Effects of Transportation sector on Japanese industries: An evaluation by the CGE model

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Contents

List of tables and figures

ABSTRACT

Transportation sector in Iraq seems to develop dramatically as country tends to increase investments particularly in transportation infrastructure projects. This is likely to bring significant impact on macroeconomic indicators of the country. Thus, it is significant to analyze how this change will impact on overall economy of the country as well as to identify which particular industries or sectors are going to be affected by this change or economic factors. Both GTAP programsoftware, which is used for the analysis of global trade and CGE model that is used to estimate how an economy would react to changes in policy, technology or external factors are used in this study to determine relationships of various industries to each other. Shock was given to transportation sector and relevant changes or outcomes have been analyzed further in detailin Japanese case.

***Key words*:** Computable general equilibrium, Input-Output table, CGE model, GTAP, Simulation analysis

INTRODUCTION

One of the most possible methods to identifyeconomic relationships among the macro economic sectors and their mutual impacts to one another is analysis on Inter-industry balance tables in 1989, 2000, 2005 that describe the overall economy in a model. Both developed and developing countries are extensively using the research method known as Computable General Equilibrium model (CGE) which can specify economic relationships of the relevant entities such as enterprises, households, government, investors, importers and exporters in terms of mathematical terms and put them together in one complex systematical form.

It has been several hundred years since the establishment of this model, however, the model has been enhanced due to technological advancement and enable economists to do inter-industry analysis as well as analysis on economic relationships among various countries.One of the most suitable software programs that provide opportunity for global trade model to develop further is GEMPACK that analyzes global trade at international level. The extended version of this program known as GTAP has been used to do simulation analysis for this research. The paper consists of the following sections: literature review, theoretical review, and methodology and data analysis. Finally, the paper will summarize the key findings and suggest possible recommendations.

LITERATURE REVIEW

The first attempt in neoclassical economics to model prices for a whole economy was made by Leon Walras. Walras' Elements of Pure Economics provides a succession of models, each taking into account more aspects of a real economy (two commodities, many commodities, production, growth, money). Some (for example, Eatwell (1989), see also Jaffe (1953)) think Walras was unsuccessful and that the later models in this series are inconsistent. In particular, Walras's model was a long-run model in which prices of capital goods are the same whether they appear as inputs or outputs and in which the same rate of profits is earned in all lines of industry. This is inconsistent with the quantities of capital goods being taken as data. But when Walras introduced capital goods in his later models, he took their quantities as given, in arbitrary ratios. (In contrast, Kenneth Arrow and Gerard Debreu continued to take the initial quantities of capital goods as givens, but adopted a short run model in which the prices of capital goods vary with time and the own rate of interest varies across capital goods.)

The modern conception of general equilibrium is provided by a model developed jointly by Kenneth Arrow, Gerard Debreu and Lionel W. McKenzie in the 1950s. Gerard Debreu presents this model in Theory of Value (1959) as an axiomatic model, following the style of mathematics promoted by Bourbaki. In such an approach, the interpretation of the terms in the theory (e.g., goods, prices) is not fixed by the axioms. Three important interpretations of the terms of the theory have been often cited.

Some of the recent work in general equilibrium has in fact explored the implications of incomplete markets, which is to say an intertemporal economy with uncertainty, where there do not exist sufficiently detailed contracts that would allow agents to fully allocate their consumption and resources through time. While it has been shown that such economies will generally still have an equilibrium, the outcome may no longer be Pareto optimal. The basic intuition for this result is that if consumers lack adequate means to transfer their wealth from one time period to another and the future is risky, there is nothing to necessarily tie any price ratio down to the relevant marginal rate of substitution, which is the standard requirement for Pareto optimality. Under some conditions the economy may still be constrained Pareto optimal, meaning that a central authority limited to the same type and number of contracts as the individual agents may not be able to improve upon the outcome, what is needed is the introduction of a full set of possible contracts. Hence, one implication of the theory of incomplete markets is that inefficiency may be a result of underdeveloped financial institutions or credit constraints faced by some members of the public. Research still continues in this area.

Until the 1970s general equilibrium analysis remained theoretical. With advances in computing power and the development of input-output tables, it became possible to model national economies, or even the world economy, and attempts were made to solve for general equilibrium prices and quantities empirically.

Applied general equilibrium (AGE) models were pioneered by Herbert Scarf in 1967, and offered a method for solving the Arrow-Debreu General Equilibrium system in a numerical fashion. This was first implemented by John Shoven and John Whalley (students of Scarf at Yale) in 1972 and 1973 respectively. In fact, this was popular method up through the 1970s. In the 1980s however, AGE models faded from popularity due to their inability to provide a precise solution and its high cost of computation. Also, Scarf's method was proven non-computable to a precise solution by Velupillai (2006). (See AGE model article for the full references)

Computable general equilibrium (CGE) models surpassed and replaced AGE models in the mid 1980s, as the CGE model was able to provide relatively quick and large computable models for a whole economy, and was the preferred method of governments and the World Bank. CGE models are heavily used today, and while 'AGE' and 'CGE' is used inter-changeably in the literature, Scarf-type AGE models have not been constructed since the mid 1980s, and the CGE literature at current is not based on Arrow-Debreu and General Equilibrium Theory as discussed in this article. CGE models, and what is today referred to as AGE models, are based on static, simultaneously solved, macro balancing equations (from the standard Keynesian macro model), giving a precise and explicitly computable result (Mitra-Kahn 2008).

General equilibrium, which dates back to Leon Walras (1834-1910), is one of the crowning intellectual achievements of economics. It recognizes that there are many markets and that they interact in complex ways so that loosely speaking, everything depends on everything else. Demand for any one good depends on the prices of all other goods and on income. Income, in turn, depends on wages, profits, and rents, which depend on technology, factor supplies and production, the last of which, in its turn, depends on sales (i.e., demand). Prices depend on wages and profits and vice versa.

To make such an insight useful, economists have to be able to simplify it sufficiently to derive predictions and conclusions. Theorists typically do this by slashing the dimensionality, say to just two goods, two factors and two countries, and often focusing on just a few parts of the system. An alternative approach is to keep the complex structure but to simplify the characterization of economic behavior and solve the whole system numerically rather than algebraically. This is the approach of Computable General Equilibrium (CGE) modeling. CGE models specify all their economic relationships in mathematical terms and put them together in a form that allows the model to predict the change in variables such as prices, output and economic welfare resulting from a change in economic policies, given information about technology (the inputs required to produce a unit of output), policies and consumer preferences.

They do this by seeking prices at which supply equals demand in every market goods, factors, foreign exchange. One of the great strengths of CGE models is that they impose consistency of one's view of the world, e.g., that all exports are imported by another country, that the sum of sectors' employment does not exceed the labor force, or that all consumption be covered by production or imports. This consistency can often generate empirical insights that might otherwise be overlooked in complex policy analysis - such as the fact that import protection gives rise to an implicit tax on exports. A key component of GTAP is a CGE model known as the GTAP Model, which is briefly documented in the GTAP book (Hertel, 1997). Another component of this project is the GTAP Data Base which underlies the GTAP Model.

The mathematical relationships assumed in the GTAP model are generally rather simple, and although many markets are recognized, they still have to be very aggregated-particularly for global economic analysis. The GTAP Data Base underlying the GTAP model has 57 sectors (in version 6), so, for example, transport and communications services appear as a single industry. In principle all the relationships in a model could be estimated from detailed data on the economy over many years. In practice, however, their number and parameterization generally outweigh the data available. In the GTAP model, only the most important relationships have been econometrically estimated. These include the international trade elasticities (Hertel et al., 2005), and the agricultural factor supply and demand elasticities (OECD, 2001). The remaining economic relationships are based on literature reviews, with a healthy dose of theory and intuition. An important limitation of CGE models is that very few of them are tested as a whole against historical experience-although GTAP is one such (Valenzuela et al., 2007, Liu et al., 2004).

The standard GTAP model is amenable to modifications. Many of these modifications are documented in the GTAP Applications. CGE modeling is a very powerful tool, allowing economists to explore numerically a huge range of issues on which econometric estimation would be impossible; in particular to forecast the effects of future policy changes. The models have their limitations, however. First, CGE simulations are not unconditional predictions but rather thought experiments about what the world would be like if the policy change had been operative in the assumed circumstances and year. The real world will doubtless have changed by the time we get there.

Second, while CGE models are quantitative, they are not empirical in the sense of econometric modeling: they are basically theoretical, with limited possibilities for rigorous testing against experience. Third, conclusions about trade policy are very sensitive to the levels assumed for trade restrictions in the base data. One can readily do sensitivity analysis on the parameter values assumed for economic behavior, although less so on the data, because altering one element of the base data requires compensating changes elsewhere in order to keep the national accounts and social accounting matrix in balance. Of course, many of these criticisms apply to other types of economic modeling, and therefore, while imperfect, CGE models remain the preferred tool for analysis of global trade policy issues.

The following history of GTAP helps to provide an understanding of the core philosophy and motivation behind the project. The timeline and history of the GTAP Data Base are also very helpful in viewing GTAP's and the Center's development over the past decades.

Table 1: The timeline and history of the GTAP Data Base

GTAP	DATE	REGIONS	SECTORS	DATABASE
GTAP 1	1993	15	37	1990
GTAP 2	1994	24	37	1992
GTAP 3	1996	30	37	1992
GTAP 4	1998	45	50	1995
GTAP 5	2001	66	57	1997
GTAP 6	2005	87	57	2001
GTAP 7	2008	115	57	2004

RESEARCH METHOD

3.1. A General Equilibrium Model with the Government and the Foreign Sector

We have so far assumed that there are only two production sectors and the household, and we did not consider any other factors such as the government and the foreign sector. Thus, we can neither explore the effects of government activities such as taxation nor the foreign trade policy such as an import tax policy. Furthermore, we have assumed that there are no intermediate goods, and we have not been able to study the relationships between different industries with our existing model.

Now we expand our model by incorporating the following sectors:

1. Intermediate goods relationships. Both the fish and the potato production industries are allowed to use their goods of both industries in their production process.

2. The government activities: The government is assumed to impose a production tax on both industries, a direct tax on the household, and an import tax on import. The import tax on import can be interpreted as a tariff.

3. The foreign Sector. Import and Export of two goods (fish and potato) are both allowed. Investment into (out of) the home country is also allowed. Thus, the effect of FDI is also considered.

4. The Savings section: The savings are also taken into account. The savings consist of private savings, government savings, and foreign savings. If the amount of feign savings is negative (positive), then it means there is a surplus (debt) in the current account. The amount of foreign savings is given by ‘import – export’. For instance, if the amount of export is bigger than the amount of import, then there exits negative savings, implying a surplus in the current account in the foreign trade.

As you can easily imagine, the model will get more complicated by incorporating the above sections. In the conventional CGE model, we normally simplify the model by assuming that the model has a tree structure where each agent always makes his/her decision over two different components at different stages as follows:

The production of composite goods

It is assumed that each of the fish and the potato company produces their own composite goods by using factors by maximizing the following profit functions:

$$\max_{Y_i,K_i,L_i} \pi_i = p_i^Y Y_i(K_i, L_i) - rK_i - wL_i \tag{1}$$

$$s.t. \quad Y_i(K_i, L_i) = K_i^{\beta_{K,i}} L_i^{\beta_{L,i}}$$

The production technology is assumed to be given by the Cobb-Douglas one, and since we keep the zero-profit assumption, we have $\beta_{K,i} + \beta_{L,i} = 1$, $i = fish, potato$. Note that $Y_i$is neither fish nor potato, but it is a good which each industry (fish and potato) needs to produce to produce its final good, fish and potato. The profit maximization behavior yields the factor demand functions such that:

$$K_i = \frac{\beta_{K,i}}{r} p_i^Y Y_i, \quad L_i = \frac{\beta_{L,i}}{r} p_i^Y Y_i \tag{2}$$

and the composite production function is given by:

$$Y_i = K_i^{\beta_{K,i}} L_i^{\beta_{L,i}} \tag{3}$$

The production of domestic goods

It is assumed that companies (fish and potato companies) which produce domestic good (Z_i) use intermediate goods for their production and its own composite good. The profit maximization behavior is given by:

$$\max_{Z_i,Y_i,X_i} \pi_i = p_i^Z Z_i - \left(p_i^Y Y_i + \sum_j p_j^X X_{i,j}\right) \tag{4}$$

$$s.t. \quad Z_i = \min\left(\frac{X_{i,j}}{ax_{i,j}}, \frac{Y_{i,j}}{ay_{i,j}}\right)$$

-whereZ_i, $X_{i,j}$ are domestic goods produced by firm *i*, and final consumption goods of *j* used by firm *i*, respectively. $ax_{i,j}$denotes the amount of intermediate good, *j*, used for producing one unit of *i*, and $ay_{i,j}$ denotes the amount of its own composite good for producing one unit of its domestic good. Note that the production function at this stage is assumed to be the Leontief type. Using $ax_{i,j}$ and $ay_{i,j}$, and assuming that the market is fully competitive, we have the zero-profit condition such that

$$p_i^Z = p_i^Y ay_i + \sum_j p_j^X ax_{i,j} \tag{5}$$

Decomposition of domestic goods into exported goods and final domestic goods

The decomposition of Z_i ($i = fish, potato$), which has just been produced at the above step is assumed to follow the CES technology. Each firm is assumed to maximize the following profit:

$$\max_{Z_i,E_i,D_i} \pi_i = \left(p_i^e E_i + p_i^d D_i\right) - \left(1 + \pi_i^p\right) p_i^Z Z_i \tag{6}$$

$$s.t. \quad Z_i = \left(\kappa_i^e E_i^{\sigma_i} + \kappa_i^d D_i^{\sigma_i}\right)^{\frac{1}{\sigma_i}}$$

where p_i^e, p_i^d are the prices when the domestic goods are sold abroad, and the price when the domestic goods are sold domestically, respectively. Note that the export good price, p_i^e, is measured in domestic currency. π_i^p is a tax rate imposed on the production of Z_i. Note that this is a direct tax. κ_i^j ($i = fish, potato, j = e, d$) is the ratio between exported goods and final domestic goods, and it is assumed to have $\kappa_i^e + \kappa_i^d = 1$ ($i = fish, potato$). Note that if we denote the substitution elasticity in transformation between the exported goods and the domestic goods by φ_i, which is by definition given by:

$$\varphi_i = \left(\frac{d\left(\frac{E_i}{D_i}\right)}{\frac{E_i}{D_i}}\right) \Big/ \left(\frac{d\left(\frac{p_i^e}{p_i^d}\right)}{\frac{p_i^e}{p_i^d}}\right)$$

then, we have

$$\delta_i = (\varphi_i + 1)/\varphi_i \tag{7}$$

Thus, φ_i determines the curvature of the transformation technology at the given level of Z_i. The firm is assumed to decompose its domestic goods based on the CES transformation technology given by the above constraint. E_i, D_i are the amounts of decomposed goods into the exported goods and final domestic goods, respectively. The profit maximization behavior given by (6) yields the following optimal decomposition equations:

$$E_i = \left(\frac{\kappa_i^e (1+\pi_i^p) p_i^Z}{p_i^e}\right)^{\frac{1}{1-\delta_i}} Z_i \tag{8a}$$

$$D_i = \left(\frac{\kappa_i^d(1+\pi_i^p)p_i^Z}{p_i^d}\right)^{\frac{1}{1-\delta_i}} Z_i \tag{8b}$$

The transformation is given by:

$$Z_i = \left(\kappa_i^e E_i^{\sigma_i} + \kappa_i^d D_i^{\sigma_i}\right)^{\frac{1}{\sigma_i}} \tag{8c}$$

Note that in the CES setting given by (8c) we have 3 unknown parameters ($\kappa_i^e, \kappa_i^d, \varphi_i$) only with 2 equations ((8a), and (8b)) available. Thus without specifying a parameter value out of 3 unknown parameters, we cannot estimate all parameter values by using the social accounting matrix. In particular we cannot obtain any information on φ_i from the conventional SAM. We thus try to obtain the parameter value of φ_i from other data sources such as empirical papers. If it seems difficult to obtain any value in terms of φ_i, then we assume several values for φ_i, and simulate the model based on different values of φ_i.

The production of the final goods

Denote the final consumption goods by Q_i ($i = fish, potato$). The final consumption goods, Q_i, is assumed to be produced by using the final domestic goods, D_i, and the imported goods, M_i. The production technology at this final stage is given by the following CES function:

$$Q_i = \left(\gamma_i^m M_i^{\lambda_i} + \gamma_i^d D_i^{\lambda_i}\right)^{\frac{1}{\lambda_i}} \tag{9}$$

where γ_i^j ($i = fish, potato$, $j = m, d$) is the ratio between imported goods and final domestic goods, and it is assumed to have $\gamma_i^m + \gamma_i^d = 1$ ($i = fish, potato$). λ_i is given by

$$\lambda_i = \frac{\eta_i - 1}{\eta_i}$$

where η_i denotes the substitution elasticity between M_i and D_i at the given level of Q_i, which is by definition given by:

$$\eta_i = \left(\frac{d\left(\frac{M_i}{D_i}\right)}{\frac{M_i}{D_i}}\right) / \left(\frac{d\left(\frac{p_i^m}{p_i^d}\right)}{\frac{p_i^m}{p_i^d}}\right)$$

Wherep_i^m, p_i^d denote the price of $M_i$and the price of D_i, respectively. Note that the import good price, p_i^m, is measured in domestic currency. The parameter value for η_i is usually obtained from the empirical literature. The profit maximization behavior is given by:

$$\max_{Q_i,M_i,D_i} \pi_i = p_i^Q Q_i - (1+\pi_i^m)p_i^m M_i - p_i^d D_i \tag{10}$$

and demand functions are given by:

$$M_i = \left(\frac{\gamma_i^m p_i^Q}{(1+\pi_i^m)p_i^m}\right)^{\frac{1}{1-\lambda_i}} Q_i \tag{11a}$$

$$D_i = \left(\frac{\gamma_i^d p_i^Q}{p_i^d}\right)^{\frac{1}{1-\lambda_i}} Q_i \tag{11a}$$

Once the parameter value for η_i is given, then (11a) and (11b) yield the parameter values for γ_i^j with the SAM.

Market Clearing Conditions

As shown in Figure 1, the market clearing conditions are given by:

$$Q_i = X_i + X_i^g + X_i^s + \sum_i X_{i,j}, \tag{12a}$$

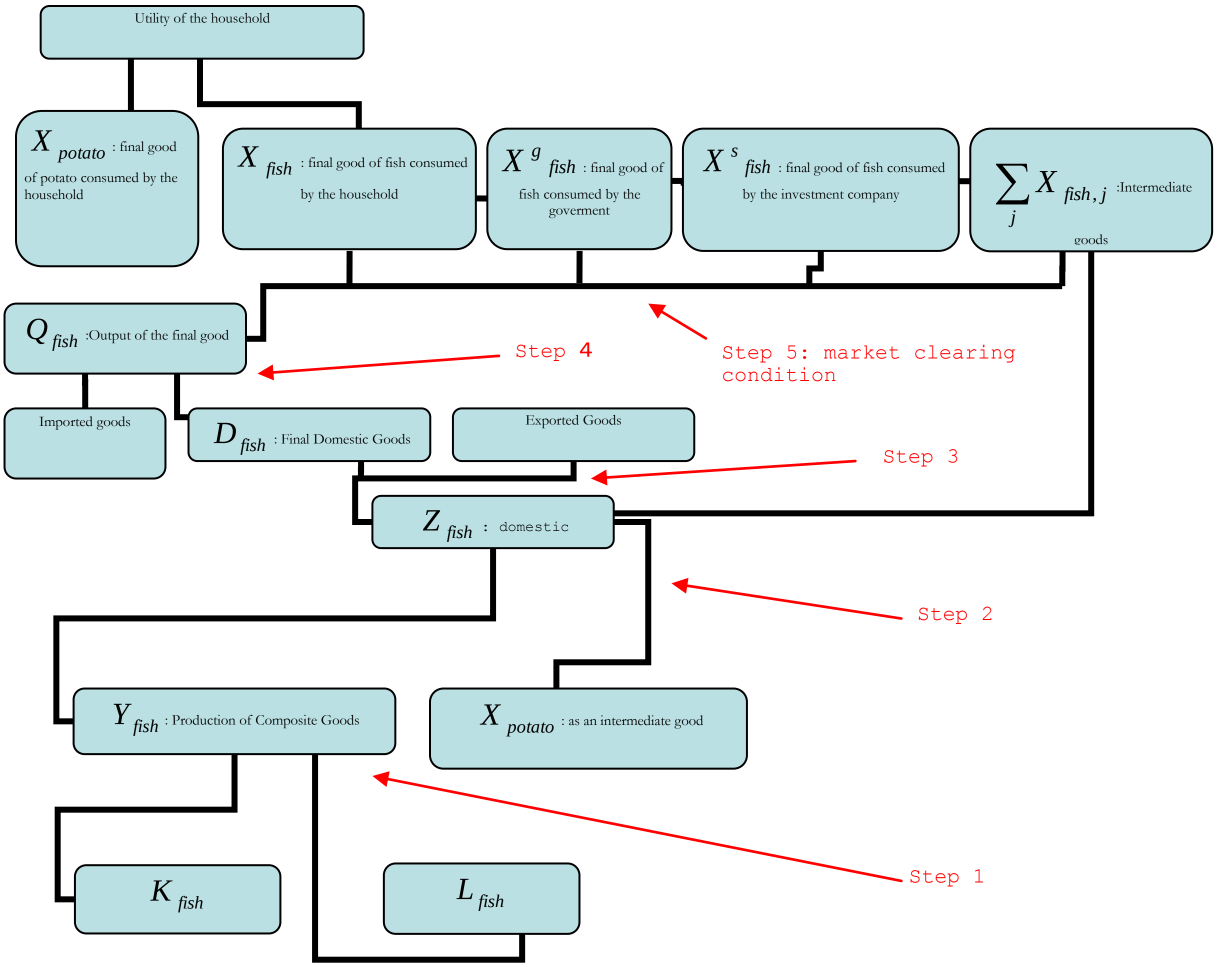
$$\bar{K} = \sum_i K_i, \tag{12b}$$

$$\bar{L} = \sum_i L_i, i = fish, potato, \tag{12c}$$

where (12a) are the market clearing conditions of commodity fish and commodity potato, and (12b) and (12c) are factor market clearing conditions, respectively.

Before moving on to actual programming, we should clarify several assumptions and modifications in the above model.

Figure 1: Static CGE Model Structure



Source:

Government

The government is assumed to impose an income tax on the household, a production tax on production, and an import tax on import. Denote the income tax rate, the production tax rate, and the import tax rate by π^y, π_i^p, π_i^m, respectively, we have the total amount of tax collected such that:

$$T^y = \pi^y Y = \pi^y (r\bar{K} + w\bar{L}),$$

$$T^p = \sum_i \pi_i^p p_i^Z Z_i$$

$$T^m = \sum_i \pi_i^m p_i^m M_i$$

Denote government consumption of the final goods by X_i^g, and the budget constraint of the government is given by:

$$\sum_i p_i^Q X_i^g + S^g = T^y + T^p + T^m, \quad (13)$$

where S^g denotes the government savings. Using $\theta_i \equiv \frac{p_i^Q X_i^g}{\sum_i p_i^Q X_i^g}$, the budget constraint of the government can be rewritten as:

$$X_i^g = \frac{\theta_i}{p_i^Q}(T^y + T^p + T^m - S^g) \quad (14)$$

Note that the right hand side of (13) is the total amount of revenue for the government. The government is assumed to save a certain amount with a constant ratio of revenue such that:

$$S^g = s^g(T^y + T^p + T^m),$$

where s^g is a constant, and exogenously given.

Consumer Behavior

Due to the incorporation of the government activities, the budget constraint of the household is modified such that:

$$\sum_i p_i^Q X_i = Y - T^y - S^y = (1 - \pi^y)(r\bar{K} + w\bar{L}) - S^y,$$

where S^y denotes private savings, or savings by the household. The private savings are assumed to be:

$$S^y = s^y(1 - \pi^y)(r\bar{K} + w\bar{L}), \quad (15)$$

where s^y is a constant, and exogenously given.

Foreign Sector

The world prices of import goods and export goods are assumed to be exogenously given. Denote the prices of import goods and export goods measured in foreign currency by $p_i^{w,m}$,$p_i^{w,e}$, we have:

$$p_i^m = \varepsilon p_i^{w,m}$$
$$p_i^e = \varepsilon p_i^{w,e}$$

where ε denotes the exchange rate. Note that the exchange rate is endogenously determined within the model. Since the amount of exported goods and the amount of imported goods are respectively given by E_i, M_i the foreign trade balance is given by:

$$\sum_i p_i^{w,e} E_i + S^f = \sum_i p_i^{w,m} M_i, \qquad (16)$$

where S^f denotes the foreign savings, or deficits in the current account. If the amount of import is bigger than the amount of export, then we have:

$$\sum_i p_i^{w,e} E_i < \sum_i p_i^{w,m} M_i. \qquad (17)$$

implying that positive foreign savings. (17) obviously implies deficits in the current account. Note that (16) is measured in foreign currency, and S^f is also measured in foreign currency. For simplicity S^f is assumed to be exogenously given so that (16) determines the exchange rate endogenously. If we want to discuss the effect of FDI, then we can incorporate FDI into the model such that:

$$\sum_i p_i^{w,e} E_i + S^f + FDI = \sum_i p_i^{w,m} M_i. \qquad (16)$$

Savings

In order to consistently close the model, we have to have an assumption regarding savings. Note that the private savings expressed by (15) are rather ad-hoc since there is no optimization behavior over savings. The reason why we have introduced savings of the household, the government, and the foreign sector is that we cannot ignore them in the actual SAM. The amount of national savings is not negligible in the actual economy. Thus, in order to make our model consistent to the actual economy, we have to incorporate savings into our model. However, we have not incorporated any optimal behavior of the household in terms of savings, and thus we have to introduce an ad-hoc assumption regarding savings. From the theoretical aspect, it is obviously inconsistent, but from the actual aspect we cannot ignore them. In the conventional static CGE modeling, in order to consistently close the model, we introduce an investment industry, which invests a certain amount of money to the final production industries (fish and potato industries in this example). The total amount of money the investment industry can use is given by:

$$S^f + S^g + S^y.$$

Denoting the amount of money the investment industry invests on the fish and the potato industries by $X_i^s, i = fish, potato,$ the budget constraint of the investment industry is given by:

$$\sum_i P_i^Q X_i^s = S^f + S^g + S^y$$

Using $\zeta_i \equiv \frac{P_i^Q X_i^s}{\sum_i P_i^Q X_i^s}$, the budget constraint of the investment industry can be rewritten as:

$$X_i^s = \frac{\zeta_i}{P_i^Q}\left(S^f + S^g + S^y\right).$$

3.2. Dynamic CGE Model

Model the reactions of the economy at different points in time. Involve simulating a reference case (a business as-usual scenario or a base simulation) and a policy scenario. Solved sequentially (behavior only depends on current and past states). Accumulation of factor supplies overtime (capital, labor etc.) and debt. Results of both scenarios are traced through time at particular intervals (often annual).

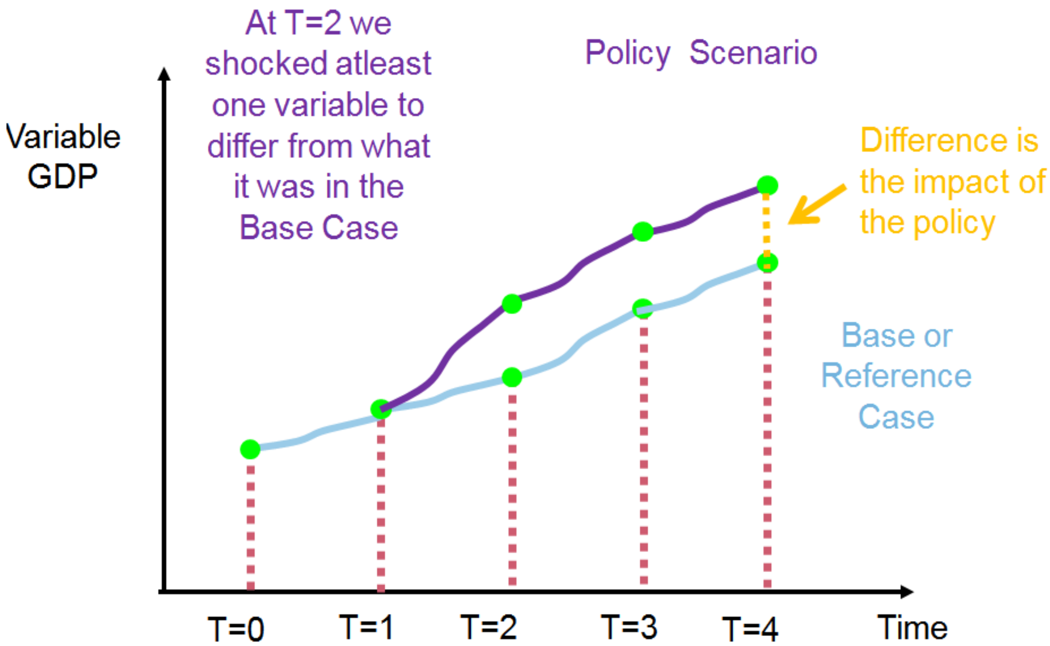
In the Reference Case we typically implement shocks each period to reflect our expectations of how each economy will grow over the period. Shocks reflect long run drivers of economic growth:

- Capital
- Labor supply
- Productivity

In the reference case we may also implement shocks based on expectations of changes in government policy or changes in demand preferences.

- Each industry produces a single good.
- All profits returned to factors (zero pure profits)
- All factor returns and tax income are given to the "Regional Household" (no foreign ownership of assets).
- Regional household distributes earnings to private consumption, savings and government expenditure (government expenditure is not directly linked to taxation).
- Market clearing equations (price endogenously adjusts to ensure all goods produced are consumed).
- Traded goods are treated as imperfect substitutes (Armington Elasticity)
- **Population** and **Labor Supply** are exogenous assumptions.
- **Natural Resource** and **Land supply** are exogenous assumptions.
- **Productivity** is an exogenous assumption.
- **Capital stocks** are endogenously determined by an investment function.
- **Debt** is determined by the cumulative difference of Investment and Savings overtime.
- **Savings Rates** (savings as a share of GNP) are exogenous.

Figure 2: Dynamic CGE Model: Baseline and Policy Scenario



Source:

Approach to dynamic modeling

- Implementing labor supply and population shocks
- Either implementing productivity shocks (say economy wide labor productivity of TFP shocks) or changing the standard closure by endogenising one of the economy wide productivity variables and exogenising real GDP growth and then shocking real GDP growth.
- In Mining version we must also shock mining production, prices and factor demand.
- May also shock other variables as desired that are consistent with your opinion of what the reference case should be.
- This involves shocking at least one exogenize variable at least one point in time.
- Note: This variable doesn't have to be exogenous in the reference case as we can change the closure in the policy.
- In the policy we can shock multiple variables and at multiple time points if we like.
- The change in each variable between the policy scenario and the reference case at each point in time is the impact of the policy shocks.
- Typically in the policy scenario we have GDP as endogenous.

Database

Utilizes the GTAP databaseconsists of 112 regions and 57 sectors and 5 primary factors.Version 7 Database begins in 2004. Model produces updated results on an annual basis. Investment Function is endogenous whereas supply of labor, population and productivity are exogenous inputs.

Table 2: GTAP database (Regions and Sectors)

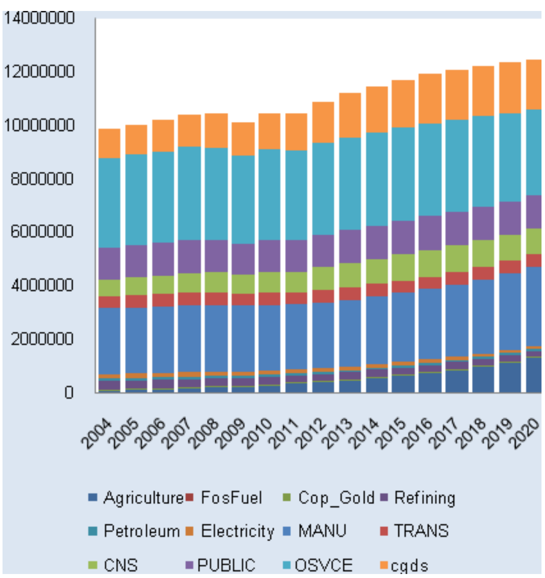
Current Regions	Current Sectors
China	Livestock
Russia	Other Agriculture
USA	Fisheries and Forestry
Japan	Oil
Korea	Gas
India	Thermal Coal
Australia	Coking Coal
Chile	Copper Orcs*
Indonesia	Gold
EU27	Copper Refining
South Africa	Other Mineral Refining
Canada	Petroleum
Mongolia	Electricity
Peru	Manufacturing
Rest of World	Transport
	Construction
	Health, Education and Public Defence
	Other Services

DATA ANALYSIS AND KEY FINDINGS

In order to do simulation analysis, the shock was given to increase the output and productivity of transportation sector in Japan. In other words, productivity of transportation sector was increased by 20 percent. This section is studied to identify how this abrupt change in transportation will impact on other sectors particularly on macroeconomic indicators. The main purpose of CGEmodel is to takemacro economy as a whole complex formand analyze relationshipsamong industries or identify industry reactions towards changes or external factors. Now, let's see how output and input of various other sectors have changed in detail. The following table shows the impact of the shocks on different sectors:

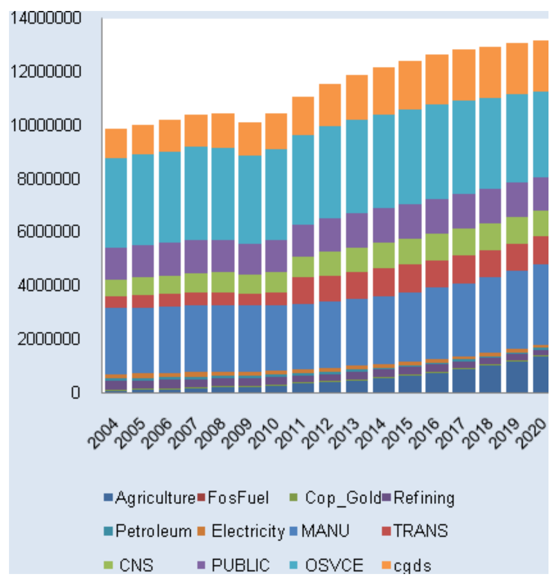
The first table shows the fundamental/base valuation whereas the other table indicates the impact of the shock or the result of the policy valuation. Based on this valuation, it has become obvious that productivity of transportation sector in Japan has great impacts on the other sectors of the country. In fact, transportation sector has positive relations with other sectors. Now, let's see how this change in transportation sector impact on several significant macroeconomic indicators of the country by doing comparative analysis of some variables with its bases:

Figure 3: Baseline Scenario



Source: Author's calculation

Figure 4: Policy Scenario

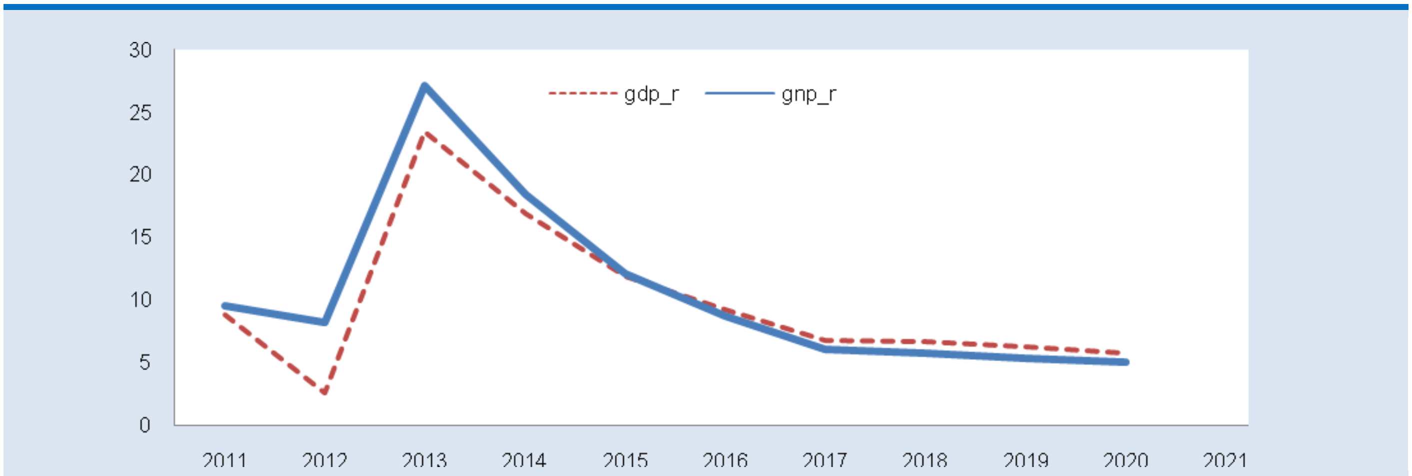


Source: Author's calculation

4.1. GDP and GNP

Both GDP and GNP are likely to increase after the shock however growth rate decreases gradually. The reason behind this phenomenon is that increase in productivity in transportation results in increase of output of other sectors. Thus when supply increases it brings excessive supply which diminishes price in the long run.

Figure 5: Real GDP and GNP in percent other than the base

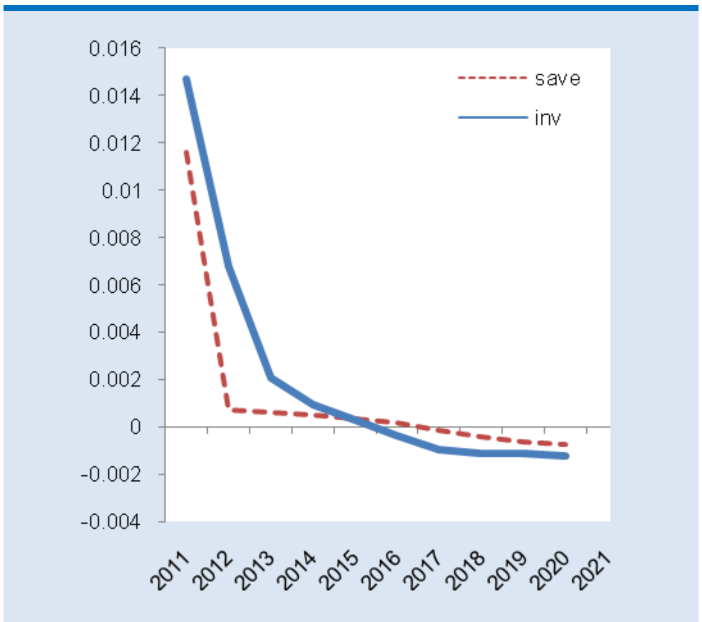


Source: Author's calculation

4.2. Savings and Investments

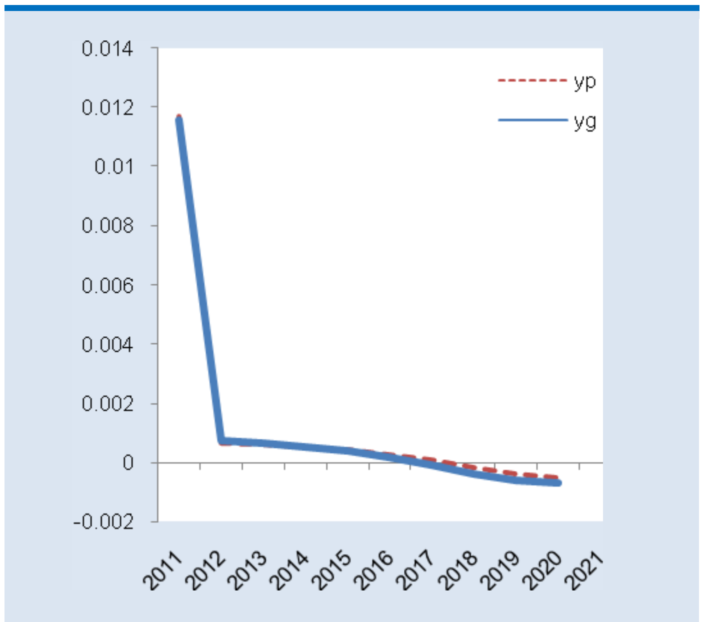
It can be seen in the below table that both savings and investment in Japan are likely to decrease in the short run however rate of decline is not that much in the long run.

Figure 6: Savings and Investments in percent other than the base



Source: Author's calculation

Figure 7: Actual spending/consumption of Government and Private sector



Source: Author's calculation

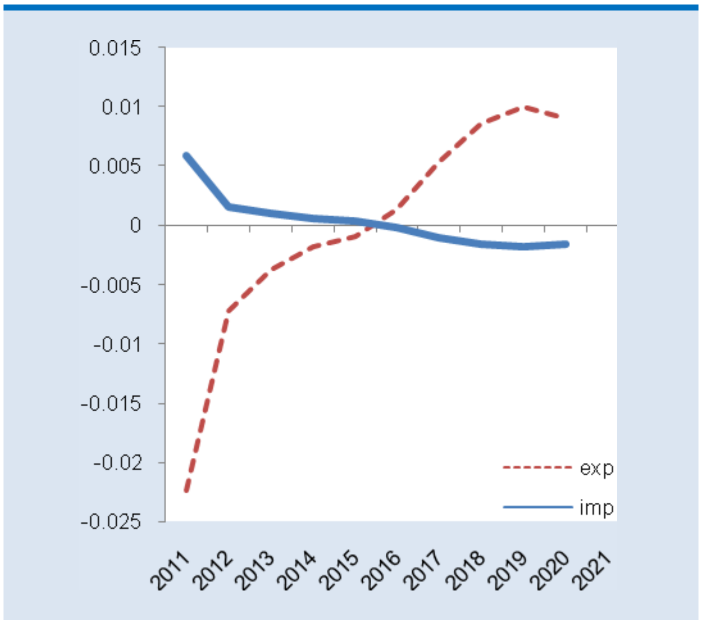
4.3. Export and Import

Once productivity increases in transportation, price is likely to decrease which will promote foreign trade. Decrease in export due to dramatic decline in transportation expenditure will make Japanese product relatively cheap compared to other countries so that it will encourage raising aggregate export. Due to above mentioned sector relationship analysis, price decline in other sectors and excessive amount of supply import will decrease which will impact on trade balance positively.

4.4. Exchange rate

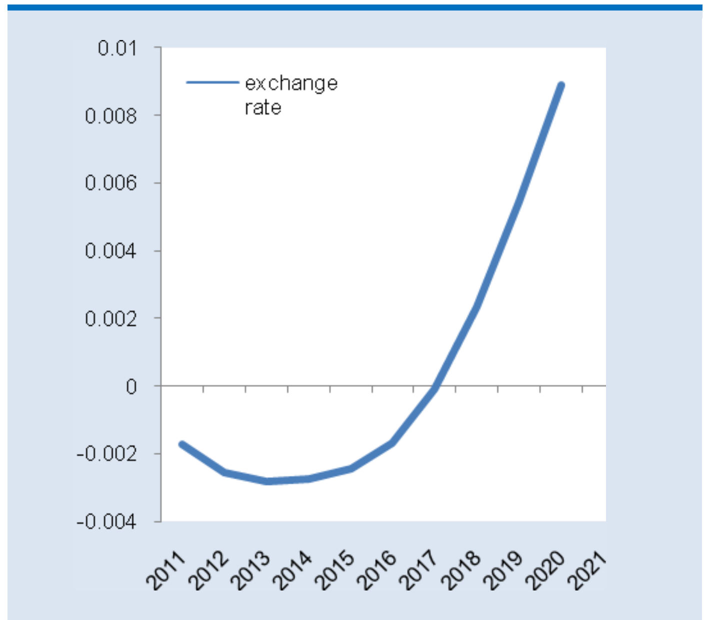
Real exchange rate gets stronger as export increases and import decreases however; it gets loose in the long run.

Figure 8: Export and Import in percent other than the base



Source: Author's calculation

Figure 9: Exchange rate in percent other than the base



Source: Author's calculation

CONCLUSION

The paper set out to evaluate how changes in transportation sector effects on other industries in Japan. Amongst the various economic models, CGE model was selected to specify the industry relationships in mathematical term.

One of the key findings of this paper is that transportation sector has positive relations with other sectors. In fact, increase in productivity of transportation sector in Japan has great impacts on the other sectors of the country.

Both GDP and GNP are likely to increase after the shock however growth rate decreases gradually. The reason behind this phenomenon is that increase in productivity in transportation results in increase of output of other sectors. Thus when supply increases it brings excessive supply which diminishes price in the long run. Both savings and investment in Japan are likely to decrease in the short run however, rate of decline is not that much in the long run.

Once productivity increases in transportation sector, price is likely to decrease which will promote foreign trade. Decrease in export due to dramatic decline in transportation expenditure will make Japanese product relatively cheap compared to other countries so that it will encourage raise of the aggregate export. Due to above mentioned sector relationship analysis, price decline in other sectors and excessive amount of supply import will decrease which will impact on trade balance positively. Real exchange rate gets stronger as export increases and import decreases however; it gets loose in the long run.

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