社会保障・介護、サービス

注3　定義により、本社から本社への投入及び本社部門の最終需要はない。

注4　四捨五入の関係で内訳と合計は必ずしも一致しない。

Table.3:40 integrated sectors 40

	Sector name
1	Agriculture
2	Mining (except Coal&Crude oil)
3	Coal, Gas, Crude oil
4	Food products
5	Textile
6	Pulp &Paper
7	Chemical
8	Petroleum
9	Coal product
10	Ceramic and Cement
11	Iron
12	Non-ferrous metal
13	Metal product
14	Machinery
15	Electric equipment
16	Transport machinery
17	Precision machinery
18	Miscellaneous manufacture
19	Construction
20	Electricity for business
21	In-house power generation
22	City gas
23	Heat Supply
24	Water Supply
25	Industrial Water
26	Sewage system
27	Waste Disposal :Public
28	Waste Disposal :Private
29	Trading
30	Finance
31	Real Estate
32	Rail transportation
33	Motor vehicle transportation
34	Ship transportation
35	Air transportation
36	Other transportation
37	Information-communication
38	Public service
39	Health and Education
40	Services

import ratio to domestic total demand.

From equation (3), we estimate some values as follows.

(1) First, we calculate the repercussion price by the initial scenario of energy price hike ($\triangle \mathbf{p_0}$), which assumes that the prices of coal, coal products, and petroleum rise due to a tax increase of 5% all together, through the transposed Leontief inverse in the equilibrium price model.

$$\Delta \mathbf{p_1} = \left[\mathbf{I} - (\mathbf{I} - \hat{\mathbf{M}})\mathbf{A}\right]^{-1\mathbf{t}} \Delta \mathbf{p_0}, \qquad (4)$$

where $\Delta \mathbf{p_1} = \begin{pmatrix} \Delta \mathbf{p_{1,T}} \\ \Delta \mathbf{p_{1,O}} \end{pmatrix}$,

Δp_0 is the initial price shock, and $\mathbf{t}$ is the transposed matrix.

(2) Second, we make a new input coefficient matrix (A^N) estimate with the transposed Leontief inverse:

$$\mathbf{A}^{\mathbf{N}t} = (\mathbf{I} - \hat{\mathbf{M}})\mathbf{A}^t(\mathbf{I} + \Delta \hat{\mathbf{p}}_1), \qquad (5)$$

where $(I + \Delta \hat{p}_1) = \begin{bmatrix} 1+\Delta p_1^1 & & & 0 \\ & 1+\Delta p_2^1 & & \\ & & \ddots & \\ 0 & & & 1+\Delta p_n^1 \end{bmatrix}$.

Further, we get a new Leontief Inverse (B^N):

$$\mathbf{B}^{\mathbf{N}} = \left[\mathbf{I} - \mathbf{A}^{\mathbf{N}}\right]^{-1}, \qquad (6)$$

(3) Third, several induced outputs according to price and demand changes can be provided by the usual procedure of Leontief inverse (equation (7)).

Here, it is assumed that the final consumption expenditure will decrease according to the degree of price elasticity of demand as energy prices rise. However, since some consumers might buy more "green products," which are supposed to be

produced with less carbon and less toxic chemicals, a certain portion of the consumption might increase, although the rest will decrease according to the price elasticity of demand.

$$\Delta \mathbf{X}_{\mathbf{m}}^{\mathbf{N}} = \mathbf{B}^{\mathbf{N}} \Delta \mathbf{F}_{\mathbf{m}}, \quad \text{where} \quad \Delta \mathbf{X}_{\mathbf{m}}^{\mathbf{N}} = \begin{pmatrix} \Delta \mathbf{X}_{\mathbf{m,T}}^{\mathbf{N}} \\ \Delta \mathbf{X}_{\mathbf{m,O}}^{\mathbf{N}} \end{pmatrix}. \tag{7}$$

Here, m represents the kind of simulation. For example, the first induced output (X^N_0) should be calculated with independent final demand ($\Delta \mathbf{F_0}$), which consists of results with a 5% rise of prices in coal mining, petroleum, and coal products:

$$\Delta \mathbf{X}_{\mathbf{0}}^{\mathbf{N}} = \mathbf{B}^{\mathbf{N}} \Delta \mathbf{F}_{0}. \tag{8}$$

Another example is the induced output by the independent final demand vector ΔF_1, which is according to the scenario of price elasticity for a certain demand sector.

$$\Delta \mathbf{X}_{\mathbf{1}}^{\mathbf{N}} = \mathbf{B}^{\mathbf{N}} \Delta \mathbf{F}_{\mathbf{1}}. \tag{9}$$

Summing up the results of these induced outputs from scenarios *0* to *k*, we can get the cumulative effect of all the scenarios we assumed here.

$$\Delta \mathbf{X}^{\mathbf{N}} = \sum_{\mathbf{m=0}}^{\mathbf{k}} \Delta \mathbf{X}_{\mathbf{m}}^{\mathbf{N}}. \tag{10}$$

ΔX^N is the cumulative induced output with changing final demand up to the *k* th step.

We assumed the following scenarios:

(3-1) In transportation machinery, without disclosing information about CO2 emissions, 11.7 % of the consumers in JOTT and 14.4 % in Tokyo continue to buy cars as earlier, but the rest of them reduce their expenditure according to the degree of price elasticity. The decreasing rates are price elasticity: -0.497×0.13% [7]in JOTT and -0.497×0.12 % in Tokyo.

(3-2) In contrast, in transportation machinery, with disclosure of information about CO2 emissions, 16.9 % of consumers in JOTT and 21.2 % in Tokyo continue to buy cars as earlier, but the rest reduce their expenditure according to the degree of price elasticity.

(3-3) In electric equipments, without disclosing the information about

[7] This percentage is a price rising rate in the transportation machinery which was induced by 5% of energy price hiking.

environmental issues such as reducing electricity consumption, 5.0% of consumers in JOTT and 7.4% in Tokyo continue to purchase the products as earlier, but the rest reduce their expenditure according to the degree of price elasticity. The decreasing rates are supposed to be price elasticity: -0.827×0.09% in JOTT and -0.827×0.07% in Tokyo.

(3-4) In electric equipments, with disclosure of the information about environmental issues such as reducing electricity consumption, 10.0% of consumers in JOTT and 15.3% in Tokyo continue to purchase the products as earlier, but the rest reduce their expenditure according to the degree of price elasticity.

(3.5) In chemicals, without disclosing the information about environmental issues such as chemical toxics, 7.6% of consumers in JOTT and 14.9% in Tokyo continue the products as earlier, but the rest reduce their expenditure according to the degree of price elasticity. The decreasing rates are supposed to be price elasticity: -0.735×0.56% in JOTT and -0.735×0.09% in Tokyo.

(3-6) In chemicals, with disclosure of information about environmental issues such as chemical toxics, 11.0% of consumers in JOTT and 14.0% in Tokyo continue to purchase the products as earlier, but the rest decrease their expenditure according to the degree of price elasticity.

(3-7) In textiles, without disclosing the information about environmental issues such as chemical characteristics, 3.6% of consumers in JOTT and 6.3% in Tokyo continue to purchase the products as earlier, but the rest reduce their expenditure according to the degree of price elasticity. The decreasing rates are supposed to be price elasticity: -1.269×0.15% in JOTT and -1.269×0.07% in Tokyo.

(3-8) In textiles, with disclosure of the information about chemical characteristics, 5.1% of consumers in JOTT and 7.2% in Tokyo are assumed to purchase the products as earlier, but the rest reduce their expenditure.

(3-9) In real estate, without disclosing the information about eco-friendly house equipments, 6.5% of consumers in JOTT and 12.2% continue to purchase the products as earlier, but the rest reduce their expenditure according to the degree of price elasticity. The decreasing rates are supposed to be price elasticity: -4.372×0.02% in both areas.

(3-10) In real estate, with disclosure of information about eco-friendly house equipments, 16.5% of consumers in JOTT and 21.6% in Tokyo are assumed to purchase the products as earlier, but the rest reduce their expenditure according to the degree of price elasticity.

As mentioned above, we calculated the effects individually.

Table 4 : Effect of an increase in total output with higher energy prices

	Induced output under price rise **5% rise in prices in coal mining, petroleum and Coal products all together**	Δ X (million yne)	%
1	Coal, gas, crude oil O	11,443.6	8.651%
2	Coal, gas, crude oil T	1,355.5	6.768%
3	Coal products O	77,528.9	6.281%
4	Petroleum T	9,385.5	6.183%
5	Coal products T	676.4	5.704%
6	Petroleum O	598,259.7	3.814%
7	City gas O	68,916.6	3.081%
8	In-house power generation T	260.5	2.760%
9	In-house power generation O	20,937.9	1.998%
10	City gas T	9,716.8	1.940%
11	Heat supply O	956.7	1.391%
12	Heat supply T	1,009.0	1.153%
13	Motor vehicle transportation T	37,720.2	1.013%
14	Iron O	198,223.3	0.786%
15	Mining (except coal & crude oil) O	3,448.7	0.709%
16	Chemicals O	190,388.6	0.688%
17	Mining (except coal & crude oil) T	48.8	0.681%
18	Iron T	2,144.4	0.679%
19	Motor vehicle transportation O	169,949.4	0.676%
20	Industrial water O	919.4	0.671%
	Total	2,513,057	
	Ratio of increase to total output	0.244%	

(Note) T represents Tokyo and O represents JOTT .

The calculation result of induced output based on scenarios (1) and (2) is shown in Table 4, and it appears that increase in energy prices as an external factor results in an output rise in each sector, as in the equilibrium price model. However, the effect is only an increase of 0.244%, and the magnitude is 2.5 trillion yen (about USD 22.8 million). Mainly energy-related products such as coal, petroleum, city gas, and in-house power generation witnessed a high rise, and transportation machinery witnessed a relatively small increase.

The integrated effects in the demand and supply side of a rise in energy prices in each sector are shown in Tables 5-9.

Table 5 indicates that the effect of a rise in energy prices in transportation machinery, including cars, is estimated to be positive regardless of the disclosure or non-disclosure of information about CO2 emissions. The effect is 1.6 trillion yen (USD 14.9 billion) without disclosure and 1.7 trillion yen (USD 15.4 billion) with disclosure. Hence, the impact of disclosing the information is about 53 billion yen (USD 481 million). The effect in the energy-related sectors such as coal, petroleum, and electricity are bigger, and also the effects in transportation machinery, finance, real estate, and construction among the top 20 sectors.

The total effect, in electric equipments, is shown in Table 6. The effect is positive and about 1.71 trillion yen (USD 15.56 billion) without disclosure and 1.76 trillion yen (USD $15.97 billion) with disclosure. Hence, the impact of disclosing the information is about 45.2 billion yen (USD 411 million). The effects in coal, petroleum, electricity, and transportation machinery are bigger.

The effects in chemicals, including detergents, and textiles, including clothes, are similarly positive (See Tables 7 and 8). The effect in chemicals without disclosure is about 623.1 billion yen (USD 5.66 billion) and 682.8 billion yen (USD 6.2 billion) with disclosure. So, the impact of disclosing the information is about 59.6 billion yen (USD 541 million).

The effect in textiles without disclosing the information is about 1.77 trillion yen (USD 16.1 billion) and 1.79 trillion yen (USD 16.2 billion) with disclosure. Hence,

the impact of disclosing the information is about 11.2 billion yen (USD 102 million). As such, the impact of disclosure in textiles is lower than that in others. The underlying reason seems to be that the purchasing attitude is less affected by disclosure and rather is more influenced by the price elasticity of demand.

Table 5 : Effect of an increase in energy prices on transportation machinery

Top 20 sectors

Transportation machinery					
non-disclosure of information	Δ X (million yen)	%	disclosure of information	Δ X (million yen)	%
Coal, gas, crude oil O	11,379	8.602%	Coal, gas, crude oil O	11,382	8.605%
Coal, gas, crude oil T	1,350	6.743%	Coal, gas, crude oil T	1,351	6.745%
Coal products O	76,066	6.163%	Coal products O	76,155	6.170%
Petroleum T	9,341	6.153%	Petroleum T	9,344	6.155%
Coal products T	673	5.675%	Coal products T	673	5.677%
Petroleum O	592,962	3.781%	Petroleum O	593,285	3.783%
City gas O	67,602	3.022%	City gas O	67,682	3.026%
In-house power generation T	250	2.649%	In-house power generation T	251	2.656%
City gas T	9,640	1.925%	City gas T	9,645	1.926%
In-house power generation O	19,714	1.881%	In-house power generation O	19,788	1.888%
Heat supply O	905	1.315%	Heat supply O	908	1.320%
Heat supply T	982	1.122%	Heat supply T	984	1.124%
Motor vehicle transportation T	36,582	0.982%	Motor vehicle transportation T	36,651	0.984%
Chemicals O	176,072	0.637%	Chemicals O	176,944	0.640%
Motor vehicle transportation O	158,020	0.629%	Motor vehicle transportation O	158,746	0.632%
Iron O	145,777	0.578%	Iron O	148,968	0.590%
Industrial water O	785	0.573%	Industrial water O	793	0.579%
Mining (except coal & crude oil) O	2,754	0.566%	Mining (except coal & crude oil) O	2,796	0.575%
Mining (except coal & crude oil) T	40	0.560%	Mining (except coal & crude oil) T	41	0.568%
Electricity for business T	6,800	0.476%	Electricity for business T	6,825	0.478%
Total	1,642,580		Total	1,695,585	53,005
Ratio of increase to total output	0.159%		Ratio of increase to total output	0.164%	

(Note) T represents Tokyo and O represents JOTT .

Table 6 : Effect of an increase in energy prices on Electric equipment

Top 20 sectors

Electric equipments					
non-disclosure of information	Δ X (million yen)	%	disclosure of information	Δ X (million yen)	%
Coal, gas, crude oil O	11,388	8.609%	Coal, gas, crude oil O	11,391	8.611%
Coal, gas, crude oil T	1,349	6.738%	Coal, gas, crude oil T	1,350	6.740%
Coal products O	76,810	6.223%	Coal products O	76,850	6.226%
Petroleum T	9,341	6.153%	Petroleum T	9,343	6.155%
Coal products T	675	5.690%	Coal products T	675	5.690%
Petroleum O	593,388	3.783%	Petroleum O	593,663	3.785%
City gas O	67,906	3.036%	City gas O	67,962	3.039%
In-house power generation T	254	2.695%	In-house power generation T	255	2.699%
City gas T	9,637	1.924%	City gas T	9,642	1.925%
In-house power generation O	20,116	1.920%	In-house power generation O	20,162	1.924%
Heat supply O	904	1.314%	Heat supply O	907	1.318%
Heat supply T	976	1.115%	Heat supply T	978	1.117%
Motor vehicle transportation T	36,391	0.977%	Motor vehicle transportation T	36,468	0.979%
Iron O	176,926	0.701%	Iron O	178,123	0.706%
Motor vehicle transportation O	158,798	0.632%	Motor vehicle transportation O	159,426	0.635%
Chemicals O	174,503	0.631%	Chemicals O	175,398	0.634%
Iron T	1,820	0.577%	Iron T	1,839	0.583%
Mining (except coal & crude oil) O	2,737	0.563%	Mining (except coal & crude oil) O	2,777	0.571%
Industrial water O	713	0.520%	Industrial water O	725	0.529%
Mining (except coal & crude oil) T	36	0.497%	Mining (except coal & crude oil) T	36	0.508%
Total	1,713,267		Total	1,758,501	45,235
Ratio of increase to total output	0.166%		Ratio of increase to total output	0.171%	

(Note) T represents Tokyo and O represents JOTT .

Table 7 : Effect of an increase in energy prices on Chemical product

Top 20 sectors

Chemical products					
non-disclosure of information	Δ X (million yen)	%	disclosure of information	Δ X (million yen)	%
Coal, gas, crude oil O	10,795	8.161%	Coal, gas, crude oil O	10,815	8.176%
Coal, gas, crude oil T	1,337	6.677%	Coal, gas, crude oil T	1,338	6.680%
Coal products O	73,701	5.971%	Coal products O	73,822	5.981%
Petroleum T	9,033	5.950%	Petroleum T	9,044	5.958%
Coal products T	673	5.671%	Coal products T	673	5.672%
Petroleum O	512,109	3.265%	Petroleum O	514,835	3.282%
City gas O	66,899	2.991%	City gas O	66,963	2.994%
In-house power generation T	198	2.093%	In-house power generation T	199	2.113%
City gas T	9,531	1.903%	City gas T	9,537	1.904%
Heat supply T	926	1.058%	Heat supply T	929	1.061%
Motor vehicle transportation T	34,642	0.930%	Motor vehicle transportation T	34,738	0.933%
In-house power generation O	8,567	0.818%	In-house power generation O	8,959	0.855%
Iron O	190,307	0.754%	Iron O	190,557	0.755%
Heat supply O	442	0.642%	Heat supply O	458	0.666%
Iron T	2,026	0.642%	Iron T	2,030	0.643%
Motor vehicle transportation O	140,949	0.561%	Motor vehicle transportation O	141,866	0.565%
Mining (except coal & crude oil) O	2,572	0.529%	Mining (except coal & crude oil) O	2,600	0.534%
Electricity for business T	6,067	0.425%	Electricity for business T	6,102	0.427%
Mining (except coal & crude oil) T	30	0.417%	Mining (except coal & crude oil) T	30	0.425%
Air transportation T	2,462	0.366%	Air transportation T	2,483	0.369%
Total	623,142		Total	682,756	59,614
Ratio of increase to total output	0.060%		Ratio of increase to total output	0.066%	

(Note) T represents Tokyo and O represents JOTT .

Table 8 : Effect of an increase in energy prices on Textile

Top 20 sectors

Textiles					
non-disclosure of information	Δ X (million yen)	%	disclosure of information	Δ X (million yen)	%
Coal, gas, crude oil O	11,356	8.585%	Coal, gas, crude oil O	11,358	8.586%
Coal, gas, crude oil T	1,350	6.742%	Coal, gas, crude oil T	1,350	6.743%
Coal products O	77,148	6.250%	Coal products O	77,153	6.251%
Petroleum T	9,326	6.144%	Petroleum T	9,327	6.144%
Coal products T	675	5.694%	Coal products T	675	5.695%
Petroleum O	588,137	3.750%	Petroleum O	588,292	3.751%
City gas O	67,929	3.037%	City gas O	67,944	3.038%
In-house power generation T	255	2.697%	In-house power generation T	255	2.698%
City gas T	9,665	1.930%	City gas T	9,666	1.930%
In-house power generation O	19,816	1.891%	In-house power generation O	19,833	1.893%
Heat supply O	791	1.150%	Heat supply O	794	1.154%
Heat supply T	975	1.114%	Heat supply T	976	1.115%
Motor vehicle transportation T	36,427	0.978%	Motor vehicle transportation T	36,446	0.979%
Iron O	196,380	0.778%	Iron O	196,408	0.779%
Mining (except coal & crude oil) O	3,375	0.694%	Mining (except coal & crude oil) O	3,376	0.694%
Iron T	2,117	0.670%	Iron T	2,117	0.670%
Mining (except coal & crude oil) T	47	0.659%	Mining (except coal & crude oil) T	47	0.660%
Motor vehicle transportation O	157,222	0.626%	Motor vehicle transportation O	157,416	0.627%
Electricity for business T	6,741	0.472%	Electricity for business T	6,748	0.472%
Chemicals O	129,731	0.469%	Chemicals O	130,660	0.472%
Total	1,774,905		Total	1,786,147	11,242
Ratio of increase to total output	0.172%		Ratio of increase to total output	0.173%	

(Note) T represents Tokyo and O represents JOTT .

Table 9 : Effect of an increase in energy prices on Real estate

Top 20 sectors

Real estate					
non-disclosure of information	Δ X (million yen)	%	disclosure of information	Δ X (million yen)	%
Coal, gas, crude oil O	11,338	8.571%	Coal, gas, crude oil O	11,349	8.580%
Coal, gas, crude oil T	1,308	6.529%	Coal, gas, crude oil T	1,313	6.554%
Coal products O	75,819	6.143%	Coal products O	76,002	6.158%
Petroleum T	9,193	6.056%	Petroleum T	9,214	6.070%
Coal products T	622	5.243%	Coal products T	628	5.292%
Petroleum O	587,748	3.747%	Petroleum O	588,873	3.754%
City gas O	67,683	3.026%	City gas O	67,815	3.032%
In-house power generation T	254	2.687%	In-house power generation T	254	2.694%
In-house power generation O	20,173	1.925%	In-house power generation O	20,255	1.933%
City gas T	8,946	1.786%	City gas T	9,028	1.803%
Heat supply O	839	1.219%	Heat supply O	851	1.238%
Motor vehicle transportation T	30,702	0.825%	Motor vehicle transportation T	31,453	0.845%
Heat supply T	625	0.714%	Heat supply T	666	0.761%
Iron O	179,126	0.710%	Iron O	181,169	0.718%
Chemicals O	182,590	0.660%	Chemicals O	183,424	0.663%
Mining (except coal & crude oil) O	3,026	0.622%	Mining (except coal & crude oil) O	3,072	0.631%
Industrial water O	834	0.609%	Industrial water O	843	0.615%
Motor vehicle transportation O	145,563	0.579%	Motor vehicle transportation O	148,172	0.590%
Iron T	1,774	0.562%	Iron T	1,814	0.574%
Mining (except coal & crude oil) T	35	0.485%	Mining (except coal & crude oil) T	36	0.506%
Total	−2,718,576		Total	−2,158,918	559,657
Ratio of increase to total output	−0.264%		Ratio of increase to total output	−0.209%	

(Note) T represents Tokyo and O represents JOTT .

Table 10 : Cumulative effect of an increase in energy prices over 5 sectors

Top 20 sectors

Cumlative effect			Cumlative effect		
non-disclosure of information	Σ Δ X(million yen)	%	disclosure of information	Σ Δ X(million yen)	%
Coal, gas, crude oil O	10,480	7.923%	Coal, gas, crude oil O	10,521	7.953%
Coal, gas, crude oil T	1,273	6.356%	Coal, gas, crude oil T	1,280	6.389%
Petroleum T	8,692	5.726%	Petroleum T	8,729	5.751%
Coal products O	69,428	5.625%	Coal products O	69,867	5.660%
Coal products T	612	5.158%	Coal products T	618	5.211%
Petroleum O	481,307	3.069%	Petroleum O	485,909	3.098%
City gas O	62,352	2.788%	City gas O	62,700	2.803%
In-house power generation T	168	1.782%	In-house power generation T	172	1.821%
City gas T	8,551	1.708%	City gas T	8,650	1.727%
Motor vehicle transportation T	23,863	0.641%	Motor vehicle transportation T	24,876	0.668%
Heat supply T	449	0.513%	Heat supply T	497	0.568%
In-house power generation O	4,635	0.442%	In-house power generation O	5,246	0.501%
Iron O	95,622	0.379%	Iron O	102,331	0.406%
Motor vehicle transportation O	80,755	0.321%	Motor vehicle transportation O	85,828	0.342%
Ship transportation O	11,736	0.263%	Ship transportation O	12,066	0.270%
Air transportation T	1,211	0.180%	Iron T	671	0.213%
Iron T	563	0.178%	Air transportation T	1,318	0.196%
Mining (except coal & crude oil) O	670	0.138%	Mining (except coal & crude oil) O	826	0.170%
Other transportation T	2,167	0.129%	Other transportation T	2,405	0.143%
Other transportation O	10,284	0.120%	Other transportation O	11,468	0.134%
Total	−7,016,912		Total	−6,288,159	728,753
Ratio of increase to total output	−0.680%		Ratio of increase to total output	−0.610%	

(Note) T represents Tokyo and O represents JOTT . 728,753

Table 9 shows us the result of the effect in real estate, but which is totally different from that on other sectors. The impact of an increase in energy prices on real estate through the economic transactions is large and negative, and there is a decrease in demand of about 2.72 trillion yen (USD 24.69 billion) without disclosure of environmental information such as CO2 emission from usage and 2.16 trillion yen (USD $19.6 billion) with disclosure. The impact of disclosing the information, however, is

greater at 559.7 billion yen (USD 5.1 billion).

There are two reasons the real estate sector has the largest influence on the economic system:

First, real estate consumption itself is the biggest demand in not only Tokyo but also JOTT. According to the IO table 2005, the total amount of consumption is 57.9 trillion yen (USD 525.9 billion) and its contribution to the total output of Japan is about 21%. This magnitude is about 8.6 times the total consumption in the electric equipments sector, and about 22 times the total consumption of the chemicals sector. Hence, any change in real estate consumption must have a great influence on the Japan economy.

Second, the price elasticity of real estate demand in Japan is much higher than that of the other sectors. Our assumption of a 5% increase in energy prices leads to a 0.02 % price hike in real estate. Although this increase is quite low, a high price elasticity and large outputs result in a large negative influence. Our estimation shows that rising rise in prices and disclosure of information pertaining to production and use in real estate cannot cancel the negative impact due to high price elasticity.

Finally, the result of the cumulative economic effect of 5 sectors is shown in Table 10. The cumulative effect as a whole is hugely affected by a change in real estate, and the total is 7.02 trillion yen (USD 63.7 billion) without disclosure of information, and 6.29 trillion yen (USD 57.1 billion) with disclosure. The cumulative impact of disclosing information is an increase in demand of 728.8 billion yen (USD 6.6 billion).

This result of Table 10 is due to the equation (10) as we mentioned above, but it consists of summation of energy price rising effect (positive sum) and demand decreasing effect (negative sum) in each sector. As a result, cumulative negative demand effect in each sector becomes much larger than energy price rising effect because all of demand effects in 5 sectors were negative.

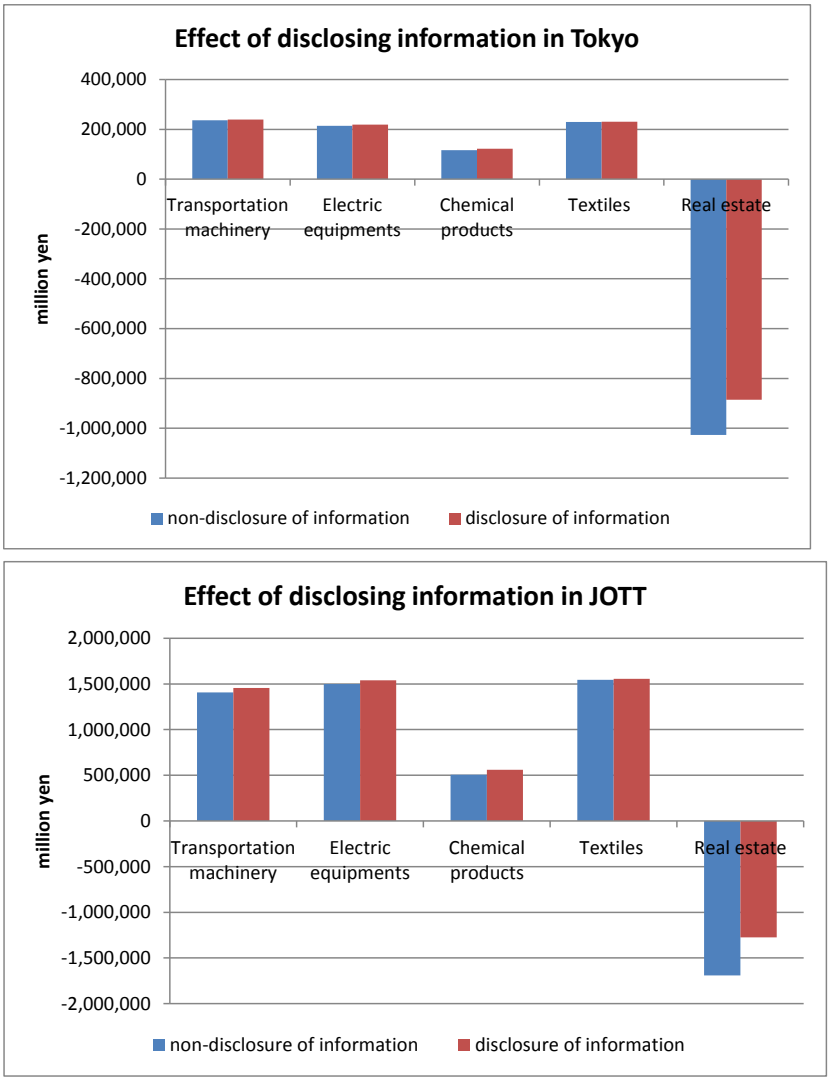
From our calculations, we can see that real estate in Japan can have a large influence on the whole economy, according to the degree of price elasticity of demand and the magnitude of the demand itself even if consumers change their behavior to buy more eco-friendly goods more due to environmental concerns. However, the negative repercussion effect of the increase in price is probably limited to certain sectors that directly raise prices due to an increase in oil prices, and that are closely related to such sectors via mutual transactions.

4. Differences between Tokyo and JOTT

Here, we see the main effects when information is disclosed by region.

Fig. 2 shows the estimated output with and without disclosure by region. Both Tokyo and JOTT exhibit a similar trend: all sectors except real estate have less of an impact. However, the negative impact of real estate in Tokyo is the most serious, and it is greater than all the positive impact in the other four sectors. Thus, we see that real estate is the key sector for Tokyo.

Fig.2: Effect of disclosing information in Tokyo and JOTT



Moreover, in both regions, real estate disclosure positively affects demand, although the total impact of price rise is negative. As shown in Fig. 3, the total increment in real estate owing to disclosure is 418.3 billion yen (USD 3.8 billion) in JOTT and 141.4 billion yen (USD 1.3 billion) in Tokyo. This effectiveness is more than ten times that in the other sectors in both regions.

In Fig. 3, we see that while the magnitude of the impact of disclosure in real estate is the largest in JOTT (around three times that in Tokyo), the population size is very different in each area (around 12.6 million in Tokyo, one-tenth that in JOTT). Therefore, once again, we need to compare these results with the normalized impact on a per capita basis.

As shown in Fig.4-1, the increment output per capita by real estate disclosure in Tokyo (around 11,000 yen or USD 102) exceeds that in JOTT (3,600 yen or USD 33) by 3.1times. Tokyo's impact per capita of real estate disclosure is the largest among the five sectors in both areas. The absolute increment value is not very large, but this shows that consumers in Tokyo are more sensitive to the disclosure of information on real estate than on other goods.

Fig 4-2 shows that besides real estate, chemical products and transportation machinery in JOTT and electric equipments in Tokyo are relatively big. In particular, the need for transportation machinery in JOTT is probably stronger in the rural areas than in the urban areas. Therefore, we can infer that consumers in JOTT might be sensitive to the disclosure of information on transportation machinery.

Fig.3: Increment of demand by disclosing information in Tokyo and JOTT

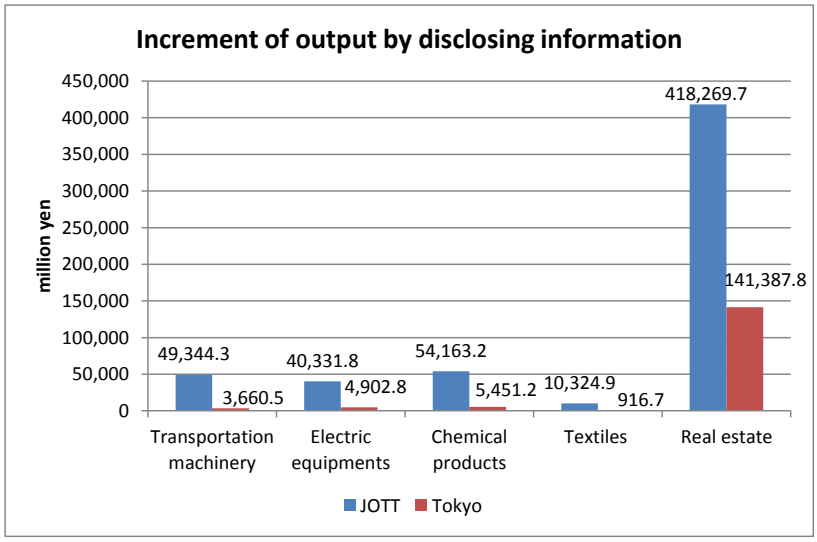


Fig.4-1: Increment per capita by disclosing information in Tokyo and JOTT

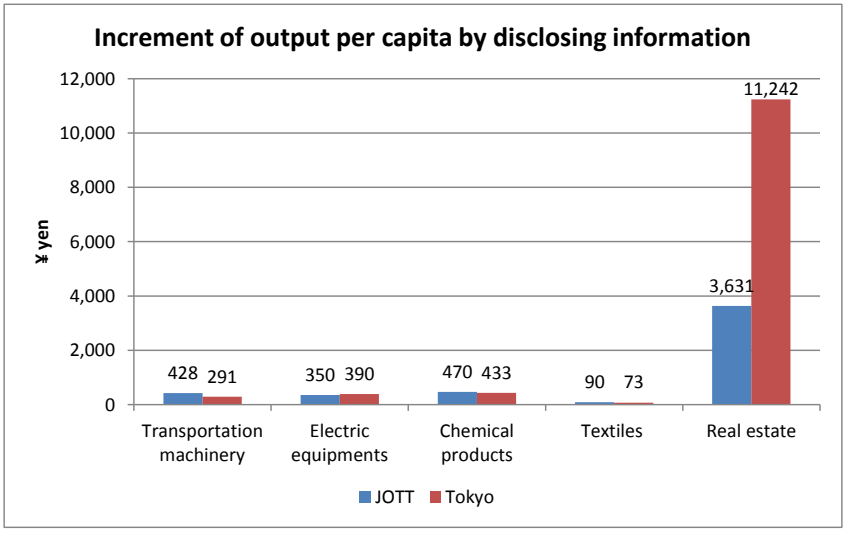
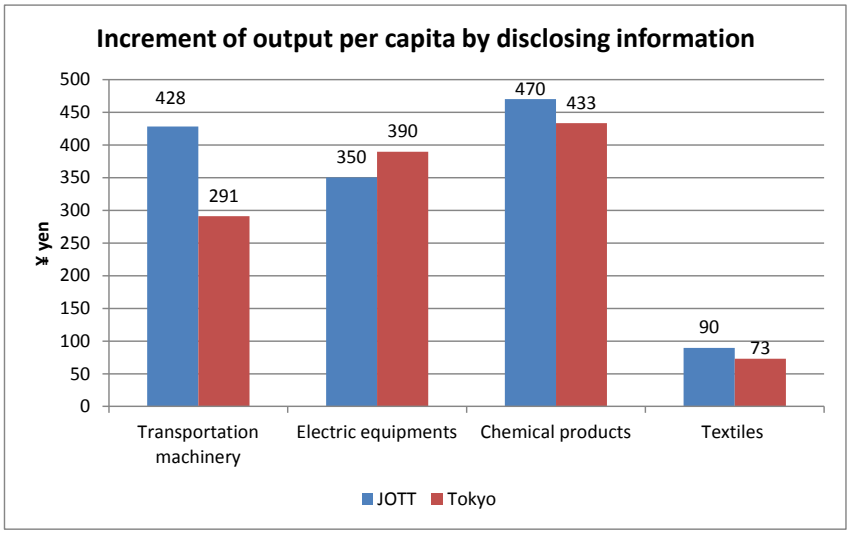


Fig.4-2: Increment per capita by disclosing information in Tokyo and JOTT 2



5. Policy implication and concluding remarks

This paper simulated the impact on the economy in a scenario where energy prices rise due to the introduction of carbon tax and technologies to save energy or reduce CO2 emissions. We particularly focus on changes in consumer behavior due to the highlighting of environmental concerns and the associated economic impact.

In the basic scenario, (1) we estimate the repercussion effect of a 5% increase in energy prices for petroleum and coal products due to policies such as carbon tax (cost-up effect) and (2) estimate how the change in consumers behavior influences the economy

with and without disclosing information about CO2 emission and chemical materials. We estimated these effects for 5 industrial sectors.

The main conclusion is that the total demand in the transportation machinery, electric equipments, chemicals and textiles sectors due to an increase in energy prices has a positive effect, and sectors negatively influenced are limited to certain sectors that directly raise prices due to an increase in oil prices, and that are closely related to such sectors via mutual transactions.

However, the total demand for real estate is estimated to decrease from 2.72 trillion yen (USD 24.69 billion) to 2.16 trillion yen (USD 19.6 billion), which is huge. The reason for this is that, first, the demand for real estate is the largest one in the Japanese economy and the influence of a change in demand will also be very large, and second, the price elasticity of real estate demand is much higher than other sectors and thus, the sensitivity to price change is more severe although the price hike may not be so high.

This magnitude of this effect, 2.72 trillion yen (USD 24.7 billion) in real estate, is nearly equivalent to the annual box-office revenue generated by Hollywood in 2009. Further, the cumulative negative effect for 5 sectors is ranged from 6.29 trillion yen (USD 57.1 billion) to 7.02 trillion yen (USD 63.7 billion). A behavioral change in consumers due to rising environmental concerns is not sufficient to prevent these negative effects.

However, the political direction from our results is rather clear.

As shown in table 9, the impact of the increase in demand when information about environmental burden is disclosed in real estate (559.7 billion yen [USD 5.1 billion]) is 10 times greater than the impact in the other sectors. In addition, the real estate sector is an extremely large demand factor for consumption in Japan. From the IO table, the share of real estate in consumption is about 1.2 to 1.5 times the magnitude of the second biggest sector, trading. Usually, real estate, typically involving buying or building houses, is a very expensive purchasing option for consumers; therefore, price elasticity of demand is higher in general[8].

We can summarize the above as follows:

(1) Sectors that experience negative effects like a decrease in total demand due to a rise in energy prices are not many and can be limited to real estate,

(2) The price elasticity of demand in real estate can be is more elastic,

(3) Real estate is the sector that is most sensitive to behavioral changes due to

[8] The elasticity we estimated in this paper was -4.37.

environmental concerns.

Therefore, one possible economic policy derived from these is issuing a kind of coupon to facilitate consumption for purchasing, rebuilding, and reforming houses. Moreover, exemption for fast depreciation of houses might be an effective policy to stimulate consumption for real estate. This sector is a key sector in Japan for considering future environmental policies such as reducing GHG emissions. Especially, these policies will be more effective in Tokyo as Fig.4-1 shows.

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