Development of Web-Based CGE Model for Tax Policy Analysis

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4 July 2013

DEVELOPMENT OF WEB-BASED CGE MODEL FOR TAX POLICY ANALYSIS[1]

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ABSTRACT

The computable general equilibrium (CGE) model has played an important role on policy impact analysis. The main strength of CGE analysis is that it models the whole economy explicitly, capture the market mechanism, interlinking between sectors and transactions between economic agents despite being under restrictive assumptions. A clear microeconomic structure with links between micro and macro aspects of the economy makes it the soundest tool for quantitative policy analysis. The simulation results help analysts to understand the essential relationships relevant to particular policy and very useful to build a bridge between economists, policy makers and also stakeholders, and provide them with a base for dialogue.

Fiscal Policy Agency (*Badan Kebijakan Fiskal/BKF*) is a unit in the Indonesia Ministry of Finance that responsible in the fiscal policy formulation. The unit intensively uses the CGE model as a tool of analysis particularly in the ex-ante impact of tax policy analysis. There are typical tax policies such as increasing (reducing) the VAT rate, excise tax, or import tariff, imposing export tax, adjusting the corporate and personal income tax rate that need to be evaluated and present the impacts into the policy formulation process. The simulation results need to be delivered concisely and in the very informative ways so that the costs and the benefits of the proposed policy clear enough to be understood; unuseful and irrelevant information are eliminated. This study attempts to develop a web-based CGE model for these purposes. Basically using cloud computing approach, the simulation processes are hidden and running in the server; in the web interface are only provided the options for policy simulation and then the presentation of the impacts (in graph and excel) after concluding the simulations.

Keywords: computable general equilibrium, web-based interface, tax policy, impact analysis

[1] Paper presented at *the 23rd Pacific Conference of the Regional Science Association International (RSAI)* Bandung, Indonesia, 2-4 July 2013.

1. INTRODUCTION

The government uses tax system not only to collect revenue for financing the public spending but also to implement tax policy in order to achieve various objectives such as income redistribution, economic stabilisation, and fostering economic growth (Gemmell, 1988). Tax policy is defined as "all the decisions and main directions that determine the characteristics of a tax system and make it possible to finance public spending and support economic activity" (Cliche, 2012). In the literature, there are a huge resources on study of tax system as a tool of government policy to stimulate the economy; some of them are: Mirrlees (1971), Feldstein (1973), Sandmo (1976), Samuelson (1986), Easterly & Rebelo (1993), Stokey & Rebelo (1995), Engen & Skinner (1996), Auerbach (1996), Lee & Gordon (2005), and Abdurohman & Resosudarmo (2012).

Tax system varies amongst countries, it depends on many factors such as economic environtment and political outlook (Gemmell, 1988). In the history of Indonesian tax system, the government has been reforming their tax system several times (Brondolo et al., 2008), at least there are four milestones: 1984, 1994, 2004, and 2008. Tax reform is a process to adjust the tax system as a policy instrument to achieve the government objectives. In the milestones of 1984 and 1994, the main objectives of the tax reform were improving it capacity to fulfill the government revenue by adopting self assessment system and modernization of tax administration. As a result, tax revenue increased from only Rp2.5 trillions (5.0% of GDP) at 1980/1981 to about Rp347.0 trilions (12.5% of GDP) at 2005 (see Table 1). Another driver of raising revenue from taxes was the government could not rely on oil revenue anymore since 1990s (Ikhsan et al., 2005).

Following by the period that the government uses tax system not only for raising government revenue but also as an instrument of government policy. As shown at Table 1 that even though the nominal tax revenue increases from Rp347.0 trillions at 2005 to Rp1,178.9 trillions at 2013 but the numbers, in term of percentage of GDP, are relatively stable at about 12%. The milestone of the reform was started by initiated a dedicated institution on fiscal policy formulation (Badan Kebijakan Fiscal/BKF or Fiscal Policy Agency/FPA) under the authority of Ministry of Finance at 2006. On policy formulation process, this unit intensively uses the economic models in the framework of statistical and mathematical approaches to support their analysis. The major mathematical model is computable general equilibrium (CGE) model.

TABLE 1: The government revenue from taxes

	80/81	85/86	90/91	95/96	2000	2005	2010	2011	2012	2013
					(Rp trilions)					
Total revenue and grants	9.1	18.7	31.6	66.3	152.9	495.2	995.3	1,210.6	1,358.2	1,507.7
Non tax revenue and grants	6.6	11.9	13.3	21.2	51.5	148.2	272.0	336.7	342.0	328.8
Tax revenue	2.5	6.8	18.2	45.0	101.4	347.0	723.3	873.9	1,016.2	1,178.9
Domestic taxes	1.8	6.0	16.2	41.4	95.5	331.8	694.4	819.6	968.3	1,120.7
Income tax	0.9	3.1	6.5	19.2	54.2	175.5	357.0	431.1	513.7	574.3
VAT and luxury sales tax	0.4	1.7	6.8	16.7	27.0	101.3	230.6	277.8	336.1	423.7
Land and building tax	0.1	0.2	0.6	1.9	2.4	19.6	36.6	29.9	29.7	27.3
Excise	0.4	1.0	1.9	3.3	10.3	33.3	66.2	77.0	83.3	89.0
Other taxes	0.0	0.1	0.3	0.3	1.1	2.1	4.0	3.9	5.6	6.3
International trade taxes	0.7	0.8	2.1	3.6	5.9	15.2	28.9	54.1	47.9	58.2
Surplus/Deficit	-1.2	-2.7	-4.6	-1.0	-44.1	-14.4	-46.8	-84.4	-190.1	-150.1
					(% of GDP)					
Total revenue and grants	18.5	19.3	15.0	14.6	14.7	17.9	15.5	16.3	15.9	16.3
Non tax revenue and grants	13.5	12.3	6.3	4.7	4.9	5.3	4.2	4.5	4.0	3.5
Tax revenue	5.0	7.0	8.7	9.9	9.7	12.5	11.2	11.8	11.9	12.7
Domestic taxes	3.6	6.2	7.7	9.1	9.2	12.0	10.8	11.0	11.3	12.1
Income tax	1.9	3.2	3.1	4.2	5.2	6.3	5.5	5.8	6.0	6.2
VAT and luxury sales tax	0.8	1.7	3.2	3.7	2.6	3.7	3.6	3.7	3.9	4.6
Land and building tax	0.2	0.2	0.3	0.4	0.2	0.7	0.6	0.4	0.3	0.3
Excise	0.7	1.0	0.9	0.7	1.0	1.2	1.0	1.0	1.0	1.0
Other taxes	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
International trade taxes	1.4	0.8	1.0	0.8	0.6	0.5	0.4	0.7	0.6	0.6
Surplus/Deficit	-2.4	-2.7	-2.2	-0.2	-4.2	-0.5	-0.7	-1.1	-2.2	-1.6
Memorandum items:										
GDP Nominal (Rp trilions)	48.9	97.0	210.9	454.5	1,042.3	2,774.3	6,436.3	7,427.1	8,542.6	9,269.5
Annual GDP growth (%)	8.7	3.5	9.0	8.4	4.9	5.7	6.2	6.5	6.5	6.8

Sources: Ministry of Finance RI (various years)

Note: From 1980 to 1999 the period of state budget was 1 April to 31 March, from 2000 onwards; it has been 1 January-31 December. For 2000 it was only nine months (1 April 2000-31 December 2000). 2012: APBN-P; 2013 APBN

The CGE model has several advantages on ex-ante impact of policy analysis such as in the analysis of the impact on tax policies. There are typical tax policies that frequently need to be assessed such as increasing (reducing) the VAT rate, excise tax, or import tariff, imposing export tax, adjusting the corporate and personal income tax rate. The CGE model plays a significant role on the impact analysis of tax policies; not only because it developed based on solid theoretical background in both micro –and macro economics but also presented a comprehensive simulation results such as the impact on the macro economy (growth, inflation, employment, etc.), industrial sectors (in term of output and price), international trade (export – import in term of output and price), fiscal (in both revenue and expenditure side), and in the household level such as the changes in household income and

consumption. Basically, a CGE model tries to model whole economy by incorporate all behavioral aspects of economic agents in all markets, commodities and factors (Burfisher, 2011). In sum, CGE model is the soundest tool for quantitative policy analysis to help analysts to understand the essential relationships relevant to particular policy.

Using CGE model that incorporated the huge of data and determined in many equations and variables, some times make it difficult to interpret the simulation results and communicate the analysis to the policy maker. Therefore there is a need of such innovation to make it more simple and easy to comprehend. This study develops the web-based CGE model in order to bridge the complexity of analysis using CGE model to the policy maker; make it clear, faster and easy to be understood.

The paper proceeds as follows. Section 2 describes the data used and the features of the CGE model. Following that is a description of the development of web based interface, the presentation of the simulation results in section 4 and the conclusion in section 5.

2. DESCRIPTION OF THE CGE MODEL: DATA USED AND FEATURES

2.1. Description of the Data

The database of the CGE model is consolidated from three key data sources: (a) the 2008 Indonesian IO Table; (b) the 2008 Indonesian Social Accounting Matrix; and (c) the 2008 National Socioeconomic Survey. All the data were published by BPS-Statistics Indonesia. There are two main steps to consolidate the three data sources into the final model database. First step is expanding household category in the 2008 SAM and the 2008 IO table using the information from Susenas 2008. Second step is combining and compiling the extended 2008 IO Table with the extended 2008 SAM to have all the features of the model database.

The 2008 Indonesian SAM is a single output type industry, one industry produce one commodity. The production sectors are classified into 66 sectors. Furthermore, there are four margins (trade and various transportation costs), two sources (domestic and import), two primary factors (16 types of labour and one capital), and 200 household classifications to represent percentile income distribution in rural and urban areas.

2.2. Description of the CGE model features

The CGE model used in the web-based platform is modified from INDOFISCAL (Amir, 2011; Amir et al., 2013) and updated with the most current data. Aspects of the model were

based on ORANI-G (Horridge, 2003) and the Applied General Equilibrium Model for Fiscal Policy Analysis (AGEFIS) developed by Yusuf et al. (2008). This model adopted AGEFIS to incorporate useful information from the 2008 Indonesian SAM, especially the part regarding transactions between agents in the economy. AGEFIS is the first fully SAM-based CGE model of the Indonesian economy with a focus on fiscal policy analysis. SAM-based CGE models provide better information, particularly if the focus is on the analysis of fiscal policy, which requires more detailed information about the flow of transactions from government revenue and expenditures, as well as households.

The theoretical structure of the model is based on the Johansen approach, in which the equations are linearised using percentage changes instead of the levels of variables. This is also the approach used by most Australian CGE models such as ORANI (P.B. Dixon et al., 1982) and MONASH (Peter B. Dixon & Rimmer, 2002). In terms of extending the household categories to have adequate features on poverty and income distribution analysis, this study adopted the approach from Yusuf (2007).

The structure of production follows the approach in models such as ORANI-G (Horridge, 2003), or WAYANG (Wittwer, 1999). The industries in the model are single output industries, using as inputs domestic and imported commodities, primary factors and other costs. The primary factors of production include capital and 16 labour types as mentioned earlier. Output is produced through a three-level process. In the top level, the production of output in each industry requires intermediate inputs, primary factors and other costs. Other costs represents to all production taxes/subsidies and payroll taxes. All of these inputs are combined via a fixed-proportion relationship of a Leontief function to produce outputs following the principle in the developing of Input-Output Table.

In the lower level of the production structure, there are two nests: import/domestic composition of intermediate inputs and primary factor proportions. Firstly, the intermediate input demands for each producer follows the cost minimisation function through an imperfect substitution of domestic and imported goods using Armington assumption (Armington, 1969). To minimise the costs, the producers choose to purchase the materials from domestic or import whichever give the cheaper price. Secondly, the cost of the demand for primary factors is minimised using the CES function. Similar to the procedure in the intermediate demands, the producers would substitute the more expensive input (capital or labour composite) with the one is cheaper. In the lowest level, the cost of the labour composite demand is minimised using a similar CES function to combine the 16 labour types of inputs.

The lowest cost labour types will substitute the more expensive of labour types in order to minimise the total cost of labour usage.

The structure of the final demand for investment by industries is very similar to those in the structure of production except there is no requirement for primary factors and other costs. Capital is assumed to be produced with inputs from domestic and imported commodities. The investment demand is derived from a two-part cost-minimisation problem. At the bottom level, the total cost of domestic and imported commodities is minimised subject to the CES production function. While at the top level, the total cost of commodity composites is minimised subject to the Leontief production function. The total amount of investment in each industry is exogenous to the above cost-minimisation problem. It is determined by other equations.

The structure of the final demand for household follows utility maximization function. There are 200 representative household categories in the economy, each household maximises its utility by choosing the commodities to be consumed subject to the budget constraint. The nesting structure for household demand is nearly identical to that for investment demand. The only difference is that commodity composites are aggregated by a Klein-Rubin utility function, rather than a Leontief function leading to a linear expenditure system (LES). The equations for the lower import/domestic nest are similar to the corresponding equations for intermediate and investment demands. The allocation of household expenditure between commodity composites is derived from the Klein-Rubin utility function (Horridge, 2003) where there are two kinds of demand: ‘subsistence demand’ for the requirement of each good that are not considering price and ‘luxury demand’ for the share of the remaining household expenditure allocated to each commodity. The household utility function only determines the composition of commodities demanded by the households to maximise their utility. The total of household consumption in an economy is generated by the total household disposable income or household income minus the level of income tax (PIT rate) subjected to the income. More detail of the household income equations will be discussed in the section of institutions in the economy.

The structure of final demand for export is divided into two groups: individual and collective exports. For an individual export commodity, foreign demand is inversely related to that commodity's price. For the remaining, collective export commodities, foreign demand is inversely related to the average price of all collective export commodities.

There are four institutions in the model: households, corporate, government, and rest

of the world. Households as a source of factors of production will have income from the ownership of factors of production. Household income can also be derived from transfers received from governments, corporations, overseas and from other households. Households' income after tax deduction is equal to disposable income, and taxes are a percentage of household income based on the marginal income tax rate structure. Part of disposable income will be spent and the rest will be saved.

Corporate income consists of the revenue from its ownership of production factors minus corporate income tax, and transfer from other institutions. While corporate spending goes to payment or transfer to other institutions. The balance can be defined as corporate saving.

Total government revenue can be described as the sum of receipts from various sources as the following: (i) indirect taxes; (ii) revenue from export tax on each commodity; (iii) revenue from import tariff on each commodity; (iv) personal income tax (PIT) revenue; (v) corporate income tax (CIT) revenue; (vi) transfers from foreign parties; and (vii) revenue from government-owned production factors. Government expenditure consists of expenditure on goods and services for each commodity, and expenditure for the transfer to domestic and foreign parties. Other expenditures made by the government are in the form of subsidies on commodity goods and for industries. Finally, the government revenue minus the government expenditure is defined as the government budget balance (surplus).

In the Rest of the World (ROW), foreign income is defined as revenue of the rest of the world from ownership of production factors, payment received from imported commodities and transfer from other institutions. Foreign expenditure consists of spending for exported commodities, payment to production factors and transfer to other institutions. The balance is defined as foreign saving.

The model has several closures. In the short-run, we assume that there is not enough time for the capital stock to adjust and that there is no new investment. Capital is sector-specific, that is, it is fixed for each industry and cannot move between sectors. The capital rate of return adjusts to reflect the changes in the demand of capital. The short-run closure also assumes that this time frame is not long enough for contractual labour to adjust. Hence the wage rate is fixed. This means that aggregate employment can change to respond to changes in the labour market. On the other hand, in the long run closure, the labour wage rate is fully flexible to keep the economy in the full-employment condition. Labour can move across sectors and different types of occupations. In addition, the capital stock is

allowed to change and move across sectors. The capital rate of return at the national level is fixed but in the sectoral level it may change or be positively correlated with sectoral capital growth. Variables that are assigned as exogenous in the short-run and long-run simulations are tax rates, imports, transfers between institutions and all technological changes.

In the policy applications, we run the simulations under two different conditions: under balanced-budget condition for long-run scenario and under non-balanced budget condition for short-run scenario. Under the non-balanced budget condition, the tax rate reduction policies will increase the government's budget deficit for the current year. To close the increment in the budget deficit, the government must seek additional budget financing which is usually from issuing government bonds or from incurring domestic or foreign debt. As a result, the government will bear the burden of repayment in the subsequent years. However, under the balanced budget condition, the potential additional burden on the government's budget can be avoided by reducing the level of spending.

3. DEVELOPMENT OF WEB BASED INTERFACE

A web based application is basically an application or a software package that can be accessed through the web browser, internet or intranet. Simply, it means that we can work with this application every time and every where. The recent life with advanced information technology, the use of web based application become more popular. The modern institutions, private and public, uses what we call it '*cloud computing*' on planning and managing the resources on their operations.

The development process of Web Based CGE Model adopts System Development Life Cycle (SDLC) method and supported by several software such as GEMPACK, SAS, Visual Studio, and Microsoft Office. The method has four steps as illustrated at Figure 1: Planning & Analysis, Design, Implementation, and Testing.

In the first step (Planning & Analysis), we define the objective of model development, the CGE model that will be used in the application, the types of policy simulations, and the information of the simulation results. As already discussed, the objective is to have the tool for ex-ante impact analysis of typical tax and other fiscal policies. The CGE model chosen is INDOFISCAL that developed by Amir (2011) because it already has accommodated the need of BKF.

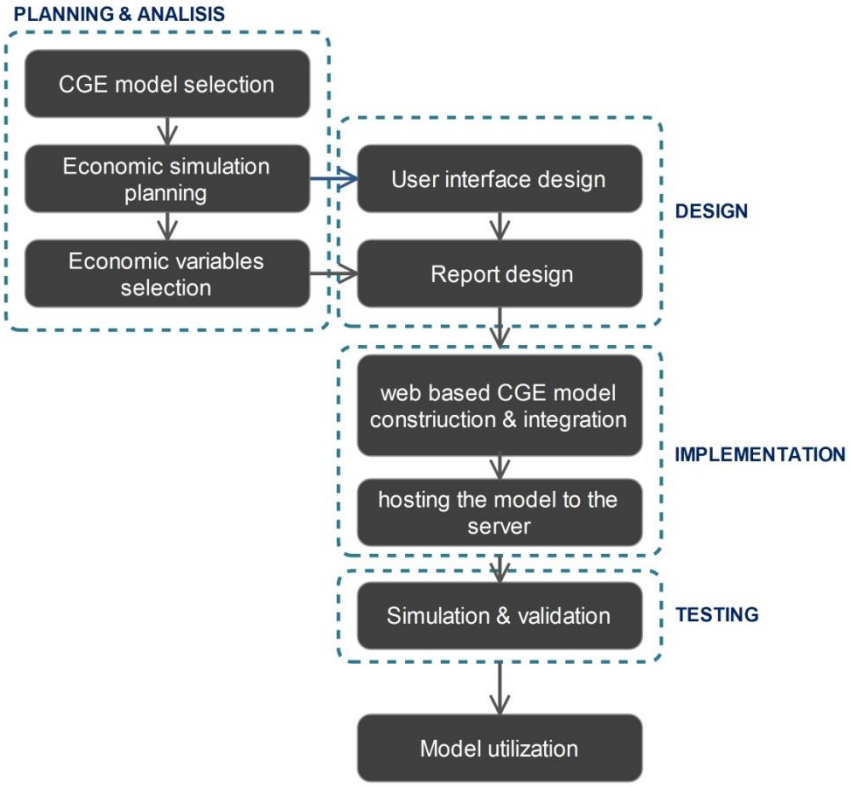
In the second step (Design), we design the features of input such as the option of type of simulations, how to set the magnitude of shock, etc. Then we also design the output of

simulation results (impacts) that classified into five categories: macro, industrial, fiscal, export-import, and household. All simulation results are presented in both graph and number (can be downloaded as MS Excell file).

In the third step (Implementation), we construct and integrate Web-Based CGE Model based on the design. This step is time consuming to make script and code on ASP program and integrate with other software and database. When the model ready, then it installs in the server.

In the forth step (Testing), we test to run the model with various policy scenarios. The testing procedure must be done to assure that the model can work properly without an error. We also compare the result with the similar model and scenarios that run without the web based application.

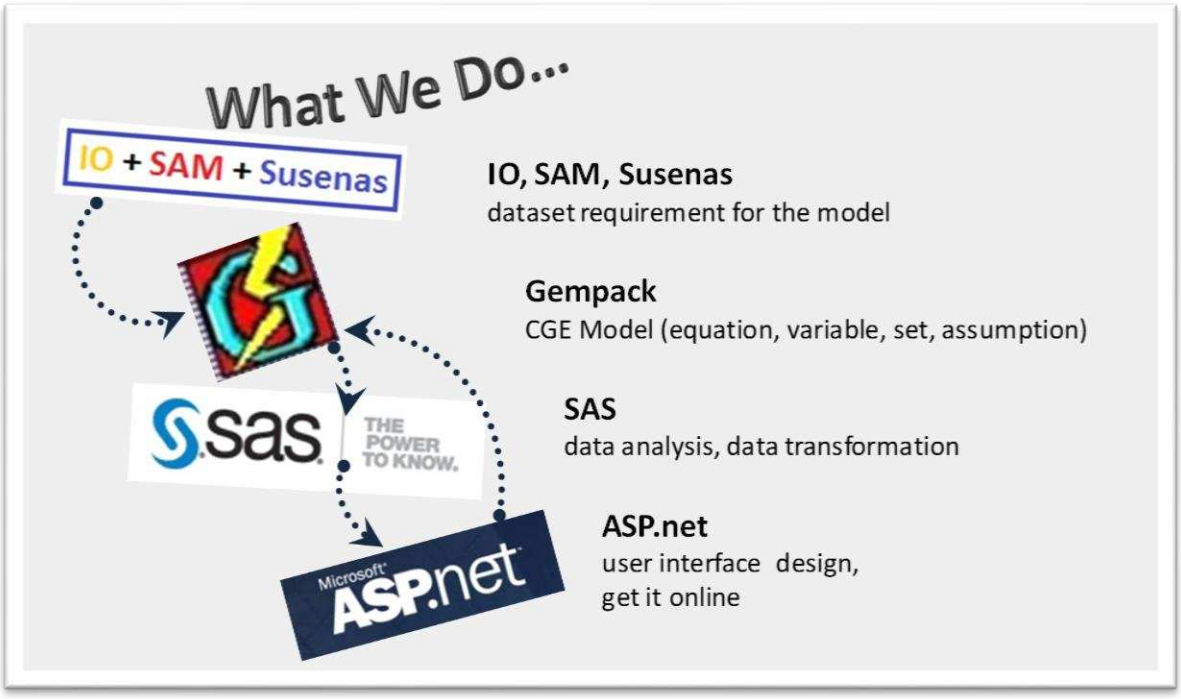
FIGURE 1: The development process of Web Based CGE Model



In brief, the development process of Web-based CGE Model can be illustrated as follows:

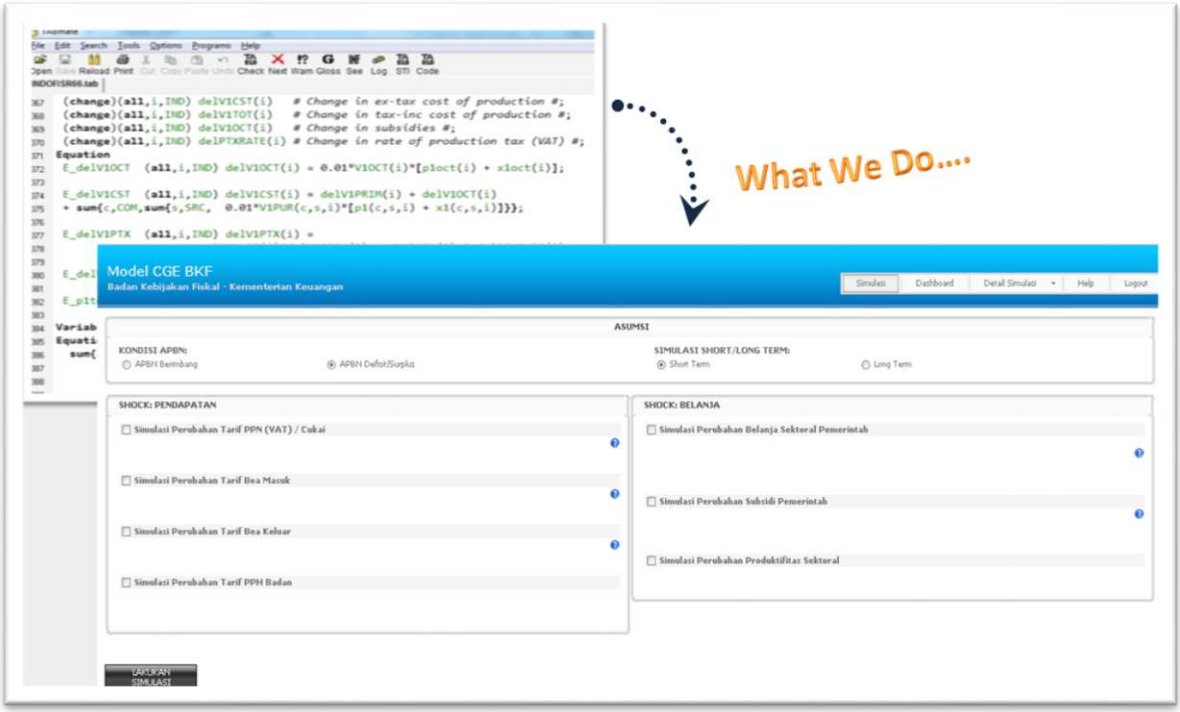
1). Integrate of huge database that consolidated from IO Table, SAM, and Susenas with the programming language of Gempack Software, create data management and transformation using SAS Software so the data can be read by Micorsoft ASP.net software and then present it in the online system (Figure 2).

FIGURE 2: The integration of database and various software



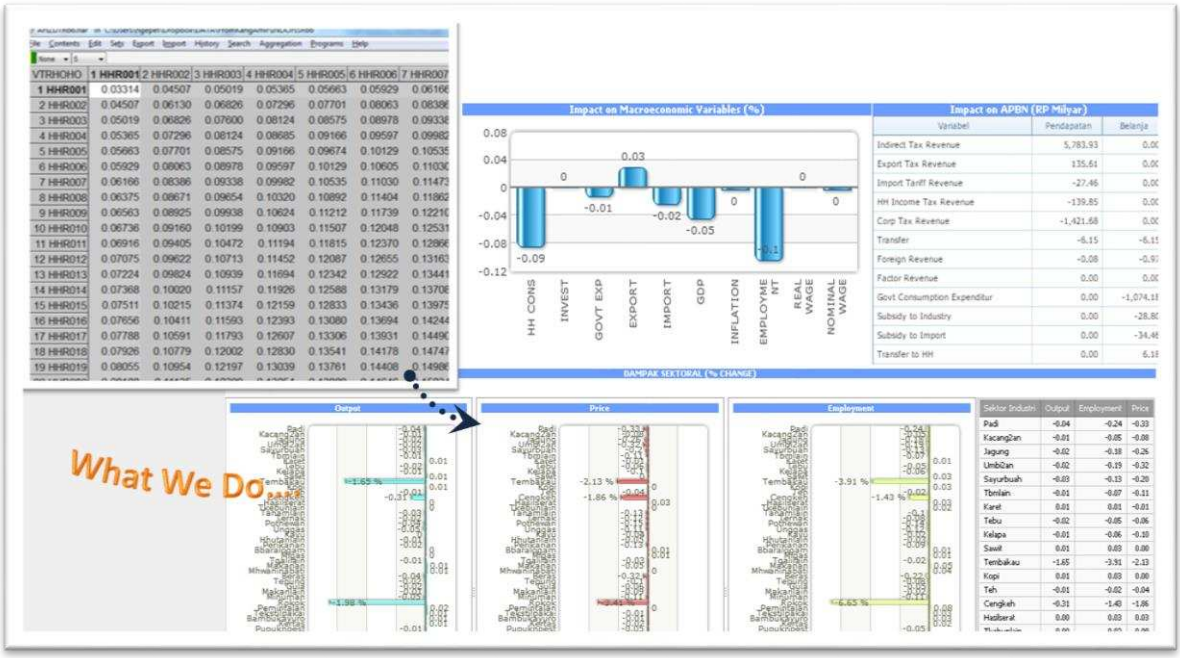
2). Transform the command for policy simulation, from 'complicated' Tablo language of Gempack Software into a simple and user friendly options in the desktop (Figure 3).

FIGURE 3: The transformation of Tablo language into simulation options



3). Transform and select the relevant information of the simulation results from Gempack file into the desktop. The simulation results are presented in the form of graphs, tables and number that can be downloaded into MS Excell file.

FIGURE 4: The transformation of simulation results into graph/table



4. PRESENTATION OF THE SIMULATION RESULTS

The presentation of simulation results are designed to give only relevant information for analysis of the policy impacts in such way that clear, simple, and easy to follow. As already mention, the relevant information of simulation results are visualized in the form of graphs and tables. The simulation results are classified into five categories: macro, industrial, fiscal, export-import, and household impacts.

After running simulation, the desktop will promp a dashboard or summary of simulation results as shown at Figure 5 that contains the presentation of the impact of macroeconomic variables, fiscal, export-import of commodities (top 5 and bottom 5), industrial in output and employment (top 5 and bottom 5), and also the pattern of household consumption changes.

The desktop also provides more detail simulation results that presented in each categories. Figure 6-10 illustrate the presentation of simulation results of the impact on macroeconomic variables, industrial, export-import, fiscal, and household consumption

respectively. These results were generated by the web based CGE model on simulation of increasing excise rate of cigarette by 20%.

FIGURE 5: The dashboard/summary of simulation results

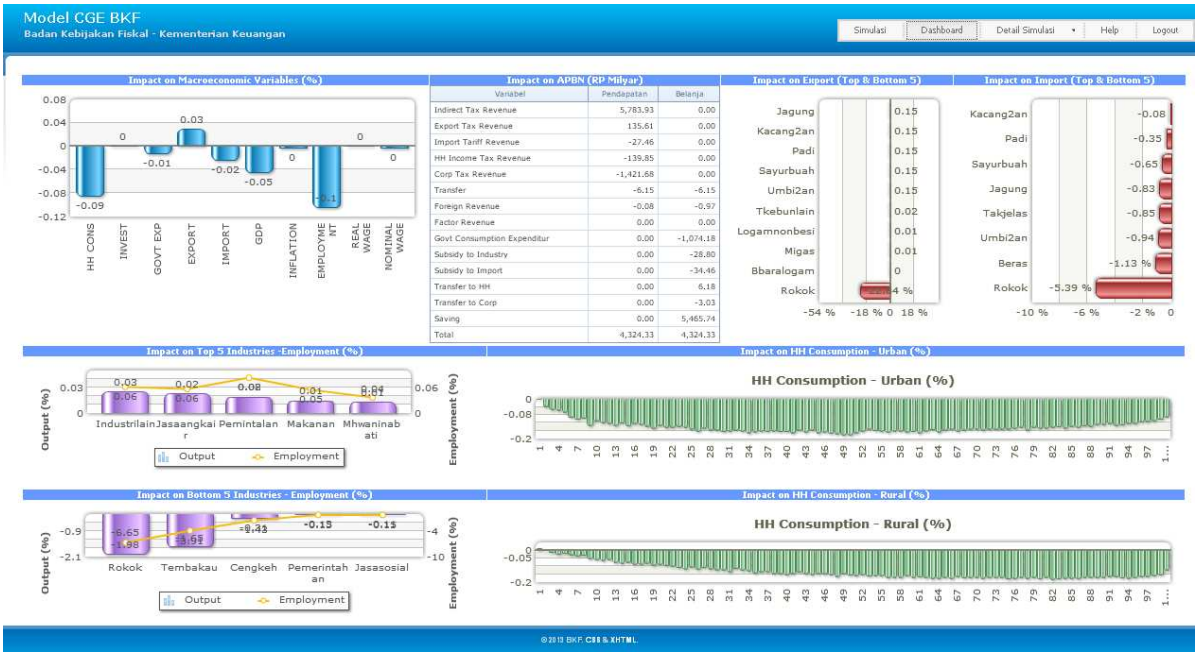


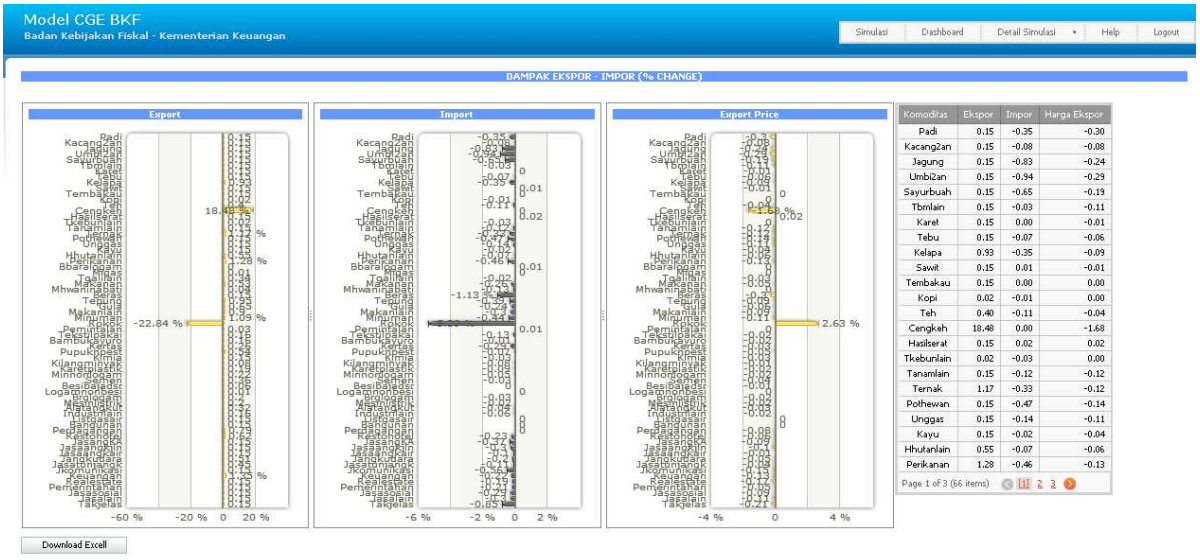
FIGURE 6: The presentation of macro impacts

FIGURE 7: The presentation of industrial impacts

Sektor Industri	Output	Employment	Price
Padi	-0.04	-0.24	-0.33
Kacang2an	-0.01	-0.05	-0.08
Jagung	-0.02	-0.18	-0.26
Umbi2an	-0.02	-0.19	-0.32
Sayurbuah	-0.03	-0.13	-0.20
Tbmlain	-0.01	-0.07	-0.11
Karet	0.01	0.01	-0.01
Tebu	-0.02	-0.05	-0.06
Kelapa	-0.01	-0.06	-0.10
Sawit	0.01	0.03	0.00
Tembakau	-1.65	-3.91	-2.13
Kopi	0.01	0.03	0.00
Teh	-0.01	-0.02	-0.04
Cengkeh	-0.31	-1.43	-1.86
Hasilserat	0.00	0.03	0.03
Tkebunlain	0.00	0.02	0.00
Tanamlain	-0.03	-0.10	-0.13
Ternak	-0.02	-0.08	-0.12
Pothewan	-0.04	-0.14	-0.15
Unggas	-0.05	-0.12	-0.11
Kayu	0.00	-0.02	-0.04
Hhutanlain	-0.01	-0.03	-0.05
Perikanan	-0.02	-0.09	-0.13

Page 1 of 3 (66 items) 1 2 3

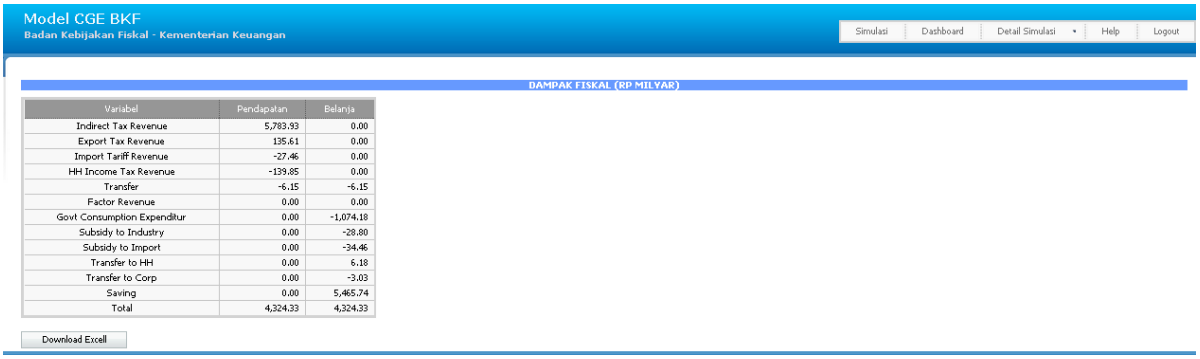
FIGURE 8: The presentation of export-import impacts



Komoditas	Ekspor	Impor	Harga Ekspor
Padi	0.15	-0.35	-0.30
Kacang2an	0.15	-0.08	-0.08
Jagung	0.15	-0.83	-0.24
Umbi2an	0.15	-0.94	-0.29
Sayurbuah	0.15	-0.65	-0.19
Tbmlain	0.15	-0.03	-0.11
Karet	0.15	0.00	-0.01
Tebu	0.15	-0.07	-0.06
Kelapa	0.93	-0.35	-0.09
Sawit	0.15	0.01	-0.01
Tembakau	0.15	0.00	0.00
Kopi	0.02	-0.01	0.00
Teh	0.40	-0.11	-0.04
Cengkeh	18.48	0.00	-1.68
Hasilserat	0.15	0.02	0.02
Tkebunlain	0.02	-0.03	0.00
Tanamlain	0.15	-0.12	-0.12
Ternak	1.17	-0.33	-0.12
Pothewan	0.15	-0.47	-0.14
Unggas	0.15	-0.14	-0.11
Kayu	0.15	-0.02	-0.04
Hhutanlain	0.55	-0.07	-0.06
Perikanan	1.28	-0.46	-0.13

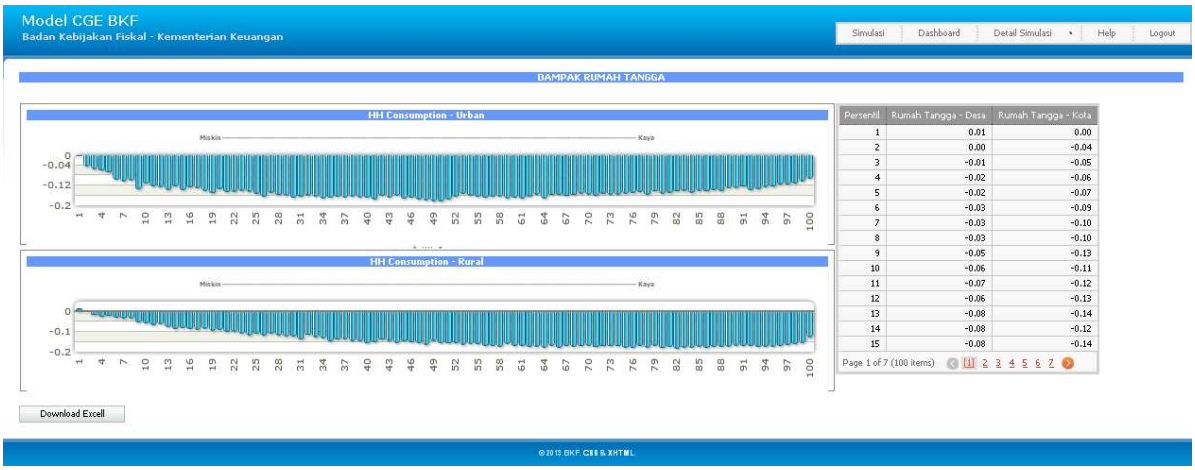
Page 1 of 3 (66 items) 1 2 3

FIGURE 9: The presentation of fiscal impacts



Variabel	Pendapatan	Belanja
Indirect Tax Revenue	5,783.93	0.00
Export Tax Revenue	135.61	0.00
Import Tariff Revenue	-27.46	0.00
HH Income Tax Revenue	-139.85	0.00
Transfer	-6.15	-6.15
Factor Revenue	0.00	0.00
Govt Consumption Expenditur	0.00	-1,074.18
Subsidy to Industry	0.00	-28.80
Subsidy to Import	0.00	-34.46
Transfer to HH	0.00	6.18
Transfer to Corp	0.00	-3.03
Saving	0.00	5,465.74
Total	4,324.33	4,324.33

FIGURE 10: The presentation of household impacts



5. CONCLUDING REMARKS AND FURTHER RESEARCH

The objective of the development of Web-Based CGE Model is to combine the advantages of CGE model as a tool analysis and web based application as a computable mobile interface. The Web-Based CGE Model is expected to improve the CGE modeling work with some features such as: (1) the complexity on doing policy simulations can be eliminated, (2) ready to run typical policy simulation with policy scenario options, (3) have generic and interesting visualization of simulation results, (4) can be accessed using mobile devices, and (5) plays better as a bridge of communication.

It is noteworthy that the economic model in general is only a tool to support discussion and analysis between experts, policy maker, and other stakeholders. In many cases, the results from the economic models itself only a small part of information that needed on policy making process. However, the accuracy and reliability of an economic model have to be improved periodically in parallel with the progress in the economic environment.

The developed Web-Based CGE Model still has possibilities to be upgraded in some areas of developments such as (1) disaggregate with more detail industrial or commodities classification, (2) set up with other models: dynamic or interregional CGE model, and (3) optimization of processing time on conducting policy simulation.

At last, the development of an economic model is a continuous process in accordance with the demands of the organization particularly for BKF as an institution at Indonesia Ministry of Finance that responsible on fiscal policy formulation. Therefore to ensure this process then the development process should be integrated with the learning process in the organization.

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