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Induced Technical Progress and Structural Adjustment: A Multi-Sectoral Model Approach to Japan's Growth Alternatives[1]

By
Shuntaro Shishido* and Osamu Nakamura*

Abstract

Induced technical progress, distinguishing neutral and biased factors, is estimated on a sectoral basis and then incorporated as endogenous variables into a large scale multi-sectoral econometric model of Japanese economy with the Leontief type input-output framework. The sectoral technical progress is explained by neutral non-price factor, neutral price factor (or barometer of market competition), and biased factors induced by relative factor prices. Two growth alternatives are explored with the model with a special emphasis on (a) import promotion and (b) increased leisure in the context of induced technical progress, output, and employment on a 64-sectoral basis. The importance for growth of the increased competition by imports is emphasized as its policy implication.

1. Introduction

Recent empirical studies on technical progress on a sectoral basis have indicated substantial differences in terms of levels and speeds among different sectors in almost all industrialized or semi-industrialized nations. A relatively slower pace in the primary sector and a faster growth in the secondary, especially in high technology sectors, are commonly observed, though there are marked differences among countries according to the stage of development, factor endowment, market performance, educational and cultural background, government policies on technology, etc.

However, impacts of such sectoral technical progress on different sectors in terms of relative prices, output, employment, investment, and foreign trade have not been specifically formulated and anlyzed in an integrated system where interdependence among different sectors is explicitly and consistently taken into account.

Furthermore, a feedback mechanism from these economic changes to sectoral technical progress has not been analyzed on a quantitative basis, so that the degree of inducement in sectoral technical progress cannot be specified in an integrated system.

This paper aims to explicitly incorporate sectoral changes in technical progress in terms of total factor productivity (TFP) in the framework of the Leontief model with 64 sectors. The paper then attempts to endogenize these technical changes in order to analyze the interdependence between technical progress and conventional economic variables, especially factor prices.

In the latter part of the paper our multi-sectoral model is simulated for two alternative scenarios [(a) import promotion and (b) increased leisure] to evaluate the Japanese growth alternatives for medium term, during 1990 and 1995. Special emphasis is placed upon policy impacts on sectoral technical progress and structural changes in output, employment, and foreign trade. The importance

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* International University of Japan
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of the impacts of foreign competition upon the promotion of domestic technical progress (or negative impact of protectionism), is emphasized in the context of this scenario. The second alternative scenario, with special reference to leisure, is discussed. This is compared with the first scenario in terms of technical progress and policy implications, etc.

2. Model[2]

The model presented in this paper is a large scale multi-sectoral econometric model based on a Leontief framework which has been developed by the International University of Japan (previously by the University of Tsukuba) since 1985. The model is an annual dynamic econometric model with 64 sectors and about 3500 equations, consisting of seven sub-blocks: (1) wages, (2) technical progress and prices, (3) macro-economic variables, (4) final demand, (5) output and input, (6) value added and its components, and (7) social and demographic variables.

The main features of the present version, JLM-G1, can be summarized in the following.

First, the annual model consists of sectoral variables, such as output, intermediate input, employment, capital stock, capacity output, output prices, export and import prices, wages and user costs of capital, and technical progress. These are integrated within a Leontief type input-output framework with a 64×64 technical coefficient matrix and a 64×22 final demand matrix. What distinguishes the present model from the ordinary multi-sectoral model with a Keynesian type mechanism is an annual updating system of an input-output (or technical) coefficient matrix based on an algorithm named V-RAS D1 which is a dynamic version of the static V-RAS used at the beginning of this research project.[3] Given technical progress, or total factor productivity (TFP) and primary factor prices, such as wage rates, user cost of capital and import prices on a sectoral basis, both saving (s) and substitution (r) parameters as well as output prices can be estimated simultaneously through RAS computation procedure. Note in this case that a rectangular technical coefficient matrix, including several rows for primary inputs, is employed instead of the ordinary square matrix so as to link the inverse of TFP (1/TFP) to the s parameter for each input column. Accordingly, the method enables us to evaluate the Leontief type forward effect of the output price reduction caused by technical progress generated in a specific sector.

Second, by means of this updating system of technical coefficient matrix and forecasts on final demand variables, the input-output table can be compiled for each year in both real and nominal terms. This type of information has proved to be highly useful for business, in particular, as medium-term information for marketing and cost-profit analysis.

Third, the interdependence between sectoral output and prices can be analyzed explicitly with this general-equilibrium type model, since almost all quantity variables are made price-sensitive with respect to private consumption, foreign trade, intermediate and primary inputs, and technical progress which will be discussed later in more detail.

Fourth, the model also covers macroeconomic variables including those on fiscal and monetary policy instruments, money flows, interest rates, taxes and transfers, income distribution etc. Accordingly, the Keynesian type analysis can also be made on the dynamic multipliers as well as sectoral analysis in a consistent framework of the Leontief system.

[2] Original model based on a 548×409 technology I-O matrix, was a statics type growth model [7], [9]. The model was then transformed into an annual econometric model with a dynamic adjustment mechanism. For use of this model see [1] [2].

[3] In V-RAS D1, annual changes in (r) and (s) parameters were estimated in the formula of dynamic adjustment of lagged explanatory variables on the basis of their annual time series. The static version was built on five-year intervals, assuming a static equillibrium. For details, see F.G. Adams and S. Shishido [1] and Shishido et al. [7] and [9].

Finally, since the previous version of the JLM-F8 model[4], a demographic block has been newly added so that the information on labor supply and population structure can be analyzed by sex and by each cohort, mostly grouped by five years. The interdependence between economic variables and these demographic variables can be explicitly analyzed. Technical progress can also be studied in context to these socio-demographic variables, especially aging, sex, educational background, etc.

3. Impacts of Technical Progress on Sectoral and Macroeconomic Changes

As mentioned in the previous section, technical progress in terms of TFP has an important role in the model in determining both quantity and price variables at both the sectoral and macroeconomic level. Figure 1 illustrates the model's causal flows. Technical progress in a specific sector first reduces the cost and the price of the output, thus causing the expansion of demand, whether intermediate, final, or external, and increasing the output, employment and investment of the sector concerned. This is a bright side to technical progress at the microeconomic level. It also tends to produce an indirect, secondary impact on industries using such newproducts, e.g. telecommunication based on glass fiber system. The prices of such "using" sectors tend to fall as an indirect impact of technical progress. Forward linkage or spill over of technical progress through such price cuts is particularly noteworthy as observed in Japan's micro-electronic revolution since the late 1970s.[5] Capital, energy and labor costs of electronic and related sectors have been dramatically reduced.

In contrast to this positive side of technical progress, there is a negative impact on employment, capital service, and raw materials and fuels. The broken line in the Figure 1 denotes this negative

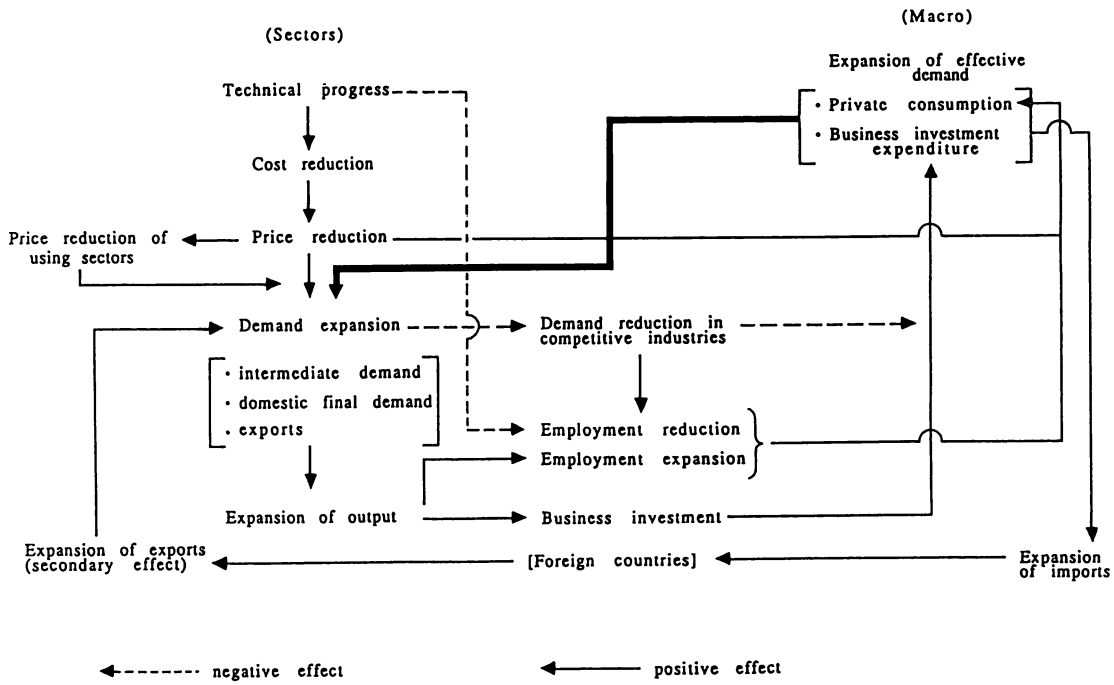

Figure 1 Causal Flows of Technical Progress

[4] See F.G. Adams and S. Shishido [2].
[5] See Shishido et al. [7], [9].

flow which can also be observed for competitive sectors, e.g. natural fiber substituted by synthetic fiber, and fossil fuels, such as coal and petroleum, substituted by atomic or solar energy. The net positive impact of technical progress, after offsetting these negative ones, can be analyzed in the model along the direction of backward linkage. A complicated interaction between these forward and backward linkage effects (or price and quantity impacts), as induced by technical progress, can be properly analyzed in the Leontief type system of the present model.

As for the macroeconomic impact, as shown in the right side of the figure, technical progress of a specific sector creates the expansion of private consumption due to increased real disposable income and business investment as a result of increased profit expectation. As widely recognized, the latter variable is particularly important in analyzing the business cycle from Schumpeterian dynamics on technical progress. The greater becomes the macroeconomic impact, the stronger technical progress tends to occur in a cluster in the related industries, as in the case of micro-electronics.

Regarding foreign trade, technical progress tends to strengthen competitiveness through price reduction, thus stimulating exports as shown in the figure. This is a typical case of forward linkage. On the other hand, there is another case in reducing imports as a negative effect of technical progress (e.g. reduced imports of iron ores substituted by new synthetic material). In both cases, the trade surplus tends to increase with a negative impact on foreign countries, especially if the macro-economic impact of technical progress and the induced imports is not strong enough to offset the rise in trade surplus. In most cases, however, technical progress is likely to occur as a cluster with a strong induced investment, as pointed out by C. Freeman et al.,[6] and a fairly positive, expan-sionary effect is usually observed on the world trade as well.[7]

4. Factors Inducing Technical Progress

We have concentrated so far on the effects of technical progress on sectoral and macroeconomic variables. The next question is how such technical progress is induced by economic variables. Although there have been many attempts to formulate endogenized technical progress,[8] few contributions have been made using TFP as a quantitative measure of technical progress in the framework of the multi-sectoral model.

In view of fairly wide fluctuations of relative prices, including factor prices, and significantly growing differentials of technical progress between different sectors in the Japanese economy since 1970, we attempted to estimate TFP functions directly for all sectors of the economy by using the following hypothesis.

First, in our theoretical hypothesis, technical progress in terms of TFP is assumed to be accounted for by three factors: (a) exogenous factor or non-price factor based on remarkable product-innovation or revolutionary scientific technology and vintage of capital stock which can affect technical progress irrespective of the price changes, (b) net output price factor, which is negatively or positively related to technical progress, depending on the degree of market competition, and (c) biased price factor in favor of saving a specific factor (or input) per unit of output. Besides these three factors, R&D expenses, which are increasingly important in Japan, are not explicitly included in our formula, because of the lack in database consistency. But they are implicitly

[6] See C. Freeman et al. [4].
[7] See S. Shishido et al., [7] and [9].
[8] See H.P. Binswanger and V.W. Ruttan [3], D.W.J Jorgenson and B.N. Fraumeni [5], and H. Wago [11].

involved in our model, as mentioned later. As the database becomes more consistent, it is to be directly included in our formula in the near future.

As easily noticed, factors (a) and (b) are well known, neutral technical progress in the Hicksian sense, but factor (b) needs to be further explained. Here, net output price is defined as p_x/p_z, the ratio of output price (p_x) to total unit cost (p_z). In the case of perfect competition with no profit, $p_z Z = p_x X$ holds, where Z is total input, and X output, both in real terms, and TFP $= X/Z$, or τ. In usual cases with a highly competitive market, the decrease in net output price due to the decline in output price or increase in factor prices (e.g. wage rate, capital cost, etc.), tends to exert a strong pressure to technical advancement or cost reduction, thus accelerating technical progress. In other words, as the market becomes more restrictive due to some entry barriers, there is a growing tendency where the parameter of this factor (b) nears zero or even turns negative, as discussed later.

In factor (c), a biasedness in technical progress has been discussed by many economists, as in robotics for labor saving, softwares for capital and energy saving, etc.

Considering these three factors, our TFP function was estimated using the following formula.

$$\ln \text{TFP} = c + \lambda \ln (p_x/p_z) + \alpha \ln (w/p_k) + \beta \ln (p_r/p_k)\ \gamma_1 v + \gamma_2 t \tag{1}$$

where p_k = user cost of capital, w = wage rate, p_r = input price of intermediate input (including energy), v = vintage factor, t = time.

The sign conditions of this equation are: $\lambda < 0$ for competitive sector, $\lambda > 0$ for non-competitive sector, $\alpha \lessgtr 0$, $\beta \lessgtr 0$, $\gamma_1 > 0$ and $\gamma_2 > 0$. In context to our theoretical hypothesis, γ_1 and γ_2 relate to factor (a), non-price neutral factor; λ relates to factor (b), neutral price factor; and α and β imply factor (c), factor price indicating biasedness. Since a homogeneity constraint of degree zero is imposed on factor (c), the parameter of p_k is implied to be $-(\alpha + \beta)$.

In the following, we first take up the meaning of parameters and in the context to biased technical progress and later discuss λ.

With respect to the property of the production function underlying these parameters, we impose no restrictions in our model such as those in Cobb-Douglas, CES, or Translog, except the restriction of homogeneity of degree zero for demand elasticity of factor price, as mentioned above. This implies that we are assuming a fairly flexible and generalized formula of a non-homothetic type in our production function. The technical progress function in equation (1), therefore, is derived from the following unit factor demand function based on such general formula of the production function. Unit factor demand (F_i/X) for a specific factor in the Leontief mode thus is made dependent on factor prices (p_j) and time trend (t) as shown below. (In our empirical expression, $F_i = K, L, R$. $p_j = w, p_k, p_r$, as in equation (1).)

$$\ln \frac{F_i}{X} = f(\ln p_1, \ln p_2, \ldots \ln p_n, t) \tag{2}$$

$$\partial f / \partial \ln p_j = \epsilon_j \tag{3}$$

$$\sum_j \epsilon_j = 0 \qquad (i, j = 1, 2, \ldots, n) \tag{4}$$

Considering business behavior in the real world, the demand elasticity for many factors ϵ_{ij}, i.e. demand elasticity of a factor i with respect to a factor price j, is preferably assumed to be affected by two aspects: (a) short-term factor adjustment ϵ_{ij}^S, and (b) long-term factor adjustment with biased technical progress ϵ_{ij}^L. (See Appendix for detail.) While the former relates to current production, the later relates to strategic costs, such as R&D expenditures, investment adjustment

costs, overhead expenses, etc., which are more or less based on long-term management strategy at the head office level. In aggregating equation (2) to obtain total unit factor cost or an inverse of TFP, it is convenient to assume a symmetry condition of the rate of substitution σ_{ij} for ϵ_{ij}^S and a non-symmetry one for ϵ_{ij}^L. This implies that for short-term factor adjustment weighted vertical aggregation of ϵ_{ij}^S gives zero value for each factor price, as shown below.

$$\sum_j \epsilon_{ij}^S = 0 \tag{5}$$

$$\sigma_{ij}^S = \sigma_{ji}^S \tag{6}$$

$$\epsilon_{ij}^S = \omega_j^S \sigma_{ij}^S \tag{7}$$

$$\sum_i \omega_i^S \epsilon_{ij}^S = 0 \tag{8}$$

where ω_i denotes cost share of factor i.

Accordingly, equation (7) indicates that, as far as ϵ_{ij}^S is concerned, there is no reason to expect that total unit factor cost, $1/\tau^S$ $(= \sum_i \omega_i^S \ln F_i^S/X)$ is dependent on relative factor prices, although in current production each factor input is likely to be adjusted in response to relative factor price changes in the short-term.

For long term business decisions, as shown below, a weighted vertical aggregation of ϵ_{ij}^L provides no-zero values for technical progress τ^L in the absence of a symmetry condition as in the short-term.

$$\sum_i \epsilon_{ij}^L = 0 \tag{9}$$

$$\sum_i \omega_i^L \epsilon_{ij}^L \neq 0 \tag{10}$$

$$-\ln \tau^L = \sum_i \omega_i^L \epsilon_{ij}^L \ln p_i + \sum_i \omega_i^L \beta_i^L t \tag{11}$$

Turning back to equation (1), the TFP function, it now becomes clear that the factor price parameters α, β, exactly correspond to $\sum_i \omega_i^L \epsilon_{ij}^L$, implying the long-term responsiveness to relative factor prices in business decisions for technical progress.

Next, we modify the above model in order to dynamize its adjustment process under a more realistic assumption. This is an attempt to introduce parameters λ, γ_1 and γ_2 into equation (1).

The neutral price factor, λ, is of great importance as it can identify the competitive condition of a specific sector of the economy according to $\lambda \gtreqless 0$. As shown in Figure 2, highly competitive sectors tend to indicate a negative value for λ, while oligopolistic or protected sectors show a positive value.

Since 1/TFP, or total unit cost, can be regarded as an average cost (AC) at given factor prices, a competitive industry tends to reduce AC by adopting new technology or improving the production process, when the market price of its output falls for some reason or other, e.g. new entry of foreign competitors or decline of domestic demand, etc. The equilibrium point then moves from P to Q and both output and TFP increase correspondingly, as shown in Case A in Figure 2.

Less competitive, oligopolistic or protected sectors tend to adjust their output in the face of the fall in market price, still keeping their high profit. The equilibrium point moves from P to Q with higher AC or 1/TFP, as shown in Case B. This behavior of a downward adjustment of output will be continued until the output price reaches the level of A, the lowest point of the AC curve. Since R&D expenses also depend on profit in these types of industries, the fall of output price tends to discourage their effort to improve technology. Schumpeterian hypothesis (Mark II) holds exactly

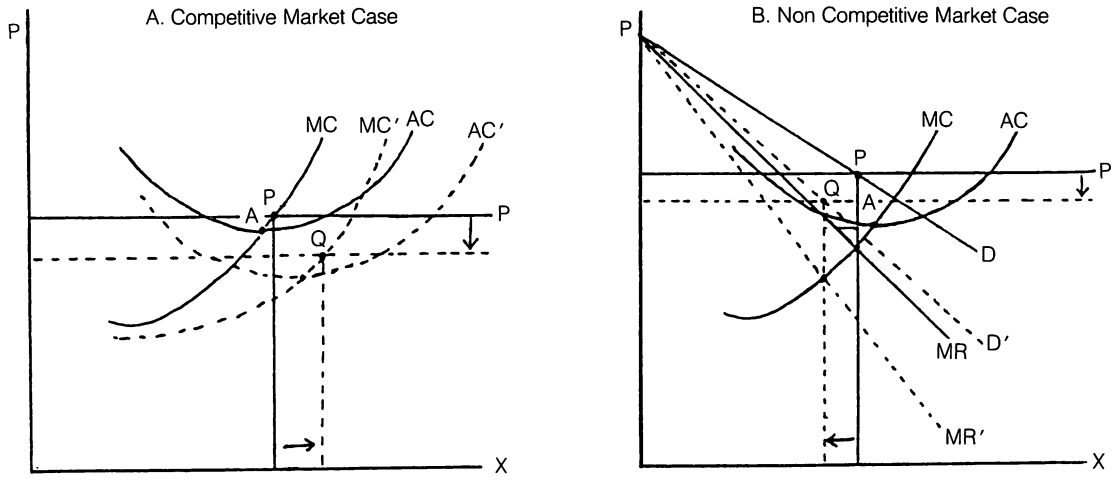

Figure 2 Cost-Price Relation

in this case,[9] since the price increase with higher profit encourage R&D efforts, enabling a reduction in AC of 1/TFP. If the expected maximum profit is sufficient, the sector attempts not only to expand its output, but also to move the AC and MC curves downward by accelerating its technical progress.

Second, a modification of the neutral factor in technical progress function is made in the context of γ_1 and γ_2 of equation (1). γ_1 represents vintage factor of capital stock which is approximated by the ratio of business investment to capital stock during the past several years. In a sense this factor could be regarded as factor augmentation for capital input accompanied by a long time lag. γ_2, therefore, is a pure non-price parameter of time, representing an innovation of revolutionary technology, invention of a new product, TQC and management improvement, etc., as noted earlier.

5. Empirical Results on Induced Technical Progress

For empirical implementation of the theoretical model in the previous section, we made a regression analysis of sectoral TFP on the basis of annual data developed for our multi-sector model, JLM G1, for the sample period of 1970 through 1983.

As summarized in Table 1 the result of the regression analysis relates to 58 sectors, covering almost all sectors of the economy on a 64 sectoral basis. (See Table 2 for further details.) Regarding the sign of λ, competitive position, more than half of the sectors indicate negative signs, suggesting that competitive sectors exceed non-competitive sectors in number. The secondary sector, i.e. manufacturing industry, dominantly shows negative signs implying that about two-thirds of this sector is highly competitive because of its heavy dependence on the international market. Particularly noticeable is the concentration of negative signs in high technology sectors and light manufacturing sectors which are now under keen competition with the Asian NIES. General machineries, electronics, automobiles, other transport equipment (mostly shipbuilding), textiles, and apparels are typical examples. Less competitive or oligopolistic sectors show positive signs as usually expected. They are mostly primary sectors, and hlaf of the tertiary sectors, such as

[9]See J.A. Schumpeter [6].

Table 1 TFP Functions: Parameters with Positive or Negative Values in Terms of the Number of Sectors

	λ			α			β			$1-\alpha-\beta$			γ_1	γ_2
(sign)	+	−	0	+	−	0	+	−	0	+	−	0	+	+
Primary	7	1	1	5	3	1	3	4	2	5	3	1	5	2
Secondary	10	22	2	17	17	0	27	6	1	10	23	1	7	13
Tertiary	7	7	1	3	7	5	12	2	1	4	11	0	7	5
Total	24	30	4	25	27	6	42	12	4	19	37	2	19	20

Note: $\ln TFP = a + \lambda \ln \frac{p_x}{p_z} + \alpha \ln \omega + \beta \ln p_r + (1-\alpha-\beta) \ln p_k + \gamma_1 v + \gamma_2 t$

construction, public utilities, finance and other services.

Regarding parameters α, β, and $1-\alpha-\beta$, biased responses factors in technical progress, the results show significantly positive signs for β, relating to material price (including energy price), and strong negative signs for $(1-\alpha-\beta)$, the capital cost. Sectors with positive signs for α, the response parameter of wage rate, account for only about fifty percent. The α's positive signs, however, are dominant in the primary sectors and high technology sectors, while an opposite tendency is observed in the tertiary sectors. Exceptionally, the positive signs of $1-\alpha-\beta$, the capital cost, are indicated for capital-intensive industries such as mining, beverage and tobacco, oil refineries, iron and steel, electric power, and railway transportation. This is highly in accordance with the factor intensity based on their technology.

Non-price neutral factors, γ_1 and γ_2, also turn out to be significant, but their numbers are rather limited, about one-third of the total, respectively. Vintage effects γ_1 are indicated in rather slow growing sectors and some of them are not highly significant as shown in Table 2. This probably represents the fact that fast growing or high technology oriented sectors tend to always maintain young vintage capital stock employing new technology because of their rapid pace of investment. It is also because technical progress in these sectors tends to depend more on R&D rather than on the vintage effect.

With respect to λ_2, purely neutral factor for technical progress, rapid rates of increase of about 3 to 6% are indicated for high technology sectors, trade, and finance, while a modest growth of 1 to 3% is observed for some of the food processing, textiles, apparels, etc. While γ_2 is limited in number, it should be emphasized that its impact on the entire economy becomes increasingly important in view of their growing share in Japan's economy.

Table 3 focuses on manufacturing sectors, distinguishing three types: (1) high technology (machineries and chemicals), (2) capital-intensive (iron and steel, non-ferrous metals, coal and petroleum products, and cement) and (3) others. In summary, the high technology sectors' TFP is highly competitive, labor and material saving, and capital using. Capital-intensive sectors show a rather reversed tendency, although parameter signs are mixed. They are characterized as less competitive and capital saving. Other sectors indicate a similar pattern to high technology sectors, but parameter signs are weaker.

Finally, in the context of the conventional Leontief type analysis of direct and indirect dependence on primary factors, parameter can be further broken down into primary factor parameters of wage rate, capital cost and import price under the homogeneity constraint as noted before. This means that on a primary factor price basis $TFP = f^*(w, p_k, p_m)$, where p_m is import price of raw materials and fuels. Although not explicitly estimated, it can be safely stated that, as far as biasedness is concerned, Japan's technical progress as a whole is characterized as labor and import saving, and capital using. This conclusion suggests two important macroeconomic policy implications: 1) Relatively lower capital cost through monetary or tax incentives will accelerate technical

Table 2 TFP Functions

SECTOR	C	λ	α	β	(1-α-β)	V	TIME DUMMY	$\bar{R}^2$	D.W.
1.	-2.60	.37 (3.7)	.07 (.9)	.007 (.5)	-.08			.60	1.72
2.	-1.76	.39 (3.7)	-.02 (-.3)	-.01 (-.5)	.03			.51	1.83
4.	-22.94	.67 (3.5)	.07 (.6)	-.32 (-2.0)	.25	.38 (1.9)	.01 (.9)	.59	2.16
5.	.57	.30 t-1 (1.3)	-.20 (-3.5)	.02 (.4)	.18			.78	1.95
6.	1.34	.85 (3.2)	-.52 (-6.2)		.52			.89	1.28
7.	-3.76		.41 (5.5)	-.02 (-1.0)	-.39	.36 t-2 (4.1)		.71	1.60
8.	-1.35	.18 (1.4)	.07 (2.0)	.16 (5.2)	.23	.006 t-2 (.3)		.95	2.39
9.	-3.68	-.33 (-1.5)	.53 (15.3)	-.05 (-2.5)	-.48	.08 (3.7)		.98	2.45
12.	-32.45	.64 (2.6)			0	.26 t-2 (3.6)	.02 (3.8)	.68	1.66
13.	-38.92	1.33 (1.5)	-.38 (-3.6)	.26 t-1 (3.1)	.12		.02 (2.6)	.59	2.78
14.	-29.70	1.32 t-1 (6.4)	-.66 (-4.8)	1.18 (5.7)	-.52	.17 t-2 (1.5)	.01 (2.1)	.94	2.06
15.	-41.83		-.54 (-2.9)	.15 (.8)	.39		.02 (3.4)	.43	0.38
16.	-1.89	.07 (2.0)	-.23 (-4.8)	.51 (5.8)	-.28			.76	2.14
17.	4.95	-1.18 t-1 (-2.8)	.16 t-1 (2.7)	-.41 t-1 (-2.3)	.25			.38	2.05
18.	-83.21	-.52 (-1.2)	-.33 (-1.0)		.33		.05 (2.3)	.47	0.46
19.	-37.34	-1.09 (-2.6)	-.20 (-1.4)	.19 (2.8)	.01			.64	1.91
20.	-19.18		.06 (1.2)	.15 (3.8)	-.22		.01 (1.7)	.72	2.44
21.	-47.02	-1.43 (-3.6)	-.29 (-3.1)	.41 (5.8)	-.12		.03 (4.9)	.85	1.93
22.	-18.64	-.31 (-.6)	-.15 (-.9)	.17 (1.6)	-.02		.01 (2.0)	.58	1.81
23.	12.84	-2.81 (-2.6)	-.02 (-4.4)	.15 (1.5)	-.13			.31	1.45
24.	3.23	-.84 (-1.5)	.03 (.3)	.20 (1.0)	-.23			.70	1.91
25.	1.59	-.22 (-1.5)	-.11 (-6.7)	.27 (7.4)	-.16			.81	1.98
26.	-4.30	1.35 (4.5)	-.23 (-3.3)	.42 (6.3)	-.19	.11 t-2 (2.0)		.90	2.54
27.	-10.03	-1.71 (-3.7)	-.44 (-4.2)	.31 (4.3)	.15	.12 t-2 (1.4)	.01 (1.1)	.57	1.84
28.	-1.13	-.37 (-.8)	.20 (3.9)	.44 (3.9)	-.66	.08 t-2 (1.6)		.94	1.82
29.	-.92	-.32 t-1 (-1.3)	.23 t-1 (3.3)	-.10 t-1 (-1.1)	-.13			.77	1.51
30.	-.82	-.28 (-1.5)	.21 (3.1)	.24 (3.1)	-.45	.04 (.5)		.98	1.52
31.	-.26	-.13 (-1.6)	.11 (1.0)	-.11 (-3.3)	0			.55	1.04
32.	3.27	-.46 t-1 (-6.6)	-.09 t-1 (-1.6)	-.23 t-1 (-4.5)	.32			.90	1.09
33.	-4.47	.44 t-1 (3.2)	.23 (2.8)	.16 (6.7)	-.39	.06 (0.9)		.94	1.06

SECTOR	C	λ	α	β	(1-α-β)	V	TIME DUMMY	$\bar{R}^2$	D.W.
34.	-1.16	.76 (2.6)	-.37 (-5.4)	.60 (3.8)	-.43			.79	1.06
35.	-4.02	.71 t-1 (3.1)	.12 t-1 (2.5)	-.26 t-1 (-3.1)	.14			.69	1.75
36.	-1.52	-.20 (-.6)	.32 t-1 (3.8)	-.50 t-1 (-2.8)	.18			.62	1.08
37.	3.16	.61 (1.2)	-.64 (-9.7)	.24 t-1 (1.7)	.40			.90	2.47
38.	.95	-.39 t-1 (-3.5)	.06 (2.7)	.16 (5.0)	-.32			.89	1.97
39.	.41	-.29 (-1.8)	.06 (1.8)	.23 (4.0)	-.29			.89	2.41
40.	-24.03	-1.58 (4.9)	-.19 (-2.8)	.28 (3.8)	-.09		.02 (4.1)	.96	1.72
41.	-58.68	-.22 (-1.3)	.14 t-1 (3.6)	.16 (2.0)	-.30		.03 (9.7)	.99	2.65
42.	1.29	-.85 t-1 (-1.2)	.19 t-1 (3.2)	.51 (2.6)	-.70			.60	0.98
43.	2.08	-.86 t-1 (-2.3)	.13 (1.6)	.48 (10.5)	-.61			.97	1.18
44.	-49.80	-1.42 (-2.4)	.12 t-1 (.8)	.47 (7.6)	-.59		.03 (2.1)	.86	1.48
45.	-114.25	.63 (1.0)	-.21 (-1.4)	.30 (2.3)	-.09		.06 (4.1)	.93	0.58
46.	-4.28	.37 t-1 (1.5)	.27 (4.2)	.11 (1.5)	-.38	.03 (1.7)		.96	2.27
47.	-3.53	.79 (1.9)	-.04 (-.8)	.23 (4.6)	-.19			.72	1.59
48.	-1.11	.44 (1.1)	-.13 t-1 (-1.4)	.34 (3.1)	-.21	.07 t-1 (.8)		.86	2.69
49.	-43.20	.46 (1.1)	-.56 (-3.6)	.61 (5.7)	-.05		.02 (2.2)	.73	2.06
50.	10.10	-1.41 t-1 (-1.1)	-.41 (-7.9)	.16 (2.0)	.25			.87	2.02
51.	.33	.12 (2.0)	-.10 (-2.6)	-.15 (-5.2)	.25			.92	1.90
52.	-2.29	.53 (2.9)		.27 (4.3)	-.27	.13 t-2 (2.0)		.74	1.94
53.	-51.47	-.46 t-1 (-3.5)	.14 (1.0)		-.14		.03 (4.9)	.90	2.13
54.	-7.17	-.59 t-1 (-2.7)		.38 (7.3)	-.38	.28 t-2 (3.1)	.005 (1.5)	.90	1.82
55.	4.19	-.41 (-3.4)	-.09 (-.7)	.20 (4.3)	-.11			.82	1.43
56.	6.94	-.72 (-5.0)	-.46 (-3.5)	.15 (.9)	.31			.93	1.87
57.	-24.58	-.06 (-.8)		.01 (.4)	-.01	.20 t-2 (3.6)	.01 (2.1)	.82	2.23
58.	-1.40		.12 (1.5)	.20 (2.0)	-.32		-.17 (-2.5)	.51	0.80
59.	-4.31	.74 (1.9)	.95 (2.3)	-.05 (-.4)	-.90	.91 t-2 (2.4)		.27	1.10
60.	-117.45	.45 (2.5)		.14 (3.2)	-.14	.37 t-2 (3.1)	.06 (6.3)	.93	1.97
63.	-.004	.54 (1.4)	-.27 (-3.7)	.25 (1.6)	.02	.20 t-2 (1.6)		.71	0.75

Sectoral Classification Japan

1. General crops 2. Industrial crops 3. Livestock for textiles 4. Other livestock and service 5. Forestry 6. Fisheries 7. Coal mining 8. Iron ores 9. Nonferrous metallic ores 10. Crude petroleum 11. Natural gas 12. Other minings 13. Meat and dairy products 14. Grain products 15. Manufactured sea foods 16. Other foods 17. Beverages 18. Tabacco 19. Natural textiles 20. Chemical textiles 21. Other textiles 22. Wearing apparel 23. Wood and wood products 24. Furniture 25. Pulp and paper 26. Printing and publishing 27. Leather products 28. Rubber products 29. Basic and intermediate chemicals 30. Final chemicals 31. Petroleum products 32. Coal products 33. Cement 34. Other ceramics 35. Iron products 36. Rollings, casting and forgings 37. Aluminium (including secondary) 38. Other non-ferrous products 39. Metal products 40. Machinery 41. Electrical machinery 42. Automobiles 43. Aircraft 44. Other transport equipment 45. Instruments and related products 46. Miscellaneous manufacturing 47. Housing construction 48. Industrial construction 49. Public construction 50. Other construction 51. Electric power 52. Gas 53. Water and sanitary service 54. Wolesale and retail trade 55. Real estate 56. Railways 57. Trucks and buses 58. Other transportation 59. Communications 60. Finance and insurance 61. Government services 62. Public services 63. Other services 64. Unallocated

Table 3 Technical Progress in Manufacturing Sectors in Terms of Parameters of TFP Functions

	λ	α	β	$1-\alpha-\beta$	γ_1	γ_2
1. High technology	−	+	+	−		+
2. Capital intensive	±	±	±	+	(+)	
3. Others	−	±	+	−	(+)	(+)

Note: See Note in Table 1 (+) denotes weakly positive.

progress of the economy as a whole; and 2) Material saving tendency in our study seems to strongly suggest a remarkable performance in energy saving, especially that of crude oil. The tendency will have to be further strengthened in view of global considerations on energy and environment.

6. Simulation Analysis on Import Promotion and Increased Leisure

The new version of our multi-sectoral model (JLM G1) incorporating endogenized TFP functions, as discussed above, has been used for various alternative scenario analyses. In the following we present two important scenarios to evaluate the impacts of (a) import liberalization and (b) increased leisure in the context of sectoral technical progress, output, employment and prices as well as macroeconomic growth alternatives including GNP, the current account balance, the rate of inflation, etc.

Before discussing alternative forecasts, we shall briefly describe the results of baseline forecast. In order to evaluate normal growth patterns, the model was simulated for the period 1990 to 1995 on the assumption that exogenous variables tend to grow along each trend in recent years, as shown in Table 4. World trade was assumed to grow around 4% and exchange rates to gradually rise from ¥150 in 1990 to ¥133 in 1995 in terms of the yen against the dollar. Regarding macroeconomic policy, fiscal expenditures such as public consumption and investment were assumed to grow on the normal trend, about 3.1% and 4.7% respectively. In light of the recent Structural Impediments Initiative Talk between Japan and the United States, the growth for public investment is fairly modest. The discount rate of the Bank of Japan was assumed to continue at the recent level. Despite recent new developments, the oil price was assumed to grow modestly.

Table 4 Exogenous Variables (Base Line Forecast)

Rate of change (%)

	1990	1991	1992	1993	1994	1995
1. World trade (M_w)	5.3	4.0	3.9	3.8	3.7	3.6
2. World import price (P_m^w, $)	2.0	2.0	2.0	2.0	2.0	2.0
3. Crude oil (P_{m10}, $)	11.6	−0.8	0.5	0.4	0.4	0.3
4. Exchange rate index (*REX*)*	2.39	2.47	2.52	2.58	2.63	2.69
5. do. (¥/$)*	150.0	145.0	142.0	139.0	136.0	133.0
6. Government investment (I_{g65})	7.4	4.7	4.7	4.7	4.6	4.6
7. Government consumption (C_g)	−0.3	3.1	3.1	3.1	3.1	3.1
8. Official discount rate (*IN*)*	5.16	5.25	5.25	5.25	5.25	5.25
9. Corporate tax rate (R_1*)*	0.49	0.47	0.45	0.43	0.43	0.43

*denotes level.

Table 5 Macroeconomic Variables (Base Line Forecast)

SELECTED ECONOMIC INDICATORS -- JAPAN MODEL, VERSION 81

		1989	1990	%CHG	1991	%CHG	1992	%CHG	1993	%CHG	1994	%CHG	1995	%CHG
GROSS NATL EXPN	GNEDS	395183.	429279.	8.6	464750.	8.3	495721.	6.7	523462.	5.6	557059.	6.4	597553.	7.3
REAL GNE	GNE	346692.	362050.	4.4	378804.	4.6	397054.	4.8	415331.	4.6	439265.	5.8	463902.	5.6
GNE DEFLATOR	P	112.65	114.73	1.9	116.75	1.7	119.08	2.0	120.83	1.5	122.69	1.5	125.63	2.4
PERS CONS DEFL	PCP	116.46	121.96	4.7	125.67	3.0	128.72	2.4	131.02	1.8	133.51	1.9	137.13	2.7
WHOLESALE PRICE	PWJ	87.320	91.464	4.7	93.564	2.3	94.747	1.3	95.205	0.5	95.838	0.7	97.231	1.5
LABOR FORCE	NL	6414.0	6522.9	1.7	6528.9	0.1	6511.7	-0.3	6514.5	0.0	6530.4	0.2	6541.0	0.2
POPULATION	N	12432.	12489.	0.5	12543.	0.4	12592.	0.4	12637.	0.4	12677.	0.3	12703.	0.2
UNEMPLOY RATE	US	2.8890	2.9578	2.4	3.0369	2.7	3.1286	3.0	3.2337	3.4	3.3245	2.8	3.4144	2.7
BANK LENDG RATE	I	5.9807	6.9851	16.8	7.0235	0.5	7.0238	0.0	7.0147	-0.1	7.0005	-0.2	7.0292	0.4
CBP	BFOOL	57.450	50.416	-12.2	56.014	11.1	52.643	-6.0	57.517	9.3	69.873	21.5	78.623	12.5
GOVT SURPLUS	BG	-14021.	-14167.	-1.0	-14345.	-1.3	-15791.	-6.4	-16173.	-2.4	-16083.	0.6	-15634.	2.8
WAGE RATE	W	49.144	51.791	5.4	54.020	4.3	56.192	4.0	58.059	3.3	59.864	3.1	61.741	3.1
T FACTOR PRODVT	TQ	4.2605	4.2709	0.2	4.2730	0.0	4.2798	0.2	4.2844	0.1	4.2890	0.1	4.2944	0.1

GROSS NATIONAL EXPENDITURE BY CATEGORY (80 Y)

		1989	1990	%CHG	1991	%CHG	1992	%CHG	1993	%CHG	1994	%CHG	1995	%CHG
CONSUMPTN-PRIVT	CP	191403.	200133.	4.6	209651.	4.8	218816.	4.4	227615.	4.0	236743.	4.0	246159.	4.0
CONS-NONPROFIT	CNP	2560.6	2686.1	4.9	2817.7	4.9	2955.8	4.9	3100.6	4.9	3252.5	4.9	3411.9	4.9
CONS-GOVERNMENT	CG	30562.	30479.	-0.3	31423.	3.1	32396.	3.1	33393.	3.1	34429.	3.1	35492.	3.1
INVESTMENT-BUSN	IP	75369.	81199.	7.7	84551.	4.1	88874.	5.1	93117.	4.8	99421.	6.8	107999.	8.6
INVES-RESIDENTL	IH	23330.	22299.	-4.4	24038.	7.8	25606.	6.5	26525.	3.6	27766.	4.7	29209.	5.2
INVES-GOVERNMNT	IG	25289.	27162.	7.4	28446.	4.7	29781.	4.7	31170.	4.7	32614.	4.6	34116.	4.6
INVENTORY-PRIVT	IP	2237.0	1452.2	-35.1	2736.6	88.4	3990.1	45.8	4359.2	9.3	5408.7	24.1	6182.3	14.3
INVT-GOVERNMENT	JG	305.90	305.90	0.0	305.90	0.0	305.90	0.0	305.90	0.0	305.90	0.0	305.90	0.0
NET EXPORTS	BLNK401	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
EXPORTS	E	66376.	74203.	11.8	79492.	7.1	82326.	3.6	86817.	5.5	94568.	8.9	100899.	6.7
IMPORTS	M	70740.	77868.	10.1	84657.	8.7	87998.	3.9	91077.	3.5	95243.	4.6	99871.	4.9

GROSS NATIONAL EXPENDITURE BY CATEGORY (CURR Y)

		1989	1990	%CHG	1991	%CHG	1992	%CHG	1993	%CHG	1994	%CHG	1995	%CHG
CONSUMPTN-PRIVT	CPDS	222901.	244072.	9.5	263461.	7.9	281658.	6.9	298217.	5.9	316083.	6.0	337566.	6.8
CONS-NONPROFIT	CNPDS	3150.5	3352.1	6.4	3566.6	6.4	3794.9	6.4	4037.8	6.4	4296.2	6.4	4571.2	6.4
CONS-GOVERNMENT	CGDS	37693.	39411.	4.6	42113.	6.9	44835.	6.5	47431.	5.8	50110.	5.6	53003.	5.8
INVESTMENT-BUSN	IPDS	70086.	78892.	12.6	85190.	8.0	90663.	6.4	95434.	5.3	102486.	7.4	112648.	9.9
INVES-RESIDENTL	IHDS	25324.	25494.	0.7	28184.	10.6	30119.	6.9	30976.	2.8	32450.	4.8	34322.	5.8
INVES-GOVERNMNT	IGDS	25560.	28745.	12.5	31369.	9.1	33485.	6.7	35464.	5.9	37501.	5.7	39828.	6.2
INVENTORY-PRIVT	JPDS	1563.8	1053.1	-32.7	2048.9	94.6	2996.2	46.2	3212.5	7.2	3935.4	22.5	4463.0	13.4
INVT-GOVERNMENT	JGDS	327.00	327.00	0.0	327.00	0.0	327.00	0.0	327.00	0.0	327.00	0.0	327.00	0.0
NET EXPORTS	BLNK403	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
EXPORTS	EDS	55586.	65428.	17.7	70605.	7.9	72671.	2.9	75828.	4.3	80684.	6.4	85335.	5.8
IMPORTS	MDS	47008.	57495.	22.3	62115.	8.0	64828.	4.4	67466.	4.1	70813.	5.0	74511.	5.2

General Footnote to Table 5

GNP and its components are in either current billion yen or 1980 billion yen. Demographic variables (NL,N) are in ten thousand people. Unemployment rate and interest rate are in %. Current account balance (CBP) is in billion US dollars. Wage rate is in 100 thousand yen per year. Total factor productivity (TQ) is an index in logarithm.

Table 6 Output for Selected Sectors

	(Base Line) 1990	1995	(1980 Bil ¥) (%)
1. General crops	7,986	7,304	−1.8
5. Forestry	1,412	1,232	−2.7
13. Meat and dairy products	5,392	6,441	3.6
15. Manufactured seafood	2,939	3,302	2.4
21. Other textiles	6,855	8,073	3.3
30. Final chemicals	9,871	13,848	7.0
31. Petroleum products	21,891	27,210	4.4
36. Steel	16,219	17,241	1.2
40. General machinery	35,959	53,083	8.1
41. Electrical machinery	55,625	87,220	9.4
42. Automobiles	25,398	36,577	7.6
47. Housing construction	20,803	26,748	5.2
51. Electric power	11,126	14,360	5.2
54. Wholesale & retail trade	71,589	97,147	6.3
57. Road transportation	10,825	12,568	3.0
63. Other services	55,863	64,718	3.0
Total	721,536	930,608	5.2

As shown in Table 5, Japan's economy in this base line forecast grows at 4.4 to 5.8% during 1990 and 1995. The growth rate seems to be fairly normal in view of the recent performance of 4.6 to 5.7% during 1987 and 1989. The index of GNP deflator tends to increase gradually at 1.9 to 2.4% but is relatively stable by the international standard. The current account balance, however, tends to grow again after a small decline in 1989 and 1990. This is rather against recent growing optimism on this variable, although it is likely to be overvalued if the recent rising tendency by foreign direct investment is fully taken into account. The adjusted amount, nevertheless, would be rather limited, since there are some indications that the foreign direct investment has already hit its peak in 1989. Population and labor force estimates for the coming six years are 0.5 to 0.2% and 0.3% respectively. This deceleration in the demographic growth rate is a recent feature mostly due to the fast pace of aging of population. This tendency provides a basis for our second scenario on increased leisure.

As for the sectoral level, Table 6 indicates changes in output only for selected sectors. In response to macroeconomic growth, structural changes in output level are particularly noticeable for final chemicals, general machinery, electrical machinery, and automobiles. Most of the other sectors, representing each industry, shows a 4 to 6% of growth, which is near the average growth rate of 5.2%. A fairly stagnant growth is observed for textiles, food processing, steel and road transportation, while negative growth is noticeable for general crops and forestry.

Regarding TFP of the selected sectors in Table 7, electrical machinery shows the highest rate of 2.9%, while other sectors, such as general machinery, wholesale and retail trade, also indicate the relatively higher rate of growth of technology. General crops in agriculture also shows a higher rate of 1.8%, which, however, is based on heavy agricultural price support of the government.

6.1. Impacts of Import Promotion[10]

The Japanese current account, though having declined slightly in 1989 and 1990, still continues to have a huge surplus and it is likely to grow again according to our base line forecast, as noted before.

[10]For manufacturing sectors based on different assumptions, see S. Shishido and O. Nakamura [8], and for details on automobiles, see S. Shishido [10].

Table 7 TFP for Selected Sectors

	(Base line) 1990	1995	(%)
1. General crops	.7266	.7954	1.8
5. Forestry	.9889	.9619	−0.6
13. Meat and dairy products	1.0217	1.0551	0.6
15. Manufactured seafood	1.1090	1.1815	1.3
21. Other textiles	.7366	.7741	1.0
30. Final chemicals	1.3713	1.4635	1.3
31. Petroleum products	1.1212	1.0935	−0.5
36. Steel	1.3458	1.3643	0.3
40. General machinery	1.1976	1.3119	1.8
41. Electrical machinery	1.3081	1.5109	2.9
42. Automobiles	1.1085	1.1139	0.1
47. Housing construction	1.1390	1.1688	0.5
51. Electric power	.6358	.6137	−0.7
54. Wholesale & retail trade	1.2932	1.4037	1.7
57. Road transportation	1.0750	1.1358	1.1
63. Other service	.8245	.7752	−1.2

In order to reduce it and to eliminate international frictions we need an alternative policy scenario aiming at highly dynamic fiscal, trade and structural policies. Here we assume a combined policy of (a) substantial import promotion of foods and manufacturings, (b) domestic demand promotion by active fiscal policy, especially through public investment, and (c) price reduction in the distribution system through deregulation and government guidance.

Regarding import promotion, we temporarily assume a more than 50% cut of current account surplus, i.e. about $35 billion reduction by 1992. In nominal terms of the yen this amounts to approximately ¥5 trillion, or a 15% increase in the 1989 imports. The breakdown of this additional increase are food imports amounting to 5% and 10% of domestic production of agricultural food and processed food, respectively, and a 35% increase in manufacturing imports.[11] In accordance with this adjustment, the constant terms of import function were shifted upward. The increased amounts are sustained until 1995.

Public investment is assumed to be boosted additionally by 2.4% of GNP, about ¥9 trillion annually in 1980 prices. This aims to not only offset deflationary impacts of import liberalization from a macroeconomic point of view, but also to minimize social frictions due to structural adjustments caused by imports. Accordingly, it also covers various capital expenditures on retraining and vocational facilities to enhance the mobility of employment and to encourage regional development for promoting employment in rural areas.[12]

The third policy measure concerns the government's price reduction in the distribution system to eliminatte differentials between domestic and imported products. Since it is difficult to quantify the amount of the direct policy impact, we temporarily assume that the constant terms of sectoral output price equations are reduced by 5% for food and 3% for non-food manufactured products.

The result of our combined policy package is shown in Table 8 for macroeconomic and demographic variables. Real GNP is shown to increase by 1.1% in 1990 and 3.4 to 3.8 during 1991

[11]Sectors selected for import promotion are 1, 13, 14, 15, 16, 17, 18, 21, 22, 24, 27, 30, 35, 36, 40, 41, 42, 43, 44, 45, and 46. (For Sector Numbers see Table 2.)

[12]In the context of the Structural Impediments Initiativese Talk, the U.S. government also urged Japan to adopt a similar policy measure to promote imports and social infrastructure. But the amount suggested was modest, as compared with this simulation.

Table 8 Import Promotion Scenario: Macroeconomic Variables

SELECTED ECONOMIC INDICATORS -- JAPAN MODEL, VERSION G1

		1989	1990	%CHG	1991	%CHG	1992	%CHG	1993	%CHG	1994	%CHG	1995	%CHG
GROSS NATL EXPN	GNEDS	0.	-4505.	-1.0	1107.	0.2	5481.	1.1	9010.	1.7	10546.	1.9	11684.	2.0
REAL GNE	GNE	0.	4055.	1.1	12865.	3.4	14811.	3.7	15824.	3.8	15539.	3.5	16410.	3.5
GNE DEFLATOR	P	0.000	-3.310	-2.9	-4.569	-3.9	-3.623	-3.0	-2.887	-2.4	-2.285	-1.9	-2.059	-1.6
PERS CONS DEFL	PCP	0.000	-3.043	-2.5	-4.232	-3.4	-4.084	-3.2	-3.725	-2.8	-3.407	-2.6	-3.419	-2.5
WHOLESALE PRICE	PWJ	0.000	-3.135	-3.4	-3.827	-4.1	-3.429	-3.6	-3.208	-3.4	-2.958	-3.1	-2.999	-3.1
LABOR FORCE	NL	0.000	-0.129	0.0	1.855	0.0	47.215	0.7	62.520	1.0	61.246	0.9	57.184	0.9
POPULATION	N	0.000	5.703	0.0	12.520	0.1	17.832	0.1	22.555	0.2	27.066	0.2	32.223	0.3
UNEMPLOY RATE	US	0.0000	-0.0202	-0.7	-0.0757	-2.5	-0.1128	-3.6	-0.1327	-4.1	-0.1324	-4.0	-0.1267	-3.7
BANK LENDG RATE	I	0.0000	-0.0885	-1.3	-0.1250	-1.8	-0.0136	-0.2	0.0401	0.6	0.0320	0.5	0.0210	0.3
CBP	BFDOL	0.00	-19.10	-37.9	-30.53	-54.5	-33.18	-63.0	-36.81	-64.0	-41.10	-58.8	-44.14	-56.1
GOVT SURPLUS	BG	0.	-4760.	33.6	-8896.	59.9	-8491.	53.8	-8253.	51.1	-8192.	50.9	-8190.	52.4
WAGE RATE	W	0.0000	-0.3975	-0.8	-0.4528	-0.8	-0.1687	-0.3	0.1359	0.2	0.4266	0.7	0.6557	1.1
T FACTOR PRDTVT	TQ	0.0000	0.0004	0.0	0.0013	0.0	-0.0007	0.0	0.0011	0.0	0.0012	0.0	0.0009	0.0

GROSS NATIONAL EXPENDITURE BY CATEGORY (80 Y)

		1989	1990	%CHG	1991	%CHG	1992	%CHG	1993	%CHG	1994	%CHG	1995	%CHG
CONSUMPTN-PRIVT	CP	0.0	816.5	0.4	2986.6	1.4	4913.7	2.2	6421.5	2.8	7499.2	3.2	8384.9	3.4
CONS-NONPROFIT	CNP	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
CONS-GOVERNMENT	CG	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
INVESTMENT-BUSN	IP	0.0	-460.0	-0.6	1108.9	1.3	1937.4	2.2	3022.0	3.2	2788.4	2.8	2951.9	2.7
INVES-RESIDENTL	IH	0.0	556.9	2.5	1974.5	8.2	2832.1	11.1	2578.6	9.7	2233.9	8.0	1978.5	6.8
INVES-GOVERNMNT	IG	0.0	4507.6	16.6	9136.9	32.1	9137.0	30.7	9136.9	29.3	9136.9	28.0	9136.9	26.8
INVENTORY-PRIVT	JP	0.0	527.6	36.3	1312.0	47.9	1062.0	26.6	471.1	10.8	276.7	5.1	254.1	4.1
INVT-GOVERNMENT	JG	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
NET EXPORTS	BLNK400	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
EXPORTS	E	0.0	425.9	0.6	1118.6	1.4	1561.6	1.9	997.7	1.1	433.9	0.5	923.4	0.9
IMPORTS	M	0.0	2319.2	3.0	4771.9	5.6	6631.9	7.5	6803.8	7.5	6830.3	7.2	7212.2	7.2

GROSS NATIONAL EXPENDITURE BY CATEGORY (CURR Y)

		1989	1990	%CHG	1991	%CHG	1992	%CHG	1993	%CHG	1994	%CHG	1995	%CHG
CONSUMPTN-PRIVT	CPDS	0.	-5119.	-2.1	-5246.	-2.0	-2812.	-1.0	-304.	-0.1	1690.	0.5	2796.	0.8
CONS-NONPROFIT	CNPDS	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
CONS-GOVERNMENT	CGDS	0.0	-432.0	-1.1	-525.0	-1.2	-341.5	-0.8	-149.5	-0.3	46.3	0.1	189.8	0.4
INVESTMENT-BUSN	IPDS	0.	-1183.	-1.5	-711.	-0.8	20.	0.0	1548.	1.6	1597.	1.6	1850.	1.6
INVES-RESIDENTL	IHDS	0.0	275.3	1.1	1953.8	6.9	3271.1	10.9	3094.8	10.0	2744.0	8.5	2441.1	7.1
INVES-GOVERNMNT	IGDS	0.0	4428.2	15.4	9050.0	28.8	9160.1	27.4	9469.2	26.7	9721.5	25.9	9950.4	25.0
INVENTORY-PRIVT	JPDS	0.0	390.6	37.1	1011.7	49.4	895.1	29.9	468.3	14.6	336.9	8.6	327.0	7.3
INVT-GOVERNMENT	JGDS	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
NET EXPORTS	BLNK400	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
EXPORTS	EDS	0.	-1046.	-1.6	-731.	-1.0	372.	0.5	94.	0.1	-332.	-0.4	-340.	-0.4
IMPORTS	MDS	0.0	1820.4	3.2	3696.6	6.0	5082.9	7.8	5210.1	7.7	5257.9	7.4	5530.5	7.4

See general footnote at the end of Table 5.

to 1993 and 3.5% for the last two years. In terms of the change in the rate of growth, the growth rate accelerates 1.1, 2.3, 0.3, 0.1% each year during 1990 to 1993 and slightly decelerates by 0.3% in 1994. Except for 1991, the growth rate of real GNP stands at about 5.0 to 5.5%, which is not unrealistic in terms of recent performances. The exceptional 7% growth in 1991 represents an initial shock of our policy package mostly due to a rise in public investment. The increased imports exert a contractionary impact on the economy, since they rapidly grow until the third year, and stay at the same level until 1995. Surprisingly, exports also start to rise because of the fall in prices. The current account balance, the most important target of this simulation, falls rapidly by $30 to $44 billion, as expected before. The average TFP at the macroeconomic level shows significantly positive signs. Sectoral details are discussed later.

Table 9 Import Pronomion Scenario: Sectoral Output

	1989	1990	%CHG	1991	%CHG	1992	%CHG	1993	%CHG	1994	%CHG	1995	%CHG
XR01	0.0	-322.3	-4.0	-480.0	-6.1	-548.6	-7.2	-639.7	-8.7	-583.1	-8.1	-531.2	-8.5
XR02	0.000	-3.120	-0.6	-1.726	-0.3	3.316	0.6	11.890	2.1	18.516	3.2	24.716	4.0
XR03	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR04	0.0	-106.4	-2.5	-119.1	-2.7	-123.3	-2.8	-105.0	-2.3	-80.1	-1.7	-73.9	-1.5
XR05	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR06	0.00	-58.76	-2.3	-53.66	-2.1	-62.29	-2.4	-49.71	-1.8	-42.63	-1.6	-42.84	-1.6
XR07	0.000	2.619	1.2	3.718	3.9	13.712	5.9	17.359	7.7	9.519	4.1	15.879	6.5
XR08	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR09	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR10	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR11	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR12	0.00	111.73	5.8	231.23	11.5	264.13	12.5	273.38	13.1	251.94	11.8	267.66	11.4
XR13	0.0	-169.9	-3.1	-232.2	-4.2	-262.4	-4.7	-210.6	-3.6	-164.3	-2.6	-142.8	-2.2
XR14	0.0	-165.2	-4.3	-282.1	-7.5	-359.5	-9.6	-384.7	-10.3	-381.2	-10.3	-398.0	-9.9
XR15	0.0	-155.1	-6.3	-272.0	-9.0	-336.1	-10.9	-334.7	-10.6	-329.2	-10.2	-330.2	-10.0
XR16	0.00	-44.77	-0.3	-27.83	-0.2	164.21	1.3	-70.30	-0.5	112.36	0.9	-17.82	-0.1
XR17	0.00	143.50	2.7	66.57	1.2	112.69	1.9	83.25	1.3	139.91	2.2	130.97	2.0
XR18	0.000	61.345	2.3	34.402	1.2	49.020	1.3	36.739	1.3	52.221	1.8	46.585	1.6
XR19	0.00	-48.24	-6.2	-36.74	-4.2	-29.33	-3.6	-25.43	-3.1	-25.27	-3.0	-24.83	-2.9
XR20	0.00	-15.44	-4.0	-10.79	-2.8	-15.05	-3.9	-12.61	-3.2	-13.31	-3.4	-12.52	-3.1
XR21	0.0	-196.7	-3.1	-88.9	-1.4	-112.4	-1.7	-114.7	-1.7	-121.5	-1.8	-125.5	-1.8
XR22	0.0	-233.8	-3.4	-191.5	-2.7	-177.6	-2.4	-198.5	-2.7	-199.2	-2.6	-224.4	-2.8
XR23	0.0	-262.8	-5.0	166.9	2.7	191.5	3.0	65.6	1.0	59.6	0.8	32.6	0.4
XR24	0.00	104.51	2.6	167.99	4.0	183.47	4.2	201.45	4.5	187.45	4.0	193.73	3.9
XR25	0.00	24.52	0.3	203.54	2.3	240.82	2.7	211.02	2.2	210.82	2.1	224.15	2.1
XR26	0.00	8.29	0.1	102.13	1.2	124.56	1.5	111.71	1.3	108.19	1.2	118.29	1.2
XR27	0.00	-13.39	-2.5	-12.18	-2.2	-15.27	-2.8	-18.02	-3.3	-18.68	-3.4	-17.62	-3.2
XR28	0.00	-90.06	-3.7	-62.92	-2.3	27.05	1.0	27.14	1.0	-13.32	-0.4	-19.76	-0.6
XR29	0.0	-112.0	-0.7	69.6	0.4	157.0	0.9	217.0	1.1	233.8	1.1	246.6	1.1
XR30	0.0	-111.4	-1.1	-131.7	-1.3	-175.8	-1.6	-124.7	-1.0	-121.8	-0.9	-95.4	-0.7
XR31	0.0	3.5	0.0	310.4	1.4	542.8	2.3	711.9	2.9	820.1	3.2	1001.8	3.7
XR32	0.00	148.15	7.7	157.93	7.9	335.98	16.6	210.61	10.2	207.84	9.2	232.29	9.5
XR33	0.000	47.953	4.7	50.900	4.7	63.182	5.5	76.464	7.0	62.620	5.3	61.774	4.9
XR34	0.00	316.77	3.7	697.12	7.6	840.12	8.8	802.39	9.1	781.98	8.3	790.85	8.0
XR35	0.0	656.6	9.0	315.3	4.1	1380.8	19.1	667.1	9.4	706.9	9.4	719.6	8.9
XR36	0.0	380.0	2.3	933.4	5.9	1139.8	7.1	1047.3	6.5	982.2	6.0	992.6	5.8
XR37	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR38	0.00	84.56	1.2	325.66	4.0	453.03	5.3	419.29	4.8	358.49	3.8	321.24	3.2
XR39	0.0	319.0	2.2	882.7	5.6	1061.4	6.5	1147.1	6.6	1168.5	6.3	1241.1	6.2
XR40	0.0	264.9	0.7	1405.0	3.5	1798.0	4.2	2013.5	4.5	1780.0	3.7	1852.0	3.5
XR41	0.0	993.1	1.8	3797.2	6.1	3616.2	5.5	4270.4	6.0	4426.7	5.6	4801.4	5.5
XR42	0.0	-16.0	-0.1	616.6	2.2	1524.3	5.3	1427.6	4.6	1173.6	3.6	1384.4	3.8
XR43	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR44	0.00	-51.18	-1.1	-20.98	-0.4	-22.38	-0.5	3.13	0.1	-6.02	-0.1	-1.44	0.0
XR45	0.00	100.98	1.9	176.02	3.1	135.38	2.3	166.56	2.7	165.25	2.5	184.75	2.7
XR46	0.00	1.49	0.0	193.14	1.6	229.30	1.9	299.60	2.1	325.38	2.2	356.99	2.3
XR47	0.0	597.5	2.9	1913.3	8.6	2625.4	11.1	2414.9	9.9	2128.7	8.3	1916.6	7.2
XR48	0.0	442.7	1.8	1276.8	4.9	1503.7	5.5	1751.4	6.1	1714.5	5.7	1762.4	5.5
XR49	0.0	1676.5	11.5	3410.4	22.6	3419.4	21.9	3430.6	21.2	3428.2	20.5	3429.6	19.7
XR50	0.0	518.2	3.0	1246.3	6.8	1355.7	7.1	1491.2	7.6	1462.4	7.1	1478.7	6.8
XR51	0.00	63.88	0.6	221.24	1.9	375.96	3.0	348.04	2.7	366.96	2.7	393.60	2.7
XR52	0.000	1.589	0.1	12.979	0.7	23.778	1.3	23.536	1.2	25.002	1.3	25.226	1.2
XR53	0.000	-5.694	-0.1	21.875	0.5	31.305	0.7	34.168	0.8	35.371	0.8	38.934	0.8
XR54	0.0	-174.9	-0.2	722.9	0.9	1335.2	1.7	1393.1	1.7	1100.7	1.2	1739.5	1.8
XR55	0.0	-29.8	-0.1	444.8	1.1	896.7	2.1	1247.2	2.8	1439.3	3.1	1629.0	3.3
XR56	0.00	-11.70	-0.4	-6.49	-0.2	10.52	0.3	14.49	0.4	13.55	0.4	14.42	0.4
XR57	0.00	61.99	0.6	213.54	1.9	291.13	2.5	282.25	2.4	265.88	2.2	267.59	2.1
XR58	0.00	6.58	0.1	106.68	1.7	185.05	2.7	198.98	2.8	206.88	2.8	227.14	2.9
XR59	0.00	-33.44	-0.5	68.58	1.0	119.85	1.6	158.00	2.0	195.32	2.4	244.94	2.8
XR60	0.00	97.66	0.4	458.10	1.8	679.01	2.6	722.03	2.7	742.06	2.6	939.38	2.8
XR61	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR62	0.0	-17.9	0.0	247.8	0.5	448.3	0.9	845.2	1.7	907.2	1.7	1096.0	2.0
XR63	0.0	50.3	0.1	745.0	1.3	1049.5	1.8	994.8	1.6	1096.6	1.7	1107.7	1.7
XR64	0.00	103.39	1.1	327.89	3.2	469.05	4.3	519.58	4.6	551.68	4.5	624.51	4.8
XR65	0.	4924.	0.7	20322.	2.6	27231.	3.4	28100.	3.4	27934.	3.2	29919.	3.2

Table 10 Import Promotion Scenario: Sectoral TFP

	1989	1990	%CHG	1991	%CHG	1992	%CHG	1993	%CHG	1994	%CHG	1995	%CHG
TFP1	0.0000	-0.0195	-2.7	-0.0246	-3.3	-0.0255	-3.4	-0.0418	-5.7	-0.0373	-5.0	-0.0436	-5.5
TFP2	0.0000	0.0006	0.1	0.0014	0.2	0.0013	0.2	0.0023	0.4	0.0029	0.5	0.0034	0.5
TFP3	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
TFP4	0.0000	-0.0177	-2.8	-0.0306	-5.1	-0.0465	-7.8	-0.0320	-4.9	-0.0186	-2.7	-0.0016	-0.2
TFP5	0.0000	-0.0023	-0.3	-0.0046	-0.5	-0.0015	-0.2	-0.0002	0.0	-0.0004	0.0	-0.0006	-0.1
TFP6	0.0000	-0.0119	-1.8	-0.0165	-2.5	-0.0166	-2.6	-0.0136	-2.1	-0.0131	-2.0	-0.0136	-2.1
TFP7	0.0000	0.0097	0.7	0.0198	1.3	0.0160	0.9	0.0103	0.6	0.0085	0.4	0.0085	0.4
TFP8	0.0000	0.0070	0.6	0.0125	1.0	0.0082	0.7	0.0040	0.3	0.0029	0.2	0.0028	0.2
TFP9	0.0000	-0.0099	-0.5	-0.0251	-1.1	-0.0415	-1.7	-0.0428	-1.7	-0.0347	-1.3	-0.0304	-1.1
TFP10	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
TFP11	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
TFP12	0.0000	0.0398	3.4	0.0784	6.8	0.1666	14.9	0.2234	17.7	0.1859	13.1	0.1443	9.8
TFP13	0.0000	-0.0694	-5.8	-0.0634	-6.7	-0.0621	-6.1	-0.0582	-5.7	-0.0590	-5.7	-0.0532	-5.0
TFP14	0.0000	-0.0300	-3.6	-0.0352	-10.3	-0.0861	-10.5	-0.1215	-14.3	-0.1279	-14.5	-0.1546	-16.0
TFP15	0.0000	-0.0064	-0.6	-0.0140	-1.2	-0.0124	-1.1	-0.0101	-0.9	-0.0110	-0.9	-0.0125	-1.1
TFP16	0.0000	-0.0132	-1.4	-0.0080	-0.8	-0.0123	-1.2	-0.0133	-1.3	-0.0178	-1.7	-0.0164	-1.6
TFP17	0.0000	0.0000	0.0	0.0416	3.4	-0.0095	-0.8	-0.0093	-0.8	-0.0157	-1.4	-0.0088	-0.8
TFP18	0.0000	0.0784	1.8	0.0485	1.1	0.0432	0.9	0.0297	0.6	0.0266	0.5	0.0173	0.3
TFP19	0.0000	0.0146	1.7	0.0069	0.8	0.0035	0.4	-0.0003	0.0	-0.0020	-0.2	-0.0036	-0.4
TFP20	0.0000	0.0012	0.1	0.0043	0.5	0.0010	0.1	-0.0007	-0.1	-0.0008	-0.1	-0.0005	-0.1
TFP21	0.0000	0.0380	5.2	0.0412	5.6	0.0331	4.5	0.0291	3.9	0.0280	3.7	0.0275	3.6
TFP22	0.0000	-0.0005	0.0	-0.0004	0.0	0.0007	0.1	0.0001	0.0	-0.0003	0.0	-0.0009	-0.1
TFP23	0.0000	-0.0086	-0.9	-0.0023	-0.3	-0.0043	-0.5	-0.0027	-0.3	-0.0024	-0.3	-0.0016	-0.2
TFP24	0.0000	0.0209	2.0	0.0130	1.3	0.0074	0.7	0.0037	0.4	0.0023	0.2	0.0021	0.2
TFP25	0.0000	0.0000	0.0	-0.0005	-0.1	-0.0010	-0.1	-0.0013	-0.1	-0.0014	-0.2	-0.0015	-0.2
TFP26	0.0000	0.0028	0.3	0.0067	0.6	0.0058	0.6	0.0040	0.4	0.0030	0.3	0.0022	0.2
TFP27	0.0000	0.0280	3.3	0.0191	2.2	0.0088	1.0	0.0046	0.5	0.0079	0.9	0.0080	0.9
TFP28	0.0000	-0.0036	-0.4	0.0060	0.6	0.0057	0.5	0.0029	0.3	0.0027	0.2	0.0028	0.2
TFP29	0.0000	0.0000	0.0	0.0000	0.0	-0.0017	-0.2	-0.0030	-0.3	-0.0030	-0.3	-0.0016	-0.2
TFP30	0.0000	0.0103	0.8	0.0139	1.0	0.0078	0.6	0.0043	0.3	0.0063	0.4	0.0092	0.6
TFP31	0.0000	-0.0005	0.0	-0.0021	-0.2	-0.0029	-0.3	-0.0033	-0.3	-0.0033	-0.3	-0.0036	-0.3
TFP32	0.0000	0.0000	0.0	-0.0555	-5.0	-0.0339	-3.3	-0.0849	-8.0	-0.0253	-2.5	-0.0467	-4.7
TFP33	0.0000	0.0115	1.3	0.0190	2.1	0.0279	3.0	0.0296	3.2	0.0296	3.1	0.0310	3.2
TFP34	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
TFP35	0.0000	0.0000	0.0	-0.0050	-0.6	-0.0123	-1.5	0.0011	0.1	-0.0055	-0.7	-0.0052	-0.6
TFP36	0.0000	0.0040	0.3	0.0270	2.0	0.0235	1.7	0.0189	1.4	0.0231	1.7	0.0241	1.8
TFP37	0.0000	-0.0026	-0.4	-0.0035	-0.5	0.0028	0.4	0.0020	0.3	-0.0021	-0.3	-0.0047	-0.7
TFP38	0.0000	0.0038	0.4	0.0063	0.6	-0.0005	0.0	-0.0041	-0.4	-0.0033	-0.3	-0.0010	-0.1
TFP39	0.0000	-0.0039	-0.4	-0.0029	-0.3	-0.0035	-0.3	-0.0052	-0.5	-0.0064	-0.6	-0.0032	-0.3
TFP40	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
TFP41	0.0000	-0.0014	-0.1	0.0011	0.1	0.0044	0.3	0.0031	0.2	0.0040	0.3	0.0045	0.3
TFP42	0.0000	0.0031	0.3	0.0307	2.8	0.0247	2.2	0.0201	1.8	0.0233	2.1	0.0248	2.2
TFP43	0.0000	0.0097	1.0	0.0361	3.4	0.0221	2.2	0.0316	3.1	0.0289	2.9	0.0291	2.9
TFP44	0.0000	0.0722	6.2	0.0677	5.9	0.0687	5.7	0.0663	5.3	0.0691	5.3	0.0711	5.3
TFP45	0.0000	-0.0325	-1.9	-0.0321	-1.8	-0.0359	-1.9	-0.0407	-2.0	-0.0454	-2.2	-0.0488	-2.2
TFP46	0.0000	0.0009	0.1	-0.0071	-0.6	-0.0090	-0.7	-0.0105	-0.8	-0.0098	-0.8	-0.0085	-0.7
TFP47	0.0000	0.0024	0.2	0.0099	0.9	0.0180	1.6	0.0205	1.8	0.0180	1.6	0.0160	1.4
TFP48	0.0000	0.0006	0.1	0.0056	0.5	0.0041	0.4	0.0026	0.2	0.0012	0.1	-0.0004	0.0
TFP49	0.0000	-0.0319	-1.9	-0.0372	-2.1	-0.0427	-2.3	-0.0552	-2.7	-0.0552	-2.7	-0.0589	-2.7
TFP50	0.0000	-0.0039	-0.5	-0.0127	-1.5	-0.0276	-3.3	-0.0387	-4.8	-0.0360	-4.5	-0.0361	-4.6
TFP51	0.0000	-0.0003	-0.1	-0.0017	-0.3	-0.0011	-0.2	-0.0007	-0.1	-0.0012	-0.2	-0.0018	-0.3
TFP52	0.0000	0.0088	1.0	0.0203	2.4	0.0182	2.3	0.0136	1.7	0.0107	1.4	0.0074	1.0
TFP53	0.0000	0.0008	0.1	-0.0092	-0.7	-0.0149	-1.1	-0.0115	-0.8	-0.0065	-0.5	-0.0026	-0.2
TFP54	0.0000	0.0032	0.2	0.0087	0.7	0.0064	0.5	0.0090	0.6	0.0144	1.0	0.0163	1.2
TFP55	0.0000	-0.0141	-0.4	-0.0293	-0.8	-0.0312	-0.9	-0.0332	-0.9	-0.0317	-0.9	-0.0319	-0.9
TFP56	0.0000	-0.0026	-0.5	-0.0040	-0.7	-0.0022	-0.4	-0.0005	-0.1	-0.0002	0.0	-0.0006	-0.1
TFP57	0.0000	-0.0013	-0.1	-0.0011	-0.1	-0.0002	0.0	0.0005	0.0	0.0005	0.0	0.0003	0.0
TFP58	0.0000	0.0045	0.4	0.0102	0.9	0.0078	0.7	0.0051	0.5	0.0051	0.4	0.0057	0.5
TFP59	0.0000	-0.0206	-3.2	0.0080	1.1	0.0340	4.1	0.0748	8.8	0.0618	7.0	0.0616	6.6
TFP60	0.0000	0.0115	0.5	0.0404	1.5	0.0734	2.6	0.0965	3.4	0.0885	3.0	0.0576	1.8
TFP61	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
TFP62	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
TFP63	0.0000	-0.0013	-0.2	0.0004	0.0	0.0024	0.3	0.0040	0.5	0.0048	0.6	0.0047	0.6
TFP64	0.0000	0.0135	1.5	0.0207	2.3	0.0192	2.2	0.0174	2.0	0.0155	1.7	0.0148	1.7

As for prices, the GNP deflator drops by about 3 to 4% in 1990 and 1991 and gradually recovers during 1992 to 1995. Consumer price and wholesale price follow a similar pattern, but the former drops less sharply and recovers more slowly as compared with the GNP deflator. The latter falls a little more deeply and recovers only slightly.

Private consumption continues to rise during the entire period due to a substantial increase in real disposable income. The induced amount in 1995 is almost as high as public investment. Private housing investment responds more quickly with a peak in 1992, while business investment grows more slowly, but steadily, with a much greater impact on the economy.

On the demographic side, total population and labor force increase by 0.3 and 0.9% respectively in 1995. The major cause for this increase is the rise in real wage which stimulates the birth rate of the female population and also the rise in labor participation ratio of a productive age population. Real wage rises by 3.6% in 1995 with an annual average rate of acceleration of 0.7%.

Structural changes in sectoral output and employment need a special attention, as it is closely

related to the future course of Japan's industrial policy. As shown in Table 9, construction sectors, especially public work construction, shows the highest impact from this policy package. Related sectors, such as iron and steel, cement and ceramic products, wood products, coal product and mining, and other mining (including ceramic clay, stone quarry, etc.), also indicate high responses in terms of percent deviation from base line scenario. Other industries which respond strongly are in the high technology sectors, particularly electrical machinery, general machinery, and automobiles, which also induce additional demand for steel. Service sectors including trade and finance also respond fairly actively.

In sharp contrast to the above positive impacts, it is noteworthy that primary sectors (except mining), food manufacturing, textiles, and apparels suffer greatly from an import promotion policy, indicating negative values in their responses. In other words, the negative impact is stronger than a positive impact on these sectors. In terms of percent contribution in 1995, construction and related sectors account for 47.6%, high technology sectors for 28%, services sectors for 21.4%, other minor sectors for 9.8% and the above negative sectors for −6.8%.

As for the changes in TFP, a similar remarkable contrast between competitive sectors and non-competitive, or protected sectors, can be observed in Table 10. As described in the previous section, a decline of net output price caused by import promotion results in a positive impact in technical progress in competitive sectors, while a negative impact is observed for non-competitive or protected sectors. The result of our simulation clearly indicates that 19 sectors selected for import liberalization follow exactly our theoretical hypothesis with only one exception, the apparel industry. In the automobiles and aircraft sectors, for example, TFP increases by 2.2 and 2.9% respectively in 1995. The steel industry, also with liberalized imports in our scenario, indicates an increase in TFP by 1.8%, while the iron industry shows a deterioration of TFP by −0.6%, both in 1995, indicating a sharp contrast in competitive response in both sectors. More conservative responses are noticeable in agriculture and food manufacturing, where the TFP falls significantly, i.e. −5.5% in general crops and −5.0% in dairy products in 1995. Deterioration of terms of trade clearly discourages technical progress in those sectors.

For other sectors which are not directly targeted for import promotion, TFP responses seem tobe rather mixed, depending on the value noted in Table 2 and the results of net output price (p_X/p_Z). Strong positive responses in communication and trade sectors are caused by the fall in net output prices, but a similar rise in manufactured gas is mostly due to the rise in net output price. Real estate and railway transportation, which are fairly competitive, show negative responses mostly because of the fall in net output prices. For similar reasons, TFP declines in petroleum and coal products.

For the employment structure, a substantial change is caused by this policy package. The increase in employment is most noticeable in construction, amounting to 192,000. The next highest increase is 183,000 in the service sectors and 88,000 in the high technology sectors. Metal products shows an increase of 13,000, but basic metal industries indicates rather negative figures. On the other hand, reduction of employment is noted in the primary sector, including mining, amounting to 238,000. This clearly exceeds an employment increase in construction but can be accommodated by the total increase, including those in the service and high technology sectors. Textile sectors also indicate negative figures of −52,000, but food processing sectors indicate a rather positive increase of 4,000. In summing up, it can be stated that on the average a fairly sizable increase in employment opportunity has enabled the accomodation of the employment released from the agriculture and textiles despite increased technical progress.

Table 11 Increased Leisure Scenario: Macroeconomic Variables

SELECTED ECONOMIC INDICATORS -- JAPAN MODEL, VERSION G1

		1989	1990	%CHG	1991	%CHG	1992	%CHG	1993	%CHG	1994	%CHG	1995	%CHG
GROSS NATL EXPN	GNEDS	0.0	527.4	0.1	2756.1	0.6	4052.9	0.8	4899.4	0.9	5612.2	1.0	6388.8	1.1
REAL GNE	GNE	0.0	1111.6	0.3	3481.2	0.9	4485.4	1.1	4869.6	1.2	5005.6	1.1	5293.0	1.1
GNE DEFLATOR	P	0.0000	-0.1003	-0.1	-0.2949	-0.3	-0.1880	-0.2	-0.0477	0.0	0.1176	0.1	0.2600	0.2
PERS CONS DEFL	PCP	0.0000	-0.2643	-0.2	-0.4416	-0.4	-0.4525	-0.4	-0.3722	-0.3	-0.2268	-0.2	-0.0761	-0.1
WHOLESALE PRICE	PWI	0.0000	-0.0846	-0.1	-0.1825	-0.2	-0.1587	-0.2	-0.1246	-0.1	-0.0719	-0.1	-0.0406	0.0
LABOR FORCE	NL	0.0000	0.5273	0.0	1.1602	0.0	5.7188	0.1	8.7500	0.1	9.9727	0.2	9.0039	0.1
POPULATION	N	0.0000	0.6875	0.0	1.7813	0.0	2.7070	0.0	3.3828	0.0	3.7734	0.0	4.0117	0.0
UNEMPLOY RATE	US	0.0000	-0.0057	-0.2	-0.0180	-0.6	-0.0224	-0.7	-0.0193	-0.6	-0.0077	-0.2	0.0053	0.2
BANK LENDG RATE	I	0.0000	-0.0027	0.0	-0.0078	-0.1	-0.0023	0.0	0.0064	0.1	0.0079	0.1	0.0081	0.1
CBP	BFDOL	0.000	-0.703	-1.4	-1.578	-2.8	-1.784	-3.4	-2.177	-3.8	-2.529	-3.6	-3.073	-3.9
GOVT SURPLUS	BG	0.00	96.83	-0.7	364.56	-2.5	563.73	-3.6	702.77	-4.3	812.40	-5.1	931.06	-6.0
WAGE RATE	W	0.0000	-0.0105	0.0	-0.0026	0.0	0.0506	0.1	0.1003	0.2	0.1350	0.2	0.1481	0.2
T FACTOR PRDTVT	TQ	0.0000	-0.0032	-0.1	-0.0013	0.0	0.0009	0.0	0.0023	0.1	0.0022	0.1	0.0016	0.0

GROSS NATIONAL EXPENDITURE BY CATEGORY (90 Y)

		1989	1990	%CHG	1991	%CHG	1992	%CHG	1993	%CHG	1994	%CHG	1995	%CHG
CONSUMPTN-PRIVT	CP	0.0	182.6	0.1	715.2	0.3	1222.4	0.6	1601.5	0.7	1961.7	0.9	2037.9	0.8
CONS-NONPROFIT	CNP	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
CONS-GOVERNMENT	CG	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
INVESTMENT-BUSN	IP	0.0	770.7	0.9	2276.4	2.7	2721.0	3.1	2978.7	3.2	3070.6	3.1	3267.9	3.0
INVES-RESIDENTL	IH	0.00	128.81	0.6	433.28	2.0	742.96	2.9	708.31	2.7	610.69	2.2	530.41	1.8
INVES-GOVERNMNT	IG	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
INVENTORY-PRIVT	IP	0.00	109.69	7.6	330.69	12.1	191.87	4.8	84.44	1.9	83.81	1.5	116.75	1.9
INVT-GOVERNMENT	IG	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
NET EXPORTS	BLNK400	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
EXPORTS	E	0.0	4.3	0.0	8.7	0.0	27.1	0.0	-109.6	-0.1	-161.3	-0.2	-93.8	-0.1
IMPORTS	M	0.00	85.00	0.1	333.12	0.4	419.87	0.5	393.81	0.4	459.94	0.5	566.00	0.6

GROSS NATIONAL EXPENDITURE BY CATEGORY (CURR Y)

		1989	1990	%CHG	1991	%CHG	1992	%CHG	1993	%CHG	1994	%CHG	1995	%CHG
CONSUMPTN-PRIVT	CPDS	0.0	-306.7	-0.1	-30.1	0.0	577.6	0.2	1244.9	0.4	1944.6	0.6	2605.6	0.8
CONS-NONPROFIT	CNPDS	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
CONS-GOVERNMENT	CGDS	0.00	-11.46	0.0	-13.46	0.0	20.22	0.0	53.85	0.1	81.20	0.2	94.08	0.2
INVESTMENT-BUSN	IPDS	0.0	728.4	0.9	2224.2	2.6	2691.4	3.0	3011.7	3.2	3175.4	3.1	3453.7	3.1
INVES-RESIDENTL	IHDS	0.00	145.81	0.6	572.73	2.0	899.36	3.0	845.23	2.7	698.10	2.2	558.64	1.6
INVES-GOVERNMNT	IGDS	0.00	-7.95	0.0	-29.31	-0.1	-37.73	-0.1	-20.39	-0.1	0.85	0.0	17.44	0.0
INVENTORY-PRIVT	IPDS	0.00	84.75	8.0	260.87	12.7	155.34	5.2	66.77	2.1	56.07	1.4	68.00	1.5
INVT-GOVERNMENT	JGDS	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
NET EXPORTS	BLNK500	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
EXPORTS	EDS	0.00	-16.16	0.0	33.63	0.0	71.81	0.1	2.50	0.0	-0.19	0.0	6.00	0.0
IMPORTS	MDS	0.00	89.32	0.2	262.48	0.4	325.12	0.5	305.12	0.5	343.75	0.5	414.75	0.6

See general footnote at the end of Table 5.

6.2. Impacts of Increased Leisure

The second policy simulation deals with a policy to reduce working hours and to promote expenditures related to leisure. This policy measure has been taken in the past several years with special reference to working hours. Local governments have also taken various policy measures, such as regional development for resort areas, strengthening welfare facilities, etc. Here we take up a scenario which is not directly linked to such policy instruments but is related to changes in consumers' behavior as influenced by such policies in order to evaluate the impact on the economy as a whole. In other words, this is an alternative scenario in which consumers place more emphasis on leisure-oriented service expenses than other conventional consumers expenditures. We temporarily assume in this new scenario that the component of private consumption for "63. Other service" is raised by about ¥4 trillion, 15%, and that other components are reduced by the same amount, leaving total expenditure unchanged.

The macroeconomic result of this structural shift of private consumption in favor of leisure-oriented services is indicated in Table 11. Although there is no macroeconomic stimulus, the economy starts to grow in 1990. Real GNP grows about 1% in terms of deviation from the base line forecast. This is mostly because of the active response of private business investment in the tertiary sector, especially in other services. Stimulated by this tertiary sector's investment, private housing, private consumption, and imports start to grow with a certain time lag. The current account surplus declines by about \$1.5 to \$3.0 billion, indicating a favorable direction of this scenario. Employment also increases more than the previous scenario, although induced GNP is only one-third of the previous case. Prices are fairly stable, particularly for the first three years, though they tend to rise slightly thereafter.

As for sectoral break-down of output, there is a marked contrast between growing and stagnant sectors, as shown in Table 12. Obviously, the highest positive response is shown in the other services sector, amounting to ¥4.0 to ¥3.5 trillion, 5.4% increase (in 1995), in terms for deviation from the base line forecast. Investment-oriented sectors also show higher percent deviations: about 2% in construction, 1.0 to 1.6% in machineries, and 1.5 to 2.4% in basic metal, ceramics and other mining. Pulp and paper also rises because of their dependence on services. Negative responses of -0.2 to -0.9% are noted for general crops, food processing, and textiles all of which are negatively affected by the change in consumption components.

Sectoral changes in employment also follow the pattern of output. As compared with the previous scenario, however, the changes are relatively more significant. Employment in the other services sector rises 4.1%, the highest among 64 sectors. Here the increased employment amounts to about 600,000, about 80% of the total increased employment. The rest of the increase is accoutned for mostly by investment-oriented sectors, such as construction and machineries. Negative responses are indicated in agriculture, food, and textiles, but the reduced employment is rather negligible.

As expected, sectoral price changes are generally small, except in other services, construction, coal products, and pulp and paper products where the output prices rise 1.5 to 2.5% in response to the demand increase in 1995.

Regarding sectoral technical progress, the changes are again very small, except for other services and communication. The former's increase is affected by the rise in net output price, while the latter's rise is mostly due to the fall in net output price. This contrast is based on the difference in their parameters λ. Cement, belonging to the former group, also shows a small increase in TFP.

In summing up, this scenario deals with a structural change in demand pattern in favor of leisure-oriented service activities. The result, therefore, is characterized as (1) service orientation and structural shift in output and employment, (2) demand increase centering investment in the

Table 12 Increased Leisure Scenario: Sectoral Output

	1989	1990	%CHG	1991	%CHG	1992	%CHG	1993	%CHG	1994	%CHG	1995	%CHG
XR01	0.00	-39.25	-0.5	-24.94	-0.3	-40.09	-0.5	-51.15	-0.7	-35.68	-0.5	-22.64	-0.3
XR02	0.000	-6.668	-1.4	-4.083	-0.8	-2.447	-0.5	-0.817	-0.1	0.585	0.1	1.594	0.3
XR03	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR04	0.00	-25.52	-0.6	-7.47	-0.2	-1.59	0.0	-1.29	0.0	0.50	0.0	0.73	0.0
XR05	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR06	0.000	9.344	0.4	0.443	0.0	-5.650	-0.2	-8.372	-0.3	-5.551	-0.2	-1.816	-0.1
XR07	0.0000	0.3010	0.1	1.6570	0.7	2.8650	1.2	1.7000	0.8	2.4170	1.0	2.7370	1.1
XR08	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR09	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR10	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR11	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR12	0.000	11.495	0.6	28.883	1.4	37.720	1.8	40.852	2.0	41.473	1.9	43.480	1.8
XR13	0.00	-50.79	-0.9	-30.90	-0.6	-18.21	-0.3	-10.71	-0.2	-9.96	-0.2	-12.68	-0.2
XR14	0.00	-30.85	-0.8	-29.47	-0.8	-39.28	-1.1	-43.75	-1.2	-38.52	-1.0	-29.08	-0.7
XR15	0.00	-19.78	-0.7	-15.51	-0.5	-15.10	-0.5	-16.14	-0.5	-15.22	-0.5	-14.16	-0.4
XR16	0.0	-106.6	-0.8	-68.6	-0.5	-84.3	-0.6	-78.1	-0.6	-47.7	-0.4	-24.4	-0.2
XR17	0.000	25.343	0.5	0.867	0.0	15.523	0.3	-3.762	-0.1	2.438	0.0	-8.152	-0.1
XR18	0.00	-49.14	-1.8	-38.59	-1.4	-25.86	-0.9	-27.19	-0.9	-23.82	-0.8	-27.48	-0.9
XR19	0.00	-15.09	-1.9	-7.47	-0.9	-3.65	-0.4	-2.51	-0.3	-1.47	-0.2	0.16	0.0
XR20	0.000	-5.892	-1.5	-3.309	-0.8	-3.211	-0.8	-1.758	-0.5	-1.327	-0.3	-0.633	-0.2
XR21	0.00	-87.09	-1.4	-15.99	-0.2	-12.70	-0.2	-14.79	-0.2	-10.93	-0.2	-4.29	-0.1
XR22	0.0	-110.8	-1.6	-63.7	-0.9	-39.2	-0.5	-42.2	-0.6	-44.7	-0.6	-47.9	-0.6
XR23	0.00	136.30	2.6	162.05	2.6	145.92	2.3	110.11	1.6	106.66	1.4	125.46	1.5
XR24	0.000	19.561	0.5	44.102	1.0	46.953	1.1	47.500	1.1	48.656	1.0	53.645	1.1
XR25	0.00	529.08	6.3	343.20	3.9	225.72	2.5	143.61	1.5	144.80	1.4	182.79	1.7
XR26	0.00	186.99	2.2	119.03	1.4	67.84	0.8	30.85	0.3	31.22	0.3	50.67	0.5
XR27	0.000	-6.208	-1.1	-3.354	-0.6	-1.131	-0.2	-0.339	-0.1	-0.920	-0.2	-1.155	-0.2
XR28	0.000	-7.952	-0.3	12.231	0.5	12.859	0.5	11.264	0.4	13.546	0.5	19.063	0.6
XR29	0.000	6.590	0.0	67.039	0.4	66.863	0.4	64.816	0.3	71.711	0.4	84.895	0.4
XR30	0.00	-36.73	-0.4	-28.78	-0.3	-26.75	-0.2	-21.83	-0.2	-16.42	-0.1	-6.18	0.0
XR31	0.00	-32.51	-0.1	28.90	0.1	50.82	0.2	75.18	0.3	109.93	0.4	146.59	0.5
XR32	0.000	11.514	0.6	48.006	2.4	37.136	1.8	31.789	1.5	37.634	1.7	40.956	1.7
XR33	0.000	5.336	0.5	14.667	1.4	19.545	1.7	18.947	1.7	17.251	1.4	18.738	1.5
XR34	0.00	43.11	0.5	116.95	1.3	148.57	1.6	147.96	1.7	151.24	1.6	159.16	1.6
XR35	0.00	45.69	0.6	241.50	3.2	181.34	2.5	157.90	2.2	177.07	2.4	196.11	2.4
XR36	0.00	30.99	0.2	233.93	1.5	285.28	1.8	240.67	1.5	232.87	1.4	262.24	1.5
XR37	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR38	0.00	13.59	0.2	77.38	1.0	116.34	1.4	103.79	1.2	91.32	1.0	93.39	0.9
XR39	0.00	47.73	0.3	184.37	1.2	210.08	1.3	213.66	1.2	209.92	1.1	227.57	1.1
XR40	0.00	233.23	0.6	638.26	1.6	691.37	1.6	694.56	1.5	745.37	1.5	848.69	1.6
XR41	0.0	224.6	0.4	846.7	1.4	980.3	1.5	1080.6	1.5	1178.8	1.5	1364.4	1.6
XR42	0.00	-25.20	-0.1	113.92	0.4	119.65	0.4	115.18	0.4	137.76	0.4	182.00	0.5
XR43	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR44	0.000	-5.648	-0.1	37.109	0.8	47.961	1.0	53.949	1.1	58.598	1.1	67.551	1.3
XR45	0.000	10.813	0.2	43.418	0.8	51.145	0.9	56.430	0.9	58.051	0.9	64.309	0.9
XR46	0.00	24.26	0.2	73.32	0.6	71.02	0.6	70.03	0.5	81.47	0.5	107.85	0.7
XR47	0.00	106.93	0.5	401.23	1.8	616.82	2.6	588.06	2.4	507.01	2.0	440.37	1.6
XR48	0.00	133.31	0.5	443.84	1.7	543.65	2.0	598.69	2.1	617.45	2.0	662.20	2.0
XR49	0.000	7.914	0.1	22.547	0.1	27.410	0.2	30.027	0.2	30.609	0.2	32.336	0.2
XR50	0.00	96.16	0.6	273.90	1.5	332.96	1.7	364.80	1.8	372.02	1.8	392.88	1.8
XR51	0.000	9.535	0.1	62.617	0.4	29.461	0.2	18.453	0.1	29.777	0.2	54.293	0.4
XR52	0.000	-3.436	-0.2	-2.649	-0.2	-6.054	-0.3	-8.591	-0.5	-6.745	-0.3	-2.571	-0.1
XR53	0.000	2.830	0.1	3.215	0.1	-2.578	-0.1	-6.379	-0.1	-3.957	-0.1	2.121	0.0
XR54	0.0	-281.7	-0.4	44.2	0.1	107.4	0.1	42.3	0.1	98.8	0.1	301.2	0.3
XR55	0.0	-523.5	-1.4	-385.8	-1.0	-296.1	-0.7	-203.5	-0.5	-109.3	-0.2	-13.3	0.0
XR56	0.00	-44.13	-1.3	-33.88	-1.0	-32.61	-0.9	-31.11	-0.9	-24.37	-0.7	-14.77	-0.4
XR57	0.00	-42.42	-0.4	-7.42	-0.1	-5.28	0.0	-10.32	-0.1	-1.55	0.0	16.03	0.1
XR58	0.00	-14.44	-0.2	10.31	0.2	6.62	0.1	4.08	0.1	16.40	0.2	35.94	0.5
XR59	0.000	-6.316	-0.1	12.410	0.2	10.633	0.1	8.512	0.1	22.984	0.3	49.297	0.6
XR60	0.00	-47.31	-0.2	21.09	0.1	20.48	0.1	11.70	0.0	37.39	0.1	87.91	0.3
XR61	0.0000	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0	0.0000	0.0
XR62	0.0	-406.5	-0.9	-423.8	-0.9	-342.9	-0.7	-231.7	-0.5	-216.9	-0.4	-220.5	-0.4
XR63	0.0	3915.3	7.0	3949.4	6.8	4029.3	6.8	3921.6	6.4	3731.6	5.9	3501.1	5.4
XR64	0.00	32.05	0.3	77.66	0.7	83.70	0.8	84.06	0.7	96.66	0.8	117.99	0.9
XR65	0.0	3888.4	0.5	7585.2	1.0	8439.8	1.1	8346.1	1.0	8696.6	1.0	9586.4	1.0

service sector, (3) technical progress in the tertiary sectors, and (4) a fall in current account surplus.

7. Concluding Remarks

We have discussed the role of sectoral technical progress in the framework of the multi-sector econometric model of Leontief type from both a theoretical and an empirical point of view. Now we briefly summarize the conclusions, which can be derived from the present research, and propose future research.

First, the sectoral technical progress was explicitly incorporated into our multi-sectoral model in order to evaluate its forward linkage effect within the Leontif framework which is based on the V-RAS algorithm as developed by our group.

Second, sectoral technical progress functions were estimated and endogenized in the present model. The sectoral technical progress was explained by neutral non-price factor, neutral price

factor (or barometer of competitiveness), and biased factors induced by relative factor prices. Although there are marked differences in the types of technical progress, it is generally observed that Japan's technical progress is mostly labor and material (including energy) saving and capital using. In regard to the neutral factor, a sharp contrast can be observed between competitive and less competitive or protected sectors in terms of net output price effect. Japan's rapid technical progress since the 1970s in high technology oriented-sectors is partly attributable to the negative response to net output price. Technical progress has been stagnant or even falling in those sectors having positive responses to such changes.

Third, the multi-sectoral model was used for two alternative scenarios through inter-sectoral interactions between forward and backward linkage effects with respect to demand, output, foreign trade, employment, technical progress, prices (including factor prices), as well as macro-economic growth alternatives.

The first policy scenario indicates that a promotion of import liberalization with appropriate fiscal policy further strengthens the competitiveness of Japan's industries, especially in the high technology sectors, and it helps to substantially reduce the current account surplus. The structural unemployment issue can be resolved as long as fiscal and structural policy is strong enough to enlarge employment opportunities.

The second scenario aims to change Japan's consumption pattern from conventional type to more leisure-oriented type expenditures. Structural changes take place with an emphasis shifting from conventional to more service-oriented output and employment. Furthermore, aggregate demand is boosted as a result of the substantial rise in investment in the service sectors. The current account surplus declines significantly. The total employment effect is greater than in the first scenario.

In view of the growing demand for Japan's import promotion and domestic demand expansion, an optimum policy-mix for alternative growth would be the one combining the above two scenarios, which satisfies both efficiency and welfare requirements.

Finally, with respect to future research, the TFP function needs to be elaborated upon with special reference to time lag structure and R&D expenditure, etc. For factor price, a database on price of material (p_r) should also be strengthened by distinguishing energy and non-energy factor prices, thus enabling the analysis of energy impact on technical progress.

Output price function needs to be further strengthened with respect to the link between import dependency and domestic prices. This will ensure a greater elaboration in import liberalization analysis.

Interaction between economic and socio-demographic variables should be analyzed in more detail in view of the growing importance of the aging population issues. The relationship between technical progress and the aging issue needs to be made more specific and more elaborated in the model framework. This would probably be one of the most challenging areas in model building if cross disciplinary research collaboration is to be successfully achieved.

Appendix

We assume a production function with n factors (F_i) and time (t). Factors are divided into F^S and F^L for short-term and long-term operation, respectively. p_i denotes factor price divided by output price and ω_i share parameter on each factor F_i. Z denotes total factor input, X output, and τ factor productivity (TFP).

$$X = f(F_1, F_2, \ldots F_n, t) \qquad (1)$$

$$(i,j = 1, \ldots n)$$

$$F_i = F_i^S + F_i^L \tag{2}$$

$$X = f(F_1^S \ldots F_n^S, \ \ldots \ F_1^L \ldots F_n^L, \ t) \tag{3}$$

$$Z = Z^S + Z^L \tag{4}$$

$$Z^S = \sum_i p_i F_i^S \tag{5}$$

$$Z^L = \sum_i p_i F_i^L \tag{6}$$

$$\omega_i^S = p_i F_i^S / Z^S \tag{7}$$

$$\omega_i^L = p_i F_i^L / Z^L \tag{8}$$

$$\sum_i \omega_i^S = 1 \tag{9}$$

$$\sum_i \omega_i^L = 1 \tag{10}$$

Unit factor demand, which is dependent on factor prices and time, is derived from an ordinary profit maximization procedure with constraints on total cost and production function.

$$\mathrm{F}_i^S / X = g^S(p_1, p_2, \ \ldots \ p_n, \ t) \tag{11}$$

$$\mathrm{F}_i^L / X = g^L(p_1, p_2, \ \ldots \ p_n, \ t) \tag{12}$$

Aggregation of these equations into an average unit factor cost, an inverse of τ (TFP), for each group provides the following relations in logarithmic form.

$$\sum_i \omega_i^S \ln \frac{F_i^S}{X} = \ln \frac{Z^S}{X} \tag{13}$$

$$\ln \frac{Z^S}{X} = h^S \left(\sum_i \omega_i^S \beta_i^S t \right) \tag{14}$$

$$\sum_i \omega_i^L = \ln \frac{Z^L}{X} \tag{15}$$

$$\ln \frac{Z^L}{X} = h^L \left(\sum_i \omega_i^L \epsilon_{ij}^L \ln p_j, \ \sum_i \omega_i^L \beta_i^L \ t \right) \tag{16}$$

$$\beta_1 = \sum_i \omega_i^S \beta_i^S \tag{17}$$

$$\beta_2 = \sum_i \omega_i^L \beta_i^L \tag{18}$$

$$\ln \frac{Z}{X} = \hat{\omega} \ln \frac{Z^S}{X} + (1-\hat{\omega}) \ln \frac{Z^L}{X} \qquad \left(\omega = \frac{Z^S}{Z}\right) \tag{19}$$

$$-\ln \frac{Z}{X} = h \left(\sum_i (1-\hat{\omega}) \cdot \omega_i^L \cdot \epsilon_{ij}^L \cdot \ln \mathrm{p}_i, \ (\hat{\omega}\beta_1 + (1-\hat{\omega})\beta_2) \ t \right) \tag{20}$$

Note that in (14) weighted average term, $\sum_i \omega_i^S \epsilon_{ij}^S \ln p_j$, is dropped, since they are all zero. As described in the text in Section 4 (equation (8)), ϵ_{ij}^S are based on symmetry condition of $\delta_{ij}^S = \delta_{ji}^S$ elasticity of substitution.

References

[1] Adams, F.G. and S. Shishido (1988), *Structure of Trade and Industry in the US-Japan Economy,* NIRA Output NRS-85-1, February.

[2] Adams, F.G. and S. Shishido (1990), *Structure of Trade and Industry in the US-Japan Economy, Phase II — Integration with Project LINK and Simulation Applications,* NIRA Research Output Vol. 3, No. 1.

[3] Binswanger, H.P. and V.R. Ruttan (1978), *Induced Innovation,* Baltimore and London, The Johns Hopkins University Press.

[4] Freeman, C., J. Clark, and L. Soete (1982), *Unemployment and Technical Innovation,* London, Frances Printer.

[5] Jorgenson, D.W. and B.N. Fraumeni (1981), "Relative Prices and Technical Change", in *Modeling and Measuring Natural Resource Substitution,* ed. E. Berndt and B. Field, Cambridge, Mass., MIT Press.

[6] Schumpeter, J.A. (1943), *Capitalism, Socialism and Democracy* New York, Harper & Row.

[7] Shishido, S., et al. (1986), *Studies on Long-Term International Impacts of Japan's High-Technology Industries,* (NRS-84-13), Foundation of Advancement of International Science, pp.1-242, (in Japanese).

[8] Shishido, S. and O. Nakamura (1992), "Commercial Policy and Restructuring the International Economy", Journal of Asian Economics, Vol. 3, No. 1, pp.97-109.

[9] Shishido, S., K. Harada and Y. Matsumura (1991), "Technical Progress in an Input-Output Framework with Special Reference to Japan's High Technology Industries", W. Peterson, ed., *Advances in Input-Output Analysis: Technology, Development and Planning,* Proceedings of Eighth International Conference on Input-Output Techniques, London: Oxford University Press.

[10] Shishido, S. (1990), "Innovation and Input-Output Analysis", *Innovation & I-O Technique,* Vol. 1, No. 2 (April), (in Japanese).

[11] Wago, H. (1983), "Energy Price, Substitution Elasticities and Technical Change — Econometric Analysis by Translog Cost Function", *Journal of Japan Statistical Association,* Vol. 13, No. 1, pp. 73-88, (in Japanese).