Welfare Effects of Reducing the Tax Evasion Rate: A Computable General Equilibrium Analysis for Korea

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Abstract

In this paper, we develop the Korean Computable General Equilibrium Model (KOCGE Model) composed of 565 structural equations. The tax evasion rate is also modeled. Simulation experiments of various reform scenarios are carried out, and the changes in the social welfare are measured to identify the optimal reform plan for Korea. In particular, we undertake a policy simulation to analyze the impact of a decrease in the evasion rate on economic welfare and income distribution. The first implication of our simulation is that a reduction in the tax evasion rate reached by reinforcing the tax administration process increases tax revenues and allows the Office of National Tax Administration to decrease the specific tax rate, thereby improving economic welfare. Our simulation results show that reduction in the value-added tax evasion rate has a more powerful economic welfare increasing effect than a deduction in the personal income tax evasion rate. A second implication is that tax authorities would not lose any tax revenues with a 9 per cent value-added tax rate (which is lower than the current 10 per cent) if the Office of National Tax Administration can reduce value-added tax evasion by 30 per cent. The results of our study suggests that the direction of tax reform in Korea should focus on reducing the tax evasion rate by reinforcing the tax administration, decreasing the value-added tax, and increasing the income tax.

Key Words: Tax Reform, Tax Evasion Rate, Korean CGE Model
JEL Classification: H2

Ⅰ. Introduction

The country's tax policy basically consists of a tax system coupled with a tax administration. However, it is more often been the case that in the design of the tax system and tax reform in Korea, issues concerning the tax administration and tax policy have been separately treated. For example, tax administration improvements have often been pursued under the condition that the existing tax system should continue independently. By treating issues of the tax system and tax administration separately, previous discussions have failed to resolve inconsistencies that burden the public.

Tax evasion in Korea is far from being uncommon. The size of the underground economy in has been estimated to reach 25% of GNP (Choi, 1987), and the size of income tax evasion estimated at around 10.0 to 11.3% of total income tax revenue (Yoo, 1994). It seems inappropriate that this serious tax evasion problem should be solved only through stricter tax administration enforcement, because under the present circumstances where people paying taxes experience excessive tax burden, reinforcing tax administration can only result in further tax resistance.

The tax system or administration alone cannot solve problems of tax evasion. Rather, it is possible to access the true nature of the tax problem and find a possible solution only through harmonizing the tax system together with the administration. In this paper, the optimal tax reform measures needed in Korea is proposed that addresses both the tax system and the tax administration together. That is, since the tax system and the tax administration have an inter-organic relationship, the complementary reform of the other sector should help to enhance the effectiveness and speed of reform of any one sector. For example, consider the case of a decrease in the tax rate and a simplified tax system through some reform plan. As the opening up of the taxable standard at the lowered tax level is introduced, the reduction in the specific tax rate diminishes the possibility of tax evasion and therefore tax administration costs such as tax investigation to detect tax dodging are avoided.

Similarly, tax administration reform should positively impact the tax system. That is, if revenue expands, say, due to some tax administration reform, the possibility to further reduce the tax rate to a lower equilibrium level may become possible. This is plausible since tax administration reform has potential to comprehensively prevent tax dodging and can rationalize the total tax administration. As tax administration reform translates into the reduction in the collection and compliance costs, the reform itself is seen to decrease the social welfare costs. Therefore the optimal tax reform should aim at the harmonious accomplishments of both administration and system reform.

The problems of the Korean tax system and administration, characterized by wide spread tax evasion and complexity, are far from being simple and too serious to be solved through fragmentary and temporary reform. Rather, as is proposed in this paper, the country's tax structure needs to be reformed combining both the system and administration simultaneously. With decreased tax evasion under a specific tax system, tax revenue increases that can encourage a reduction in the tax rate under the equal tax revenue constraint. An interesting problem then is to specify the amount by which the government can reduce the tax rate to induce a fall in the tax evasion rate by 1 percent. Since the elasticity of tax rate to tax evasion rate has an important meaning in the process of tax reform, a proper and objective estimation is critical. Estimation by econometric regression poses difficulties when trying to find the general equilibrium effect of the tax rate and tax evasion rate reduction. Therefore, we use a computable general equilibrium (CGE) model to empirically understand the organic relationship between the tax system and administration.

Ⅱ. KOCGE Model

1. Overview of KOCGE Model

The KOCGE Model (Korean Computable General Equilibrium Model) used in this paper is one in a line of generic numerically computable general equilibrium model widely known and applied such as the CGE Model (Computable General Equilibrium Model) or the AGE Model (Applied Computable General Equilibrium Model). The first type of CGE Model was developed by Johansen (1960)[1]. After Johansen, Scarf (1967a, 1967b, 1973) proved the existence of equilibrium by theory and furthermore provided an algorithm, which contributed greatly to popularizing the CGE model[2]. CGE models can be classified by the following genealogies: First is the Harberger-Scarf-Shoven-Whalley (HSSW)[3] type model succeeding Scarf. This type of model is mostly used in analyzing the effect and incidence of the fiscal policies. A second type of model is the multi-sector

[1]) On a broader definitions, CGE modelling starts with Leontief's(1936, 1941) input/output models of 1930s and includes the economy-wide mathematical programming models of Sandee(1960), Manne(1963) and others developed in 1950s and 60s. However Dixon and Parmenter(1996) insists that Johansen would be the first model of CGE model, because others before Johansen have insufficient specification of the behavior of individual actors and the role of prices.

[2]) In their paper `Computable General Equilibrium Modeling for Policy Analysis and Forecasting',Dixon & Parmenter(1996) insists that Johansen had already solved a relatively bigger CGE model by a simple, computationally efficient method well before the Scarf algorithm was invented and Scarf's technique was never the most effective method for doing CGE computation.

[3]) Shoven and Whalley(1972), Fullerton- Shoven -Whalley (1983), Ballard- Fullerton- Shoven- Whalley (1985) .

(113 industries and 230 products) ORANI Model,[4] which has been applied to the Austrian economy. Yet another is the World Bank Model, which has been used to analyze the economic policy effects in developing countries. Auerbach & Kotlikoff (1988) and Jorgenson & Yun (1991) expand the model from the static model to the dynamic model

The model in this paper is based on the Ballard-Fullerton-Shoven-Whalley (1985) type model which is descended from the Harberger-Scarf-Shoven-Whalley (HSSW) type model. The advantage of this model is that is allows the analysis of the impact of changes in the tax system and tax rate structure on economic agents' decision making such as labor supply, saving and investment behavior. It also makes possible the analysis of the impact on income distribution by class and by factor of payment as well as changes in total economic welfare. Using the KOCGE model, quantitative analyses of various tax issues that have long been discussed are carried out, such as the economic effects of a composite income taxation implementation, a reduction of value added tax rate, an integration of corporate profit tax and personal income tax, and a reduction of tax exemption. In this paper we refine the model making it more flexible and having stronger analytical power to explain the effect of changes in the tax system and tax administration. For example, it is generally known that tax reform can affect the size of tax evasion, which maybe reduced thereby increasing revenue. In our model, such changes can be analyzed quantitatively as well as qualitatively. With these analytical and quantitative results from policy simulation, a harmonious reform of both the tax system and administration is proposed.

2. Model

(1) Overview of Model

Four important factors incorporated in the general equilibrium model are resource endowments of the consumers, demand function, production technology, and the equilibrium condition. The model in this paper has three sectors, the consumption sector, the production sector, and the government sector. Households in the consumption sector are divided into 10 income groups with each household category maximizing its utility function subject to a given budget constraint. Business firms in the production sector maximize their profit producing an overall of 26 different manufacturing goods and 10 consumption goods under a CES production function, using labor and capital. The government collects taxes, such as personal income tax, special consumption tax, corporate profit tax, value-added tax and spends within the budget so as to keep the budget balanced.

(2) Production

[4]) For a detailed explanation for ORANI model refer to Dixon, Parmenter, Sutton, and Vincent (DPSV) (1982).

In the model used here, labor L and capital K are the two basic factors of production employed to produce goods and services. It is assumed that both labor and capital are homogeneous and easily mobile among the sectors as well as internationally. Capital is owned by the ten consumer groups and by government, and we denote endowments by K_j (j = 1, . . . , 10) and Kg, respectively. Capital can be used in any of the 26 producer industries or in the general government sector. These uses of capital are denoted by Ki (i = 1, . . . , 26). Only consumers have endowments Ej (j = 1, . . . , 10) of labor, but because they also consume leisure, their actual supplies are Lj (j = 1, . . . , 10) with leisure denoted Ij (j = 1, . . . , 10). Labor can be used in any of the twenty-six sectors and for each consumer, then, we have Ej = Lj + Ij . In total, we have,

$$(1)\quad E = \sum_{j=1}^{10} E_j = \sum_{j=1}^{10} L_j + \sum_{j=1}^{10} I_j = L + I = \sum_{i=1}^{26} L_i + \sum_{j=1}^{10} I_j$$

Each of these factors is defined in service units per period. When a unit of capital services is rented out for one period, the owner receives a price, P_K, which is net of factor taxes and depreciation. In addition to the rental price, P_L and P_K, which are paid to factor owners, producers are required to pay value-added taxes at rates τ_{Li} and τ_{Ki}. These taxes differ by sector. Therefore the i^{th} factor user faces gross of tax P_{Li}^* and P_{Ki}^* which equal the following:

$$(2)\quad P_{Li}^* = P_L(1+\tau_{Li})$$

$$P_{Ki}^* = P_K(1+\tau_{Ki})$$

Capital and labor appear in a constant elasticity substitution (CES) value-added function of the form:

$$(3)\quad VA_i = \Phi_i[\delta_i L_i^{\frac{\sigma_i - 1}{\sigma_i}} + (1-\delta_i) K_i^{\frac{(\sigma_i - 1)}{\sigma_i}}]^{\frac{\sigma_i}{\sigma_i - 1}} \qquad i = 1, \ldots, 26$$

where Φ and δ are production parameters, and σ is the elasticity of substitution. For expositional simplicity, we have suppressed the i subscripts of all variables and parameters.

This model uses a 26 ×26 fixed coefficient input-output matrix, denoted by A, with columns giving the intermediate input requirement per unit of output. The industry outputs are represented as Q_i (i = 1, . . . , 26). In this model we do not allow for substitution between intermediate input and value-added.

A single output is characterized by cost minimization for each unit of output. Minimization of factor costs ($P_L^* L + P_K^* K$) subject to the constraint that VA =1 in equation (4) yields the labor and capital demand requirement per unit of value-added as shown in equation (5) and (6).

(4) $$\min_{L,K} \quad P_L^* L + P_K^* K$$

$$\text{s.t.} \quad VA_i = \Phi[\delta\, L^{\frac{\sigma-1}{\sigma}} + (1-\delta_i)\, K^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} = 1$$

(5) $$R_{Li} = \Phi_i^{-1}[(1-\delta i)(\frac{\delta i\, P_{Ki}^*}{(1-\delta i)\, P_{Li}^*})^{(1-\sigma i)} + \delta i]^{\frac{\sigma i}{1-\sigma i}} \qquad i= 1, \ldots, 26$$

(6) $$R_{Ki} = \Phi_i^{-1}[\delta i(\frac{(1-\delta i)\, P_{Li}^*}{\delta i\, P_{Ki}^*})^{(1-\sigma i)} + (1-\delta i)]^{\frac{\sigma i}{1-\sigma i}} \qquad i= 1, \ldots, 26$$

To find out the demand for labor and capital, we denote the value-added contributed by industry i by VA_i and then the contribution ratio to output, **var**$_i$, is defined in equation (7) and determined exogenously.

(7) $$\text{var}_i \equiv \frac{VA_i}{Q_i}$$

Once **var**$_i$ is determined, the demand for labor and capital follows:

(8) $$L_i = VA_i R_{Li} = VA_i\, \Phi_i^{-1}[(1-\delta i)(\frac{\delta i\, P_{Ki}^*}{(1-\delta i)\, P_{Li}^*})^{(1-\sigma i)} + \delta i]^{\frac{\sigma i}{1-\sigma i}}$$

(9) $$K_i = VA_i R_{Ki} = VA_i\, \Phi_i^{-1}[\delta i(\frac{(1-\delta i)\, P_{Li}^*}{\delta i\, P_{Ki}^*})^{(1-\sigma i)} + (1-\delta i)]^{\frac{\sigma i}{1-\sigma i}}$$

Given parameters δ, Φ and σ for each industry, we use the net of tax factor prices together with the tax rate to calculate each producer's gross-of-tax price for each factor. Thus the tax system distorts factor input decisions. We assume perfect competition in both the factor and good markets. Therefore there is no economic profit left after the producer pays for factor costs and taxes. In this zero economic profit condition the price of a producer's good is P_i (i = 1, . . . , 26). The before tax price of one unit of the ith good is the cost-covering price of producer goods, that is, the price being paid to value-added (V_i) in equation (10) and intermediate good (a_{ij}) which is inputted in one unit of the producer's good. This is shown by equation (11).

(10) $$V_i = P_{Li}^* R_{Li} + P_{Ki}^* R_{Ki} \qquad i= 1, \cdots, 26$$

(11) $$P = (I - A^T)^{-1} V$$

$$P(26\times1)=\begin{bmatrix}P_1\\ .\\ .\\ P_{26}\end{bmatrix}\qquad V(26\times1)=\begin{bmatrix}V_1\\ .\\ .\\ V_{26}\end{bmatrix}$$

where A^T is the transpose matrix of the input-output matrix A

We impose different value added tax rates on each industry's intermediate purchases from each other industry. Each industry is supposed to share its tax burden at the same level, the effective value added tax rate of each industry is different each other, due to the economic policies of the government. We impose different tax rate on each industry. To analyze the performances of tax administration, we added tax evasion rate in this model, as follows.

(12) $$P_i^* = P_i[1+\tau_{vi}[(1-a_{vi})enc_i + ec_i]]$$

Here t_{vi} is the value added tax rate, a_{vi} is the avoidance rate on value added tax. enc_i and ec_i are respectively the ratio of corporate sector to whole industry and that of non-corporate sector within each industry, $enc_i + ec_i = 1$. The tax evasion rate is defined as follows.

(13) $$a_{vi} = \frac{total\ amount\ of\ value\ added\ tax\ in\ economy - value\ added\ tax\ actually\ paid}{total\ amont\ of\ value\ added\ tax\ in\ economy}$$

i=1, … , 26

Consumer goods X_m (m = 1, . . . , 10) are produced as producer goods Q_i through a fixed coefficient Z matrix as shown in (14). Each of the coefficient Z_{im} in the Z matrix gives the amount of producer goods *i*, needed to produce one unit of consumer good *m*. Since perfect competition is a assumed, producers make zero profits after payments for factors, factor taxes, and output taxes. The zero profit condition also applies to the production of consumer goods. The costs covered in consumer good prices are given by P_m in equation (14).

(14) $$P_m = \sum_{i=1}^{26} z_{im}P_i^* \qquad m= 1,\ldots, 9$$

When consumers purchase good X_m, they must pay additional value added taxes. We model sales taxes on the purchase of each good at rates τ_m (m = 1, . . . , 9). Gross-of-tax prices paid by consumers are shown in (15). Sales taxes τ_m include all the taxes that the consumers face, for example, special consumption tax, telephone tax, liquor tax, stamp tax, security trading tax.

(15) $$P_m^* = P_m(1+\tau_m)$$

(3) Households

We assume that the households in this model own all the goods and factor of payments. The market demand function for goods are non-negative and continuous in prices. Individuals make saving decisions based on expectations about the resulting increment in future consumption. We assume that expectations are myopic in the sense that individuals expect all current prices, including the return to capital, to remain constant through all future periods. With this assumption, we are able to calculate the savings of individuals based only on current prices.

The household chooses the demand for consumer goods based on three-stage maximization of the nested utility function. In the first stage, consumers choose present consumption H and future consumption C_F, to maximize their CES utility function. Equation (16) shows the 1st stage consumers' maximization problem. Each consumer group has its own set of parameters and values, which is a CES utility function; we suppress indexes for expositional simplicity.

$$(16) \qquad \max_{H,\, C_F} \quad U(H, C_F) = [\alpha^{\frac{1}{\sigma_2}} H^{\frac{\sigma_2 - 1}{\sigma_2}} + (1-\alpha)^{\frac{1}{\sigma_2}} C_F^{\frac{\sigma_2 - 1}{\sigma_2}}]^{\frac{\sigma_2}{\sigma_2 - 1}}$$

$$\text{s.t.} \qquad I = P_H H + \frac{P_s \overline{P}}{P_K \gamma} C_F$$

Here I is current expanded income after taxes and transfers, α is a weighting parameter and σ_2 is the elasticity of substitution between H and $\mathbf{C_F}$. γ is the physical service flow per unit of capital goods purchased, which is assumed exogenous.

In the second stage, consumers distribute their present consumption H, after saving. They choose their composite good $\overline{X}$ and leisure ℓ maximizing a CES Utility function U($\overline{X}$, ℓ) . The 2nd stage maximization problem is written in equation (17).

$$(17) \qquad \max_{\overline{X},\, l} \quad H = [(1-\beta)^{\frac{1}{\sigma_1}} \overline{X}^{\frac{\sigma_1 - 1}{\sigma_1}} + \beta^{\frac{1}{\sigma_1}} l^{\frac{\sigma_1 - 1}{\sigma_1}}]^{\frac{\sigma_1}{\sigma_1 - 1}}$$

$$\text{s.t.} \qquad I - P_s S = \overline{P}\overline{X} + P_l l$$

where β is a weighting parameter, and σ_1 is the elasticity of substitution between $\overline{X}$ **and** ℓ **. The price of leisure,** P_l is taken to be the after-tax return to labor of each group. Since a unit of labor earns P_L after factor taxes, $P_l = P_L$ (1- τ_j), where τ_j id the jth consumer's personal marginal tax rates.

After spending P_l ℓ on leisure, consumer have $I - P_s S = \overline{P}\overline{X} + P_l l$ available to spend on the consumption components on $\overline{X}$ **, i**n the third stage. They choose X_m (m=1, . . . , 9) to maximize a Cobb-Douglas form of the sub-utility function in (18),

$$(18) \qquad \max \qquad \overline{X} = \prod_{m=1}^{9} X_m^{\lambda_m}$$

$$\text{s.t.} \quad I - P_s S - P_l l = \sum_{m=1}^{9} X_m P_m^* \mathrm{I}$$

The λ_m weighting parameters are the Cobb-Douglas expenditure shares. Constrained maximization of the subutility function, $\overline{X}$, provides the demand functions as follows:

$$(19) \quad X_{mj} = \frac{\lambda_{mj}(I_j - P_S S_j - P_{l_j}^* l_j)}{P_m^*}, \qquad m= 1, \cdots, 9, \quad j= 1, \cdots, 10$$

With the important property of the nested Cobb-Douglas and CES utility function, we derive the following price functions in (20), (21), and (22):

$$(20) \quad \overline{P} = \prod_{m=1}^{15} \left(\frac{P_m^*}{\lambda_m}\right)^{\lambda_m}$$

$$(21) \quad P_H = [(1-\beta)\overline{P}(1-\sigma_1) + \beta P_l^{(1-\sigma_1)}]^{\frac{1}{(1-\sigma_1)}}$$

$$(22) \quad P_U = [\alpha P_H^{(1-\sigma_2)} + (1-\alpha)[\frac{P_S \overline{P}}{P_K \gamma}]^{(1-\sigma_2)}]^{\frac{1}{(1-\sigma_2)}}$$

(4) Government

The government collects personal income tax, value-added tax, sales tax, and factor payment tax as tax revenues and maintains a balances budget. The personal income tax follows marginal rates that differ among income groups. It also includes special features that discriminate by industry. For example, industry with more corporate sector will have a higher tax burden. Within the corporate sector, the industry with higher residual earnings will pay more taxes than the industry with higher dividends and interest payments. We assume that there is a tax evasion rate a_{vi} assigned to each industry *i* in the non-corporate sector, which includes mostly self-owned firms. This is shown in equation (12).

The sum of each industry's capital income net of corporate income is the same as the capital income received by the ten consumer classes. The right hand side of equation (23) is the sum of capital income received by the ten consumer groups and the left hand side is the sum of capital expenditure paid by twenty-six industries.

$$(23) \quad \sum_{i=1}^{26} CAI_i = \sum_{j=1}^{10} CAI_j$$

Each of the 10 consumer groups has a marginal tax rate on all capital and labor income, denoted by τ_j (j = 1, . . ,10). Many transfer payments are not subject to income tax. In our model we assume that all transfers are tax-exempt, while labor income is fully taxable. This is expressed by the following formula for income taxes paid by group j.

$$(24)\quad T_j^I = B_j + \tau_j P_L L_j + \tau_j (1 - a_{ij}) P_K K_j$$

The intercept of each linear tax function, B_j may be interpreted as a kind of social security tax: it is negative reflecting the fact that marginal tax rates exceed average tax rates. While marginal changes in income are taxed at the appropriate marginal rate for each group, this marginal rate does not change as income changes. Expanded income, I_j, equals transfers plus labor and capital income, plus the value of leisure, minus income taxes. Therefore, for each group j (j = 1,⋯, 10), we have

$$(25)\quad I_j = (R - G)d_j - B_j + E_j P_L (1 - \tau_j) + K_j P_K [1 - \tau_j (1 - a_{ij})]$$

Here, G is government expenditures, which is the sum of government's fixed capital formation (Q^{FIG}) and government's consumption expenditures (Q^{FG}), that is $G = Q^{FIG}+Q^{FG}$, and is exogenously determined. We divide government expenditures into two categories. Some publicly supplied goods and services are offered free of charge, while other expenditure for goods and services and investment are subject to a user's charge. The government distributes the residual after paying expenditures (G) from tax revenues (R) to each group of consumers as a transfer. The distribution for jth consumer group is d_j (R-G) which can be interpreted as a kind of social securities. Since the government transfers to the consumers all residuals, the government budget is always balanced as shown in (26).

$$\begin{aligned}(26)\quad & \sum_{j=1}^{10}[B_j + \tau_j P_L L_j + \tau_j (1 - a_{ij}) P_K K_j] + \sum_{m=1}^{9}(\sum_{j=1}^{10} \tau_m P_m X_{mj}) \\ & + \sum_{m=1}^{9}[(\sum_{i=1}^{26} Z_{im} P_i \tau_{vi}^*)(\sum_{j=1}^{10} X_{mj})] + \sum_{i=1}^{26}(\tau_{Li} P_L L_i + \tau_{Ki} P_K K_i) \\ & - (G + \sum_{j=1}^{10} d_j (R - G)) = 0\end{aligned}$$

3. Equilibrium of Model

The equilibrium of the model is defined under given governmental policy variables {G , d_j } and parameter values (enc_i , ec_i , a_{vi} , a_{ij} }, distribution variables {H_j , C_{Fj} , S_j , $\overline{X}$, l , X_{mj} , R_{Li} , R_{Ki} , Q_i , L_i , K_i } and price variables {P_H , P_S , P_L , P_K , P_i , P_m , $\overline{P}$, P_l } (i=1,..26, j=1,...10) satisfying the following conditions:

A. Optimization condition:
A-1. Producer's optimization condition: equation (4)
A-2 consumer's optimization condition:
A-1-1. 1st step optimization condition: equation (16)
A-1-2. 2nd step optimization condition: equation (17)
A-1-3. 3rd step optimization condition: equation (18)
B. Government's budget balanced condition: equation (26)
C. Feasibility Condition
D. Market equilibrium condition
D-1. Good market equilibrium condition
D-2. Factor market equilibrium condition

(1) Goods Market Equilibrium

In the goods market, the demand for final producer good are divided into consumption demand (Q^{FC}), investment demand (Q^{FI}), government consumption demand (Q^{FG}), and foreign demand (Q^{FX}). We assume that foreign demand is balanced. The equilibrium condition for the good market is determined where total demand for final producer goods equals total supply in production sector.

(27) $Q = (I - A)^{-1}(Q^{FC} + Q^{FI} + Q^{FG} + Q^{FX})$

Here the consumption demand for final producer good, Q_i^{FC}, is defined as follows:

28) $Q_i^{FC} = (\sum_{m=1}^{9} Z_{im} X_m) P_i$ i = 1, ⋯ , 26

(29) $Q^{FC} = \sum_{i=1}^{26} Q_i^{FC}$

In this model, the investment demand for final producer goods, Q^{FI}, is the sum of the household sector's savings (Q^{FIH}), the corporate sector's savings (Q^{FIC}), the government's savings(Q^{FIG}) and depreciation (D), and changes in inventories (IV) as shown in (30). We assume that government and corporate sector savings and inventory changes are given exogenously.

(30) $Q^{FI} = Q^{FIH} + Q^{FIC} + Q^{FIG} + D + IV$

Here, household's savings equals investment demand for final producer goods, as shown in (31).

(31) $Q_k^{FIH} = Z_{i10} S_H$, i = 1, ⋯ , 26

(2) Factor Market Equilibrium

Capital market equilibrium is as follows:

(32) $$\sum_{i=1}^{26}(K_i - D_i) - \sum_{i=1}^{26} Q_i^{FIC} - \sum_{j=1}^{10} K_j = 0$$

Labor market equilibrium is as follows:

(33) $$\sum_{i=1}^{26} L_i - \sum_{j=1}^{10} L_j = 0$$

4. Derivation of Model Equilibrium

The equilibrium in this model is summarized by 565 equations with 565 variables. To solve this system of equations, we replace the variables in equations reducing this system of equation into 3 equations with 3 variables, P_L, P_K, R, as follows:

(33) $$\begin{aligned} F^1 &\equiv \sum_{i=1}^{26} L_i - \sum_{j=1}^{10} L_j \\ &= \sum_{k=1}^{26}[\sum_{j=1}^{10} T_{ij}(\sum_{m=1}^{10} Z_{im}(\sum_{j=1}^{10}\frac{\lambda_{mj}(I_j - P_S S_j - P_l l_j)}{P_m^*}))]R_{Li} - \sum_{j=1}^{10} L_j \\ &= 0 \end{aligned}$$

(34) $$\begin{aligned} F^2 &\equiv \sum_{i=1}^{26} K_i - \sum_{j=1}^{10} K_j \\ &= \sum_{k=1}^{26}[\sum_{j=1}^{10} T_{ij}(\sum_{m=1}^{10} Z_{im}(\sum_{j=1}^{10}\frac{\lambda_{mj}(I_j - P_S S_j - P_l l_j)}{P_m^*}))]R_{Ki} - \sum_{j=1}^{10} K_j \\ &= 0 \end{aligned}$$

(36) $$\begin{aligned} F^3 &\equiv \sum_{j=1}^{10}[B_j + \tau_j P_L L_j + \tau_j (1 - a_{ij}) P_K K_j] + \sum_{m=1}^{9}(\sum_{j=1}^{10} \tau_m P_m X_{mj}) \\ &+ \sum_{m=1}^{9}[(\sum_{i=1}^{26} Z_{im} P_i \tau_{vi}^*)(\sum_{j=1}^{10} X_{mj})] + \sum_{i=1}^{26}(\tau_{Li} P_L L_i + \tau_{Ki} P_K K_i) \\ &- R = 0 \end{aligned}$$

Ⅲ. Data and Calibration

1. Data on intermediate goods and value added in production sector

The benchmark year of our KOCGE model is 1993, as it is the most convenient year in which data is available. Furthermore, 1993 is assigned as the benchmark year. In particular, the input/output table was the most up-to-date when modeling begun. We classify the production sector into 26 industries as shown in <Table 1> - the simplest classification we can draw from Korean input-output transaction matrix of 1993.

<Table 1> 26 Industry Classification

1. Agriculture, forestry, and fisheries	10. Metals	19.Transportation and Custody
2. Mining	11.General Machinery	20. Telecommunications
3. Food and beverages	12. Electric and electronic equipment	21. Finance and insurance
4. Textiles and leather	13. Accurate equipment	22. Real estate and business services
5. Paper and woods	14. Transportation equipment	23. Public and security services
6. Chemicals	15.Miscellaneous manufacturing	24. Education and public health
7. Petroleum and Stone Plates	16. Electricity, gas, water	25. Social and private services
8. Clay and ceramics	17. Construction	26. Others
9. First metal	18. Whole sales and Retail sales	

Sources: Bank of Korea, 『Input output Table in 1993』, published in 1996

The data for producer's sector such as, value added, labor and capital income, and depreciation on 26 industries are obtained from input-output table.

(1) Factor income and factor income taxes on each industry

Gross-of-factor-tax return to labor on each industry is obtained from the employee's income in the input-output table.[5] Since taxes on labor are those taxes that the firms should pay to employ one unit of labor, we estimate these with the employer's burden in pension funds. Pension funds in Korea is 2% of gross-of-factor-tax return. The data on each industry is obtained from the national pension funds statistics.

Capital income is represented by rewards for capital and is composed of corporate profit, net interest payment, and net rent payment. Corporate profit is also composed of retained earnings and dividend. To estimate the capital income on each industry, we use the *Corporate Management Analysis* and the *National Income Accounts* published by the Bank of Korea. First we figure out the total size of capital income for the Korean economy from the *National Income Accounts* and use the

5) Since the indirect taxes such as ad-valorem tax is transferred to the household consequently, we include the indirect taxes in the gross-of-factor-tax return to labor.

Corporate Management Analysis to find out capital income weights and the capital income on each industry. Tax on capital income means tax that the firm pays when it invests one unit of capital and derives income from it. In Korea, corporate profit tax and property tax can be included in this category. In this model, however, only corporate profit tax is included in capital income tax.

(2) Input-Output Transaction

The KOCGE model is established based on industrial transaction data. The input-output table in 1993 is constructed and published by the Bank of Korea in 1996. The transaction table is classified into the producer price evaluation table, domestic transaction table, and imported transaction table. Each transaction table is developed from 405 basic industries level and aggregated to 164 industries (aggregated small classification), 75 industries (aggregated middle classification), and 26 industries (aggregated large classification). In this model we use the input-output matrix in the producer price evaluation table by aggregated large classification.

(3) Producer and Consumer Goods Transition Matrix: Z Matrix

The producer goods form 26 industries and do not match the 10 consumer goods directly. For instance, households do not buy and consume the goods produced from the mining industry directly. Therefore, there is a separate process of transit from producer goods to consumer goods. In this model we assume that producer goods transit to consumer goods by a Z-Transition matrix, following the BFSW (1985) model.

$$QZ = X$$

Here, Q (1×26) is the producer good vector, Z (26×10) is the transition matrix, and $X(1 \times 10)$ is the producer good vector.

The Z matrix can be estimated as follows: First, by using the (405×405) transaction table in the input-out put matrix we arrange 405 input sectors into 26 producer sectors and also arrange 405 sectors into 10 consumer sectors. Here we follow the procedures of input-output table in 1993 to reduce the 405 sectors to 26 producer goods. Second, we make a (26×10) transaction table in a similar way. Third, we normalize this transaction by dividing each element by the sum of each element of the row and obtain the Z-transition matrix.

2. Incomes, Expenditures, and Investment in Household Sector

(1) Composition of Final Demand

In the KOCGE model, the final demand for the 26 producer goods consist of 4 elements. These are private consumption expenditure (*C*), corporate investment (*I*), government expenditure (*G*), and exports (*E*). The demand vector for intermediate goods can be obtained by multiplying the input-output coefficient matrix (A) by the total domestic output vector (X). The total supply of specific goods equals the sum of total domestic output vector (X) and imports (M). Hence, the good market equilibrium condition is when total demand equals total supply and the following condition is established:

(37) $$\mathrm{X + M = AX + C + I + G + E}$$

We can rewrite equation (37) to get the total domestic output vector as follows:

(38) $$X = (I^{*} - A)^{-1}(C + I + G + E - M)$$

Here, I^* is an identity matrix. Given the price vector of 26 goods, the right hand side of equation (38) is the total domestic output satisfying total demand.

(2) Personal Income Tax

The households in this model own and provide labor and capital. In return, they get labor and capital incomes. The sum of demands for production factors must equal total endowments in the economy. The unit of labor and capital is measured in service units, which earns one Korean Won as reward. Therefore, we estimate the factor of production endowments for each income class and these must equal the sum of consumption expenditures, tax payments and saving for each income class.

We use the『Annual Report on the Family Income and Expenditure Survey』, the 『National Income Accounts』, and the 『Input-Output Table』 to estimate the household income and tax payment for each income class. The problem is there are three different sources of statistics that give different numbers. To solve this statistical differences, we adjust the data first adjusting the micro-data, based on macro-data if available, and second, by adjusting the tax data. Lastly, we adjust the data to keep consistency in the model.

Furthermore, the sum of factor payments that the firms and government pay equals the sum of factor income that the households receives in return when providing production factor. The government keeps a balanced budget. We also assume that the external sector is balanced. Total tax payment by each income group should equal total tax revenue received by the government. Under these principles, we estimate the household income and tax payment for each income class.

In the KOCGE model the household income consists of labor income, capital income, and transfer for the government. The household in this model is divided into 10 classes each with an equal number of households. For convenience, we assume that each income class is one representative household.

First of all, we estimate the labor income for each income class. We use the 『Annual Report on the Family Income and Expenditure Survey』 and the 『National Income Accounts』 for this purpose. Total labor income is estimated from employee's salaries in macro-data of the 『National Income Accounts』 and the distribution of labor income for each income class is estimated from micro-data.

(3) Disposal of Household Income

① Disposable Income, Saving, and Consumption expenditure

The disposable income of the household is the sum of total income and social security minus income tax and social security tax. The household consumes the remaining of disposable income after subtracting saving. Total saving for each income class is estimated from the *Input-Output Table in 1993* and the *National Income accounts*. The distribution of saving for each income class is estimated from the *Annual Report on the Family Income and Expenditure Survey*.

The household consumes 9 consumer goods, such as food, housing, electricity and water, furnishings and appliances, clothing and shoes, health, education and recreation, transportation and telecommunication, other miscellaneous expenditures, following the classification of the *Annual Report on the Family Income and Expenditure Survey*. We estimate total consumption expenditure for each income class from the *National Income accounts*. We finally multiply this by the weights on 9 consumer goods obtained from the *Annual Report on the Family Income and Expenditure Survey* in order to find the expenditure of the 9 consumer goods for each income class.

② Consumption Tax

The Korean consumption tax in 1993 classifies the value-added tax, special consumption tax, liquor tax, telephone tax, stamp tax, and security trading tax as a national tax and tobacco consumption tax, automobile tax, acquisition tax, registration tax, license tax as local tax. In this model consumption tax is modeled as value-added tax and commodity tax. The value-added tax is levied on the initial price of producer good and ultimately transferred to the consumers. The tax on final good is a commodity tax. The data on consumption tax are from the *Statistical Yearbook of National Tax* and the *Yearbook of Local Public Finance*.

3. Data on Tax evasion Rate

(1) Value-added Tax evasion Rate

The research results so far have focused on estimating the total size of tax evasion rate. It is impossible to find out the value-added tax evasion rate on each industry. Therefore, we use the tax evasion rate which estimated by An (1994) on each industry[6]. An (1994) investigated the changes in national consciousness and tax compliance behavior of the corporate and individual business firms (number of sample is 664), whose capital under 100 million Won, for one month in June 1994. In this process, we get information about the value-added tax evasion rate on each industry.

An(1994) estimated the realization ratio of the value-added tax by using the actual tax payment in 3rd quarter in 1994 and average value-added tax rate on each industry. We compared the actual amount of sales in the 3rd quarter in 1994 by the estimated amount of tax payment, based on the sales that were answered through the questionnaires. This allows us to estimate the amount of tax evaded indirectly. The results are shown in <Table 2>. The tax realization ratio of the corporate and individual firms under 100 million of their capital is 52.2%. The reason that the tax realization ratio is so low is due to tax evasions such as false purchase, omission of sales, and transaction without materials are widely spread.

The tax realization rate in the manufacturing sector is the highest at 80.5% construction is 45.6%, and food and lodging is lowest at 30.3%. The tax realization rates by types of taxpayers are 92.3%, 67.1%, and 32.5% for corporates, general taxpayers, and special taxpayers respectively.

<Table 2> Value-added Tax Realization Rates

(unit: %)

Total	52.2
Manufacturing	80.5
Wholesales	54.9
Retail sales	54.5
Food and lodging	30.0
Construction	45.6
Transportation, Custody, and Telecommunication	42.1
Real estate rent and brokerage	42.4
Public and private services	50.1

Our tax evasion rates are 1.0 less the tax realization rates of An et. al.(1994). An et. al.(1994) estimate the tax evasion rates for 8 industries, representing a larger classification of industry, while in this paper the tax evasion rates cover 26 industries. We use the same tax evasion rates with An et. al. if the industry belongs to the large classification of industry. For three industries such as

6) An Jong Bum and 3 others, 『Evaluations and Further Tasks of Real Name System in Financial Sector, after 1 year of Implementation』, Research Paper 94-11, Korea Tax Institution, 1994. In this paper An (1994) and other estimate the income tax evasion rate on each industry.

electricity·gas·water supply, banking and insurance industries, and other public administration and national defense, the tax evasion rates are set at zero. These industries do not belong to the large classification and tax payment cannot usually be avoided. The tax evasion rates we use for the 26 industries are showed in <Table 3>. We further assume that there is no value-added tax evasion in the corporate sector, while there is value added-tax evasion in non-corporate sector in the KOCGE model.

<Table 3> Value-added tax evasion rate of non-corporate sector on each industry (a_{vi})

Industries	Value-added tax evasion rate(%)	Industries	Value-added tax evasion rate(%)
1. Agriculture, forestry, and fisheries	47.8	14. Transportation equipment	19.5
2. Mining	47.8	15.Miscelloneous manufacturing	19.5
3. Food and beverage	70.0	16.Electricity, gas, and water	0
4. Textile and leather	19.5	17.Construction	54.4
5. Pulp and woods	19.5	18.Wholesales and retails sales	45.3
6. Chemicals	19.5	19. Transportation and custody	57.9
7. Petroleum and coals	19.5	20. Telecommunication	57.9
8. clays and ceramics	19.5	21. Finance and insurance	0
9. First metals	19.5	22. Real estate and business services	57.6
10. Metals	19.5	23. Public and security services	0
11. General machinery	19.5	24. Education and public health	0
12. Electric and electronic equipment	19.5	25. Social and private services	49.9
13. Accurate equipment	19.5	26. Others	47.8

(2) Personal income Tax evasion Rate

The researches on personal tax evasion in Korea have focused on estimation of business income tax evasion. There are two groups of researches, related on this subject in Korea. Hyun and Na(1994), Bae and Hong(1998), Choi(1997), and Lee(1998) make comparative studies of the tax burden on earned income tax and on business income tax. On the other hand, Yoo(1994) and Lee and Jung(1996) estimate the size of the underground economy in Korea. In former type of researches, researchers employ income-expenditure approaches, first estimating the income from consumers using *Annual Report on the Family Income and Expenditure Survey* or *Daewoo Panel Data* and then making comparison of tax burden.

In this paper we use Bae and Hong(1998)'s estimated results to estimate the personal income tax evasion rates of 10 income groups. In estimating the personal income tax evasion rate for each income class, we reflect the differences between tax burden on wage income and that on business income. We assume that tax evasion develops only in capital income and not in wage income.

<Table 4> shows the personal tax evasion rates by income class.

<Table 4> Personal tax evasion rates by income class

(unit: %)

Income classes	Personal income tax evasion rate	Income classes	Personal income tax evasion rate
Ⅰ	17	Ⅵ	64
Ⅱ	42	Ⅶ	71
Ⅲ	38	Ⅷ	72
Ⅳ	21	Ⅸ	77
Ⅴ	58	Ⅹ	80

4. Benchmark Calibrations and Derivation of Equilibrium

To investigate the quantitative implication of policy changes such as a tax reform, we calibrate the benchmark equilibrium. There are two criteria for selecting the values of the parameters that we use to calibrate the KOCGE model. One is that we choose the parameter values for which the model economic variables are near average values for the Korean economy in1993. The other is that we use the same parameter values for the specification of preferences and technology found in other empirical studies. Using these two criteria, we replicate the Korean economy in 1993, as a benchmark equilibrium economy. In benchmark equilibrium, the solutions of 565 structural simultaneous equation systems are close to the real values of the economic variables of 1993 characterizing the Korean economy. We call this process the benchmark calibration[7]. Once we set the parameter values for the benchmark equilibrium, we proceed to find the counter-factual equilibrium by changing the policy variables.

5. Algorithms and Program

We set up the algorithm to find the solutions of 565 endogenous variables of the nonlinear simultaneous equation system. The Gauss Program is used. A stable equilibrium solutions is arrived at using both the Hook-step method and the Line-search method[8]

Ⅳ. Simulation Results

In this chapter we analyze how the reduction in the tax evasion rate affects the economy's efficiency and equity.

7) For detailed benchmark calibration procedures and parameter values, see Kim and others (1998)

1. Welfare and Income Distribution Effects

The impact of specific tax reform on the efficiency of the economy can be calculated either by the 'Equivalence Variation (EV)' or by the 'Compensating Variation (CV)' measures. In this paper, we use the Hicks' Compensation Variation depicted as follows:

$$CV = E(u^N, p^N) - E(u^o, p^o)$$

Here, the function E(·) represents the expenditure function. u^0 and p^0 are the utility level and price vector respectively under the initial benchmark equilibrium. u^N and p^N are the utility level and price vector respectively under a new counter-factual equilibrium after changing the policy variables. $E(u^N, p^N)$ is the expenditure level needed to keep the utility level u^N under the new price vector p^N. The compensation variation represents the income compensation needed to keep the consumer at the initial utility level as the price vector changes. When consumer's preference are assumed homothetic, compensation variation CV can be expressed as follows:

$$CV = \frac{u^N - u^0}{u^N} \cdot I^N$$

Here I^N is the income level in the counter-factual equilibrium. The total compensation variation is the sum of compensation variation of each income class. That is:

$$CV = \sum_{j=1}^{H} CV_j$$

where CV_j is compensation variation for income class j, and H is total number of the class in this model and H=10.

The impact of specific tax reform on the equity of the economy is estimated both by the 'Gini Index' and the 'Deciles Distribution Ratio'. Deciles The latter is measured by the ratio of total income of the lower 40% income class to total income of upper 20% class. The higher the Deciles Distribution Ratio is, the fairer the income distribution. The lower the Gini Index the fairer the distribution of income.

2. Welfare Effect of Tax evasion Rate Deduction

We analyze the welfare effect of an improvement in the tax administration system resulting from a reduced tax evasion rate. We focus on the efficiency and equity changes when the avoidance

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[8]) KOCGE model solution algorithm can be provided to the by request.

rates of the personal income tax and the value-added tax are lowered.

(1) Economic Effect of Reduction in the Value-added Tax evasion Rate

As a way of lowering the value-added tax evasion rate, enforcing tax payment by self-assessment, improving the tax information system, advancing the tax investigation technique are currently being discussed. In this paper, we analyze efficiency and equity changes, when the value-added tax evasion rate is lowered by 100%, 50%, and 30% from the current level. <Table 5> shows the welfare effects of a reduction of the value-added tax evasion rate. The reduction in the value-added tax evasion rate resulted in increased tax revenue. In the KOCGE model, the increased tax revenue is redistributed to the private sector and the equilibrium solution is calculated.[9] We consider two cases of redistribution of increased tax revenue. In case Ⅰ, the increased tax revenue due to the reduction in the value-added tax evasion rate is distributed to households in proportion to the existing total government subsidies. In case Ⅱ, the increased tax revenue due to the reduction in the value-added tax evasion rate is distributed to households by the same amount.

<Table 5> Economic Effect of Reduction in Value-added Tax evasion Rate

Reduction in value-added tax evasion rate	Increased tax revenue (billion won)	Revenue increase / value-added tax revenue (%)	Compensation variation (billion won)	
			Case Ⅰ	Case Ⅱ
30%	226.65	(1.79)	541.06	541.70
50%	377.62	(2.99)	702.15	704.78
100%	754.59	(5.97)	1,104.44	1,112.11

주 : In case Ⅰ, the increased tax revenue due to the reduction in value-added tax evasion rate is distributed to households in proportion to the existing total government subsidies.

In case Ⅱ, the increased tax revenue due to the reduction in value-added tax evasion rate is distributed to households by the same amount.

The simulation results show that a 30% reduction in the value-added tax evasion rate increases the value-added tax revenue by 226.6 billion won, 1.79% of total value-added tax revenue by 12.6 trillion won. Furthermore, 50%, 100% reduction in value-added tax evasion rate increases the value-added tax revenue by 377.6 billion won (2.99%), 754.5 billion won (5.97%) respectively.

The simulation results also show that the reduction in the value-added tax evasion rate increases social welfare. For example, 30%, 50%, 100% reduction in the value-added tax evasion rate increases the total social welfare by 541 billion won, 702.1 billion won, and 1.1 trillion won respectively. However, the differences in redistribution method (case Ⅰ and case Ⅱ) do not affect

9) In KOCGE model the social security benefits plays the same role as the lump-sum transfers.

the size of the increased social welfare.

The reduction in value-added tax evasion rate increases the welfare of the household sector in two ways: One is that the reduction in value-added tax evasion rate increases the tax revenue and therefore lightens the tax burden of household and increases disposable income for consumption. The other is that the reduction in value-added tax evasion rate decreases the differences in effective tax rate across the industries and the distortion of resource allocation.

<Table 6> Income distribution Effect of Reduction in Value-added Tax evasion Rate

	Benchmark Equilibrium	Comparative Equilibrium					
		Case Ⅰ			Case Ⅱ		
		30% reduction	50% reduction	100% reduction	30% reduction	50% reduction	100% reduction
Gini Index	0.27858	0.27870	0.27879	0.27899	0.27863	0.27849	0.27813
Deciles Distribution Ratio	60.05	60.02	60.00	59.95	60.06	60.08	60.18

In case Ⅱ, the increased tax revenue due to the reduction in value-added tax evasion rate is distributed to households by the same amount.

As shown in <table 6>, the reduction in value-added tax evasion rate deteriorates the income distributions in case Ⅰ and improves them in case Ⅱ. This result comes from the opposite effect of increased tax revenue disposition on the income distribution. However it is noteworthy that the absolute magnitude of income distribution effect is not significant. Changes in both Gini Indices and Deciles Distribution indices for two cases are quit similar. This tells us that the economic effect of the reduction in value-added tax evasion rate is more meaningful in efficiency aspect rather than in the equity aspect.

(2) Economic Effect of Reduction in the Personal Income Tax evasion Rate

30% reduction in the personal income tax evasion rate increases the tax revenue by 758.4 billion won, 8.4% of total value-added tax revenue 8.97 trillion won. 50%, 100% reduction in the personal income tax evasion rate increases the personal income tax revenue by 1.26 trillion won, 2.53 trillion won respectively. The increased tax revenue effect of the reduction in the personal income tax evasion rate is bigger either in the absolute size or in the gravity.

<Table 7> Economic Effect of Reduction in Personal Income Tax evasion Rate

Reduction of Personal Income Tax evasion Rate	Increased tax Revenue (100 million won)	Increased tax revenue over total personal income tax revenue (%)	Compensation Variation (100million won)	
			Case Ⅰ	Case Ⅱ
30%	7,584.12	(8.4%)	3,028.68	3,104.12
50%	12,640.2	(14.1%)	3,052.82	3,194.01
100%	25,280.3	(28.2%)	3,113.31	3,418.81

(2) The size of increased tax revenue is quite close in both cases. We show the result of case 1.

The reduction in personal income tax evasion rate increases the social welfare, similar to the value-added tax case. There is not much differences in the size of the increased social welfare, depending on the redistribution method(case Ⅰ and case Ⅱ). For example, 30%, 50%, 100% reduction in the personal income tax evasion rate increases the total social welfare by 303 billion won, 305 billion won, and 311 billion won respectively.

Contrary to the value-added tax case, in the personal income tax case, the increase social welfare effect of the deduction in the tax evasion rate does not differ depending on the size of deduction rate. However the compensation variation size across the income classes differs depending on the size of deduction rate. The bigger the deduction rate is, the bigger the decreased welfare size of upper income class and the increased welfare size of lower income class.

The increased welfare effect of personal income tax is smaller than that of value-added tax. When the tax evasion rates are reduced by 100%, 50%, and 30% respectively, the increased welfare effects of personal income tax are only 30.7%, 45.3%, and 57.3% of that of value-added tax. This means that the deduction in value-added tax evasion rate has only an income effect due to the increased tax revenue, while the deduction in personal income tax evasion rate has not only income effect due to the increased tax revenue, but also a price effect of correcting price system distortion. So, in terms of efficiency the deduction in the value-added tax rate is more important than the personal income tax rate.

<Table 8> Income Distribution Effect of Reduction in Value-added Tax evasion Rate

	Benchmark Equilibrium	Comparative Equilibrium					
		Case Ⅰ			Case Ⅱ		
		30% reduction	50% reduction	100% reduction	30% reduction	50% reduction	100% reduction
Gini Index	0.27858	0.27817	0.27789	0.27720	0.27730	0.27626	0.27368
Deciles Distribution Ratio	60.05	60.18	60.26	60.47	60.41	60.70	61.42

As shows in <Table 8>, reduction in personal income tax evasion rate improves income distribution in both cases. This means that the personal income tax evasion rate is higher in upper income classes than in lower income classes, and that reduction in personal income tax evasion rate implies redistribution of income from the upper income classes to the lower income classes. The bigger income redistribution effect in case Ⅱ relative to case Ⅰ is attributable to the income redistribution effect of increased tax revenue. This tells us that the economic effect of a reduction in the personal income tax evasion rate is more meaningful in terms of equity rather than in terms of efficiency.

3. Estimation of the Elasticity of Substitution between value-added tax disclosure rate and statutory rate

(1) Equal Real Tax Revenue Constraint

Strengthening the tax administration system can increase the tax evasion disclosure rate and therefore increase the tax base and lower the tax rate itself. It also reduces the size of **tax distortions of resource allocation** and furthermore the tax burden of national economy. This is the key point to harmonize the tax administration system and tax system. What is important is how much statutory tax rate can be reduced, when the tax evasion disclosure rate is increased by 1%. As shown, this depends on the elasticity of substitution between value-added tax disclosure rate and statutory tax rate. If the tax evasion- disclosure rate increases, the price vector in a new equilibrium will differ from that in the benchmark equilibrium, and the equal tax revenue constraint should change as follows:

$$R^N = R^0 \frac{\sum_{m=1}^{10} P_m^N x_m(P^0)}{\sum_{m=1}^{10} P_m^0 x_m(P^0)}$$

Here superscript N represents the new equilibrium and superscript 0 the benchmark equilibrium. As such, R^0 represents tax revenue under the benchmark equilibrium, while R^N represents tax revenue under the new equilibrium. The second term in the above equation is the Laspeyres price index. P^N and P^0 represent price vectors under the new and benchmark equilibrium respectively. x_m is the consumption of consumer good *m*. Our task is to find the new tax rate satisfying the equal real tax revenue constraint, and to estimate the elasticity of substitution between value-added tax disclosure rate and statutory tax rate.

(2) Substitution Elasticity between Value-added Tax disclosure Rate and Statutory Tax Rate

According to <Table 9>, when the value-added tax evasion rates are reduced by 100%, 50%, and 30% respectively, it is possible to lower the current statutory 10% value-added tax rate by 0.797%, 1.031%, and 1.568%. For these three cases, the elasticities of substitution between value-added tax disclosure rate and statutory tax rate are 0.6325, 0.2062, and 0.1568 respectively. **This means that the effect of increased tax evasion disclosure rate is negatively related to the tax- disclosure rate itself. The deduction in the value-added tax rate turns out to increase economic welfare. CV reaches 880 billion won for a 0.797% deduction in the value-added tax rate (30% deduction in the value-added tax evasion rate). Unlike the value-added tax case, the elasticity of substitution for personal income tax is somewhat stable.**

<Table 9> Substitution Elasticity between Value-added Tax disclosure Rate and Statutory Tax Rate

Deduction in value –added tax evasion (A)	Increased value-added tax revenue (B)	Portion of decreased value-added tax (C)	Decreased value-added tax rate (D)	Substitution Elasticity (B/C)
30%	12.6%	7.97%	9.0213%	0.6325
50%	50.0%	10.31%	8.0700%	0.2062
100%	100.0%	15.68%	7.4320%	0.1568

(3) The Elasticity of Substitution between Personal Income Tax disclosure Rate and Statutory Tax Rate

According to the <Table 10>, when the personal income tax evasion rates are reduced by 100%, 50%, and 30% respectively, it is possible to lower the personal income tax rate by 10.19%, 14.75%, and 24.35% from the current level. For these 3 cases, the substitution elasticities between value-added tax disclosure rate and statutory tax rate are 0.6325, 0.2062, 0.1568 respectively. **This**

means that the effect of increased tax evasion disclosure rate is negatively related to the tax-disclosure rate itself. The deduction in the value-added tax rate turns out to increase economic welfare. CV reaches 880 billion won for a 0.797% deduction in the value-added tax rate (30% deduction in the value-added tax evasion rate). Unlike the value-added tax case, the elasticity of substitution for personal income tax is somewhat stable.

<Table 10> Substitution Elasticity between Personal Income Tax disclosure Rate and Statutory Tax Rate

Deduction in personal income tax evasion (A)	Increased Personal Income tax revenue (B)	Portion of Increased personal income tax (C)	Substitution Elasticity (B/C)
30%	35.2%	10.19%	0.2894
50%	50.0%	14.75%	0.2950
100%	100.0%	24.35%	0.2435

It is interesting to note that total welfare effect is not the largest when the personal income tax evasion is 100%. This is because the welfare effect differs for each income class. As the personal income tax evasion rate decreases, the size of the resulting welfare gain for the upper income class is smaller, while that for lower income class is bigger. As a whole, the welfare effect in the value-added tax case is larger than that in the case for personal income tax. So the direction of tax reform in Korea should begin with reducing the tax evasion rate by reinforcing the tax administration, and decreasing value-added tax.

Ⅵ. Conclusion

In this paper we developed the Korean Computable General Equilibrium Model (KOCGE Model) composed of 565 structural equations. We specifically model the tax evasion rate. Simulation experiments of various reform scenarios are carried out, and changes in social welfare are measured to help us identify the optimal tax reform plan for Korea. In particular, we undertake policy simulation to analyze the impact of a decrease in the tax evasion rate on economic welfare and income distribution. The first implication of our simulation is that a reduction in the tax evasion rate reached by reinforcing the tax administration process increases tax revenues and allows the Office of National Tax Administration to decrease the specific tax rate, thereby improving economic welfare. Our simulation results show that reduction in the value-added tax evasion rate has a more powerful economic welfare increasing effect than a deduction in the personal income tax evasion rate. A second implication is that tax authorities would not lose any tax revenues with a 9 per cent value-added tax rate (which is lower than the current 10 per cent) if the value-added tax evasion is reduced by 30 per cent. The results of our study suggests that the direction of tax reform in Korea should focus on reducing the tax evasion rate by reinforcing the tax administration, decreasing the value-added tax, and increasing the income tax.

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