

Dynamic Impacts of Trade Liberalization: In the Framework of Endogenous Growth with Productive Public Capital*

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Abstract

The purpose of this study is to provide an assessment of a question how trade related policy changes, such as tariff liberalization and temporary protection, affect regional welfare levels, growth rates, and economic structure when the possible negative impacts through decelerated accumulation of public capital is important. We approach the question using a *forward-looking* Applied General Equilibrium (AGE) model of global trade that incorporates endogeneous growth with productive public capital. The model consists of three linked regional models: high-, middle-, and low-income countries. Each regional model has three sectors, i.e., primary industries, manufacturing, and services, and is linked to other regions through bilateral trade flows for all traded sectors. The parameters and exogenous variables are calibrated assuming that the benchmark data is obtained from the global economy in a stationary state. To construct the benchmark data, the Government Finance Statistics Yearbook (GFS), the International Financial Statistics (IFS), and the National Accounts Statistics (NAS) are used to obtain information on government revenue and public expenditure, in addition to the Global Trade Analysis Project (GTAP) version 4 databases. Simulations with the model revealed that the role of middle-income countries to supply products to high-income countries with cheap prices, under the trade liberalization between high- and middle-income countries. If we look at economic growth, the trade liberalization has a positive impact on not only high- and middle-income countries, but also low-income economies. The temporary protections by high-income countries against low-income countries also have similar impacts to the tariff liberalization. Finally, the endogenous productivity change through productive public capital may have synergistic effects that enlarge the impacts of trade-related policies on both private and public investments.

Keywords: applied general equilibrium model; endogenous growth; productive public capital; global trade; trade liberalization.

JEL Classification Numbers: C68, D58, E62, F15, F41.

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1 Introduction

Over the past decade, there has been a great deal of interest in analyzing and evaluating the impact of economic integration on individual countries, international trade, and global welfare, with the integration of individual economies into the global economy has been progressing. Many economists believe that increased economic integration among countries has tended to increase long-run economic growth rates, and that deepening openness and economic interdependence through free trade will be major factors in generating prosperity for the global economy.

Some recent studies, such as Francois *et al* (1997), and Keuschnigg and Kohler (1997), emphasize the importance of the dynamic gains from trade, and the essential dynamics that characterizes commercial policy. Policy changes may induce changes in savings and investment patterns, and thus the accumulated growth effects largely exceed the static efficiency gains. At the same time, trade liberalization is often expected as being phased in over several periods, rather than being induced taking economic agents by surprise. Moreover, some protectionist measures may be temporary in nature, because of certain legal restrictions such as General Agreement on Tariffs and Trade (GATT) provisions (antidumping duties, countervailing duties, or safeguard protection). In either case, it might be expected that such commercial policy scenarios generate time profiles of adjustment, which may be captured with an intertemporal models.

While dynamic models enable us to capture the accumulated growth effects, the possible negative impacts through decelerated accumulation of public capital, caused by the reduction in tariff revenue, on the economic growth tend to be left behind discussions. The purpose of this study is to provide an assessment of a question how trade related policy changes, such as tariff liberalization and temporary protection, affect regional welfare levels, growth rates, and economic structure when public capital is productive. We approach the question using a *forward-looking* Applied General Equilibrium (AGE) model of global trade that incorporates endogenous growth with productive public capital. To make discussion clear, results from simulations with a model that is based on the Ramsey-Cass-Koopmans type exogenous growth are also referred.

In the following section, we present the major assumptions of the analysis. In section 3, the basic structure of the model is outlined. In section 4, we perform simulations with the model and interpret the results. Section 5 presents our conclusions.

2 Nature of the Model

In this section, we present the major assumptions of this study.

Model Dimension The framework is that of a dynamic multi-regional growth model. The model consists of three linked regional models: high-, middle-, and low-income countries. Each regional model has three production sectors, i.e., primary industries, manufacturing, and services, and is linked to other regions through bilateral trade flows for all traded sectors. Economic growth

is led by the exogenous labor input growth, and the endogenously determined productivity growth caused by the accumulation of public capital¹. In order to obtain a stationary state as the reference case, the economic growth rates should be equal among regions. If there are differences between regional labor growth rates, initial public capital stock in each region is calibrated in order to obtain productivity growth rate that fills up the difference. Anyway, this assumption is unrealistic so that we focus on the qualitative impacts of policy changes.

Dynamic Consistency The agents' intertemporal behavior is assumed to be rational, so that the entire system of prices across sectors and over time is internally consistent. This is because the model calculates variables of all periods at the same time. Consumption and investment are determined on the basis not of what happened in the past, but of the assumed future conditions of technology and preference. Changes in the future exogenous variables can affect present endogenous variables.

Discrete Time Formulation For the purpose of numerical implementation, the intertemporal problem is formulated in discrete time. Discounting in discrete time requires a dating convention. In order to keep the derivation and calibration simple, all transactions are assumed to take place at the end of the period (while decisions are made or planned at the beginning of the period).

Terminal Conditions To solve a growth model that has an infinite horizon, we follow the usual procedure of imposing stationary state conditions at some future terminal period. Since we assume that the benchmark data set is obtained from an economy in a stationary state, we analyze short-/mid-term impacts defining a global stationary state with regional trade imbalances. As long as this global condition is satisfied, the sums of various infinite series pertaining to the consumption functions and the investment equations will be finite and well defined. A sufficient condition is that the discount rate and the rate of time preference are positive and greater than the balanced-growth rate by the terminal period.

Choice of Terminal Period As variables of different time-periods are interdependent, the computation burden is much larger than that for models that calculate solutions period by period. Moreover, extension of the calculation horizon increases calculation difficulty more than proportionally, and expansion of models with respect to the number of sectors or regions is more difficult. Because of these difficulties and a limited amount of computational resources, we set the terminal period at 50².

¹ The model is essentially based on the Barro's endogenous growth model (Barro (1990)). However, there is no transition path since the model includes public expenditure as a flow variable. To realize an analysis of transition, Futagami *et al* (1993) introduce stock of public capital, and reexamine the Barro's results. The AGE model used in this study is based on this Futagami-Morita-Shibata type model with the dynamic decision problem of the government to choose a time path of public investment that maximizes the household's welfare.

² The qualitative changes are not affected by the choice of terminal period. See Devarajan and Go (1998).

Perfect Competition The solution of the model can be regarded as the result of perfect competition³. This is one straightforward implication from the model. Since perfect competition is hardly realizable in actual economies, the simulation results should be read as giving only a potential picture of a hypothetical economy under conditions of perfect competition, on the basis of which we can abstract fundamental determinants of economic growth. Because the main purposes of this study are to establish a basic model incorporating endogenous growth with public capital and to focus on the qualitative dynamic impacts of trade-related policy changes, we commence with the assumption of perfect competition.

Interregional Trade Products of firms in every region are not treated as homogeneous across countries but as imperfect substitutes for each other. By way of example, American and Japanese cars are not treated as a single homogeneous product, “cars”, but as differentiated products between which there is a specific elasticity of substitution due to demand. This assumption is called the Armington assumption (Armington (1969)) and is necessary to accommodate cross hauling; that is, the phenomenon of a country both importing and exporting the same product at the same time. This is inconsistent with a traditional Heckscher-Ohlin type trade model that premises homogeneous products.

Factor Mobility The primary factors are assumed to be mobile across sectors, but immobile beyond the regional boundary. On the other hand, investment capital flows across regions (foreign capital inflow/outflow), and is determined so as to balance each region's current account. It is assumed that the representative consumers in each country receive factor income from domestic firms, and that they then invest a fraction of their income through the interregional capital market. This kind of approach is appropriate to analyze the impacts on the international capital market in a short-/mid-term equilibrium, assuming highly mobile capital.

Nominal Variables based on Dual Variables Although the model does not have nominal variables, dual variables can be interpreted to indicate relative prices. Thus future nominal variables can be calculated, given the assumption of an overall rate of inflation.

3 Structure of the Model

In this section, we outline the basic structure of the model used in this report.

Enterprise There is also one competitive enterprise in every region, which produces one kind

³ Because of the difficulties in parameterizing the model, neither imperfect competition nor biased information is incorporated in this study. While Yeldan and Roe (1994) point out the importance of modeling non-competitive or missing market structures and heavily politicized, regulated managerial practices which are often based on imperfect and biased information, we concentrate on an analysis assuming perfectly competitive markets.

of product. Production and factor inputs are all determined endogenously so that resources are optimally used from the viewpoint of a maximization of net income. Factor substitutability is assumed between labor, two kinds of capital, and intermediate inputs. Note that the public capital is provided to producers without user charges. The dynamic decision problem of the enterprise is to choose a time path of private investment that maximizes the value of the firm, defined as the present value of net income.

Household The representative consumer in each region maximizes her/his discounted utility of the temporal sequence of aggregated private consumption. The utility function is homogenous and additively separable with constant elasticity of marginal utility. The utility is discounted by the consumer's positive and constant rate of time preference. Since the financial claims are perfect substitutes ex-ante, we cannot uniquely determine the individual consumer's optimal portfolio shares. However, a condition of interregional security market equilibrium defines the foreign saving for each region endogenously⁴. Without uncertainty and with efficient financial markets, financial assets among sectors and regions earn the same anticipated rate of return.

Government The government revenue comes from import tariffs, export duties, domestic indirect taxes, and direct taxes. The government current expenditure includes government consumption and public investment. We introduce the dynamic decision problem of the government to choose a time path of public investment that maximizes the household's welfare. On the other hand, fixed share of the fiscal budget is accounted for by the government consumption. The difference between government revenue and expenditure equals government saving (if negative, fiscal deficit), and assumed to be transferred/levied as a lump-sum transfer/tax. The government saving rate (if negative, fiscal deficit rate) is endogenously determined.

Composite Aggregators It is assumed that each agent consumes or uses an aggregated composite of sectoral commodities. The choice of the quantity of demand for each product is determined by cost-minimizing behavior.

Equilibrium Conditions To arrive at a solution, both the intertemporal and general equilibrium conditions have to be satisfied simultaneously. At every point in time, the usual general equilibrium conditions require that: (i) material balance in the demand and supply of all goods in the economy holds; (ii) the total demand for labor equals its supply; and (iii) global total of savings equals total investment⁵.

Data Source and Parameterization The main data source is the GTAP version 4 database. The reason why we use the version 4 databases is that other additional data set is quite limited for the

⁴ The model treats capital flows as equal to the balance of trade, adjusted for net foreign transfers/remittances and debt service payments.

⁵ This condition can be dropped because of the Walrus' law.

newer version. We also collect data for public investment, government saving, and government revenues from direct/indirect taxes from the Government Finance Statistics Yearbook (GFS) issued by the International Monetary Fund (IMF), and the National Accounts Statistics (NAS) by the United Nations (UN). The exchange rate, rf , appeared on the International Financial Statistics (IFS) is used for the conversion from local currencies to U.S. dollar term. Regions and industries are both aggregated into three, and a fixed fraction of the output of the services output is supplied for interregional shipping services. Parameters and exogenous variables are calibrated from the data on the assumption that the data is obtained from an economy in a stationary state.

Software The model is formulated as a Mixed Complementarity Problem (MCP) and solved by “PATH” of the General Algebraic Modeling System (GAMS)⁶. MCP is a set of Kuhn-Tucker conditions derived from certain optimization problems.

4 Simulations

We now report on the results of simulations in this dynamic framework. In the figures, R1 to R3 respectively denote high-, middle-, and low-income countries. The first scenario that we are going to focus on is trade liberalization between high- and middle-income countries. In this scenario, we examine both announced and unannounced cases of implementing the policy. In the case of announced implementation, tariff reduction is imposed in the fifth period. Our second scenario is temporary tariff protection by high-income countries against low-income countries. We examine both targeted protection of a single sector and general import surcharge applied to all sectors, which are anticipated two periods ahead and last for two periods. We take primary industries as the targeted sector for example. In the first case, we increase tariffs on primary products by 50 percent, and in the second case we assume a uniform increase of all tariffs by 50 percent.

4.1 Trade Liberalization

We begin with a permanent abolition of the import tariffs on interregional trade between high- and middle-income countries. Figure 1 shows the effects on the private investment scaled by the base run when the tariff reduction is imposed by surprise. The private investments in high- and middle-income countries surge in the first period because increases in the output prices affect the discount rate that firms in both countries face. In order to maintain asset equilibrium, the firms invest more. After the second period, the firms in high- and middle-income countries produce more, and their output prices depreciate from the levels in the first period. The reduction in the output price is remarkable especially in middle-income countries so that the cheaper products are exported to high-income countries. In this reason, the private investment in high-income countries settles in at a level that is lower than in the base run after the second period. Since low-income

⁶ Brook, Kendrick, and Meeraus (1992).

countries also expand production to export to high-income countries, the level of private investment steadily increases from the base run.

The public investments reflect the changes in the tax revenues caused by expansions/reduction in production. This is shown in Figure 2. In the first period, public investments in high- and middle-income countries are crowded-out by the private investment. The levels of public investments also affect the production volumes through productivity growth. In high-income countries, the reduction in the public investment accelerates the reduction in the production. This is apparent if we look at the gross investment obtained from simulation results with a model based on Ramsey-Cass-Koopmans type exogenous growth⁷, which is shown in Figure 3. The level of gross investment in high-income countries is not so smaller than in the reference run. Similarly, the synergistic effects enlarge the volumes of private and public investments in middle- and low-income countries.

In turn, Figure 4 shows the impacts on the private consumption. Since the government in high-income countries cuts expenditure and the government saving rate becomes positive in the first several periods, lump-sum transfer to the representative household helps expanding the private consumption. After that, the private consumption in high-income countries gradually decreases to the level below the base run, because of the reduction in production volume. The private consumption in low-income countries is also below the base run level, since the countries expand export to high-income countries in addition to the fact that the enlarged investments crowds out the consumption. In middle-income countries, the private consumption grows fast, and then converges to the new stationary state level reflecting the gradual decrease in the production level.

Figure 5 shows the impacts on per capita Gross Domestic Product (GDP) growth rate in each region. Note that GDP includes effects on both prices and quantities. In high-income countries, output prices are comparatively high, while those are low in middle-income countries. As a result, the per capita GDP growth rates in every region converge to the new stationary state levels those are higher than the reference run. One striking effect of the trade liberalization between high- and middle-income countries is that it also promotes economic growth in low-income countries.

Finally, Figure 6 shows the effects of announced tariff liberalization on the private investment. It is apparent that the rational economic agents start expanding the investment in the first period. An interesting point is that the private investment in middle-income countries once decreases in the second and third periods but increases again when the tariff cut is imposed, while this second impacts are comparatively small in high- and low-income countries. The impacts on other variables are essentially similar to those of the unannounced case.

In this scenario, the results show the possibility of middle-income countries to be a production base that supplies products to high-income countries with cheap prices. If we focus on

⁷ This exogenous growth model is calibrated with the same data set, and as a result most of the parameter values are the same as those of the model with productive public capital. In this reason, one may compare impacts on variables by their volumes.

the per capita economic growth, the trade liberalization between high- and middle-income countries has a positive impact on not only high- and middle-income countries, but also low-income economies. The policy change promotes the production in low-income countries to supply products along with middle-income countries for high-income countries.

4.2 Temporary Protection

Temporary import surcharges are a frequently considered form of trade intervention. It is because peaking trade deficits worries policy-makers, or because individual sectors are seeking relief from import competition that would otherwise supposedly cause a serious damage. Figure 7 depicts the targeted protection of primary industries by high-income countries against low-income countries. As in the case of announced tariff liberalization, significant changes in the private investment take place in the first period. A curious finding is that the order of regional levels in the new steady state is similar to those of tariff liberalization between high- and middle-income countries. After the second period, the private investments in both middle- and low-income countries take higher levels than in the base run, while high-income countries decreases the investment. This is because the cost of using the primary products from low-income countries increases and is reflected to the appreciation of output prices in high-income countries, and comparatively cheap products by middle-income countries are used as substitutes.

In addition, it is apparent that the existence of productive public capital enables policies to have lasting effects even though they are imposed temporarily. If we look at the gross investment with the exogenous growth model, which is shown in Figure 8, fluctuations are converge to the base run level within first ten periods. In this case, the products by low-income countries become substitutes for those by high-income countries.

Intuition tells us that granting protection to a single sector is at the expense of other sectors, where resources are pulled out to be employed in the protected sector. However, our results show that intertemporal effects generate an overall picture. In Figure 9, we can observe a similarity between sectors in the evolution of private capital stocks in high-income countries, where S01 to S03 respectively denote primary industries, manufacturing, and services. This is caused by the fact that high-income countries build up physical capital during the initial period, in anticipation of higher acquisition prices for the capital good that prevail later.

Figures 10 and 11 respectively depict the public investments reflecting the changes in production as in the previous scenario and the private consumption. The cutting in the government expenditure and lightened burden from lump-sum taxation initially expands the consumption level of representative household in high-income countries. In this scenario, the private consumption in middle-income countries shows significant decrease from the base run. The consumption is crowded-out by both private and public investments, while the investment capital continuously outflows to the other regions.

Next, we take a look at the general import surcharge applied to all sectors that temporarily imposed. Figure 12 shows the impacts on the private investment. Note that the firms in every

country change their plans for investment in the first period. Except low-income countries that directly face the strong trade barrier during the implementation periods, the firms' investment paths are not affected by the period when the protection being imposed. The impacts on other variables are not so different from those of the targeted protection.

In this scenario, results show the temporary protection by high-income countries against low-income countries has similar impacts to the tariff liberalization between high- and middle-income countries. Another finding is that the existence of productive public capital enables policies to have lasting effects even though they are imposed temporarily, that is different from the results from an exogenous growth model. Finally, there is a similarity between sectors in the evolution of private capital stocks in high-income countries even though the protection is targeted to primary products.

5 Concluding Remarks

The purpose of this study is to provide an assessment of a question how trade related policy changes, such as tariff liberalization and temporary protection, affect regional welfare levels, growth rates, and economic structure when the possible negative impacts through decelerated accumulation of public capital is important. We approach the question using a *forward-looking* AGE model of global trade that incorporates endogenous growth with productive public capital.

Simulations with the model revealed the response of the global economy to the policy changes. The key findings can be summarized as follows:

1. Middle-income countries have a possibility to be the base that supplies products to high-income countries with cheap prices, under the trade liberalization between high- and middle-income countries.
2. The trade liberalization between high- and middle-income countries promotes the production in low-income countries to supply products along with middle-income countries for high-income countries. As a result, the policy change possibly has a positive impact on not only high- and middle-income countries, but also low-income economies.
3. The temporary protection by high-income countries against low-income countries may have similar impacts to the tariff liberalization between high- and middle-income countries.
4. There is a similarity between sectors in the evolution of private capital stocks in high-income countries even though the protection is targeted to primary products.
5. Different from the results from an exogenous growth model, the existence of productive public capital enables policies to have lasting effects even though they are imposed temporarily.
6. The endogenous productivity change through productive public capital may have synergistic effects that enlarge the impacts of trade-related policies on both private and public investments.

We close this study by noting a potentially important issue that is not taken into account in the

present analytical framework. We feel that the model used in this study is too sensitive to the interregional capital movements. A country that is going to expand exports tends to be worse off. Since the assumption of complete interregional security market is unrealistic, it is better to include the idea of country bias in investment.

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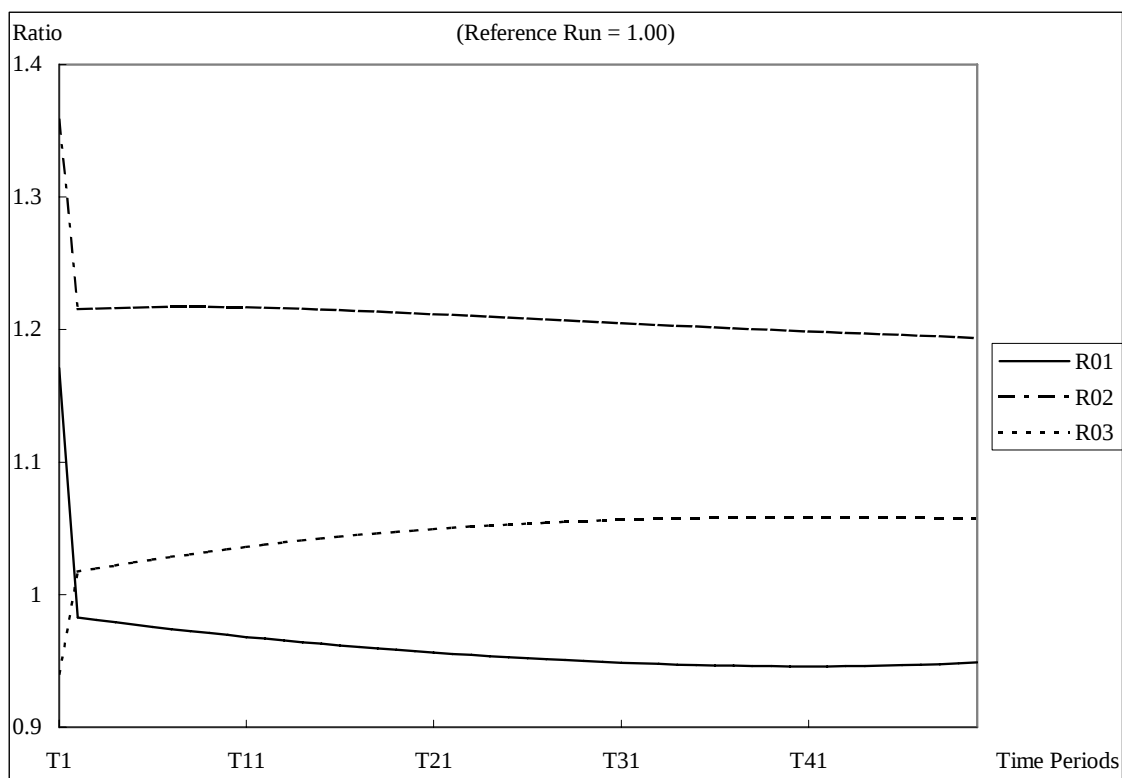


Figure 1: Effects on Private Investment (Unannounced Trade Liberalization)

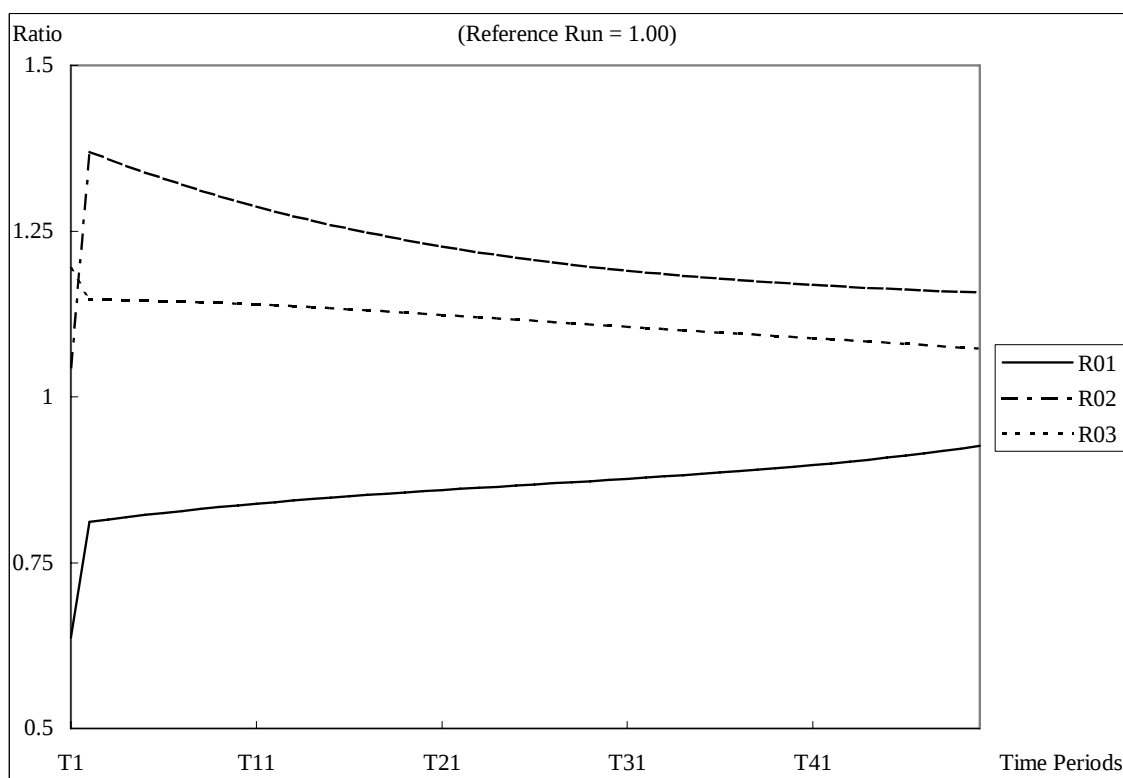


Figure 2: Effects on Public Investment (Unannounced Trade Liberalization)

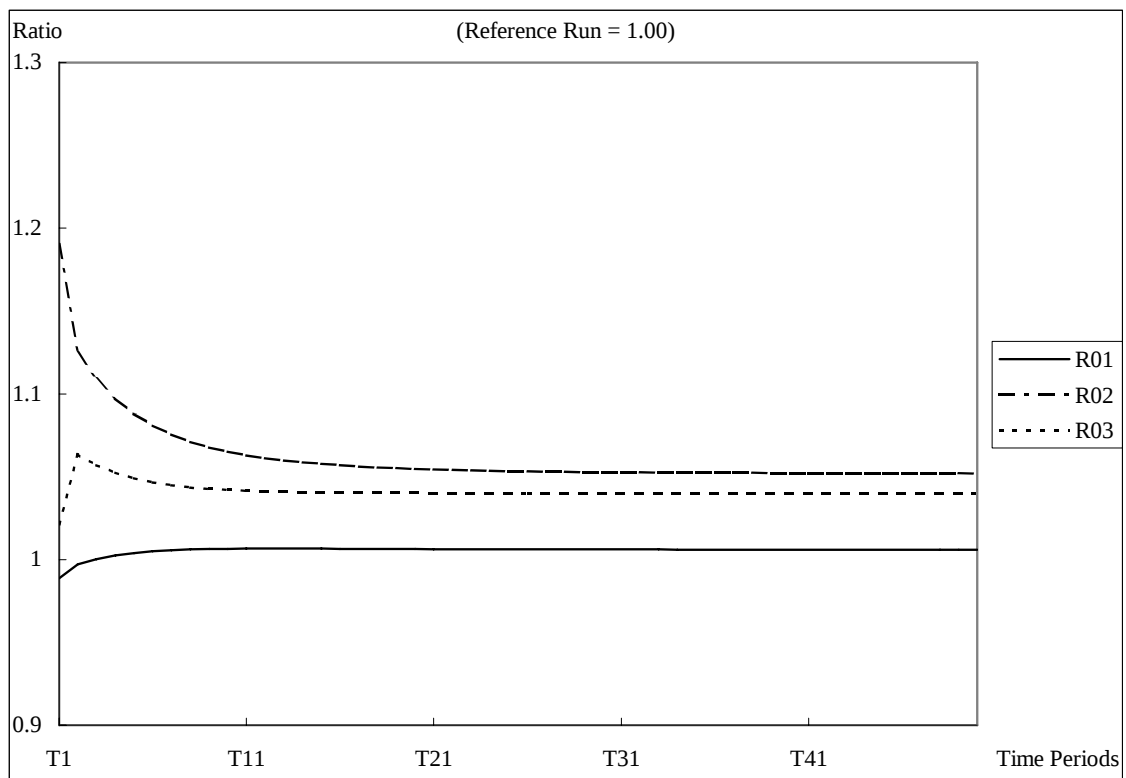


Figure 3: Effects on Gross Investment (Unannounced Trade Liberalization, RCK)

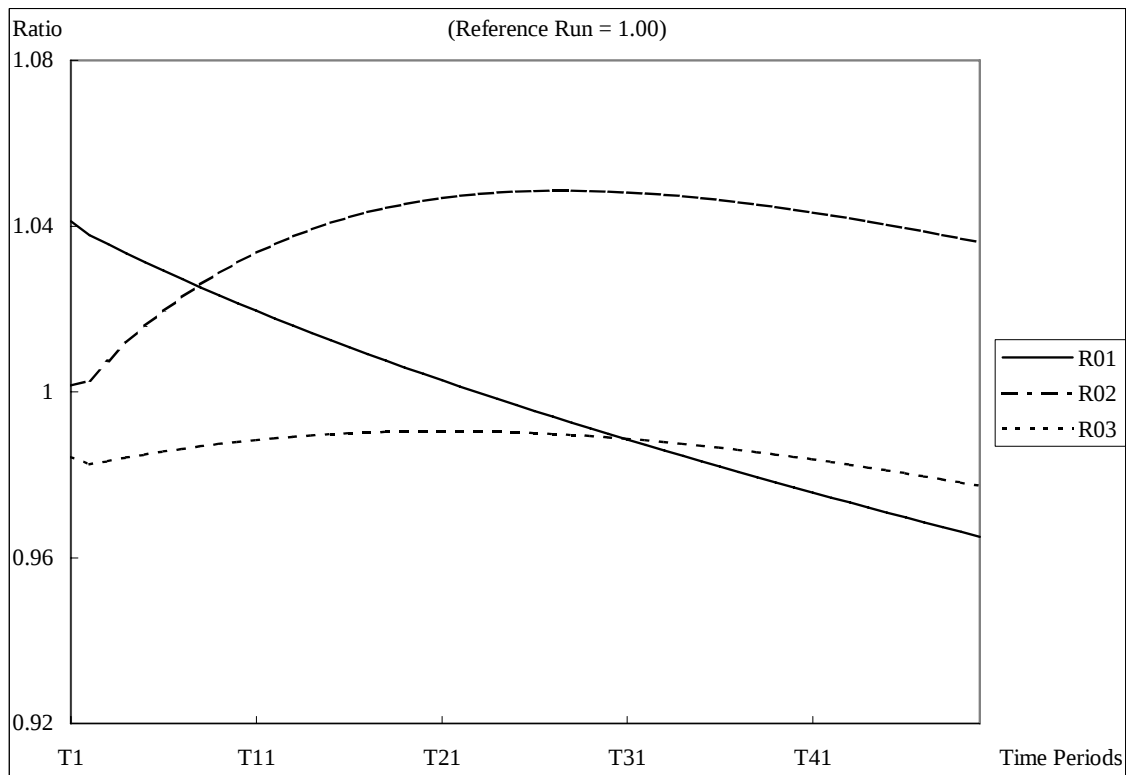


Figure 4: Effects on Private Consumption (Unannounced Trade Liberalization)

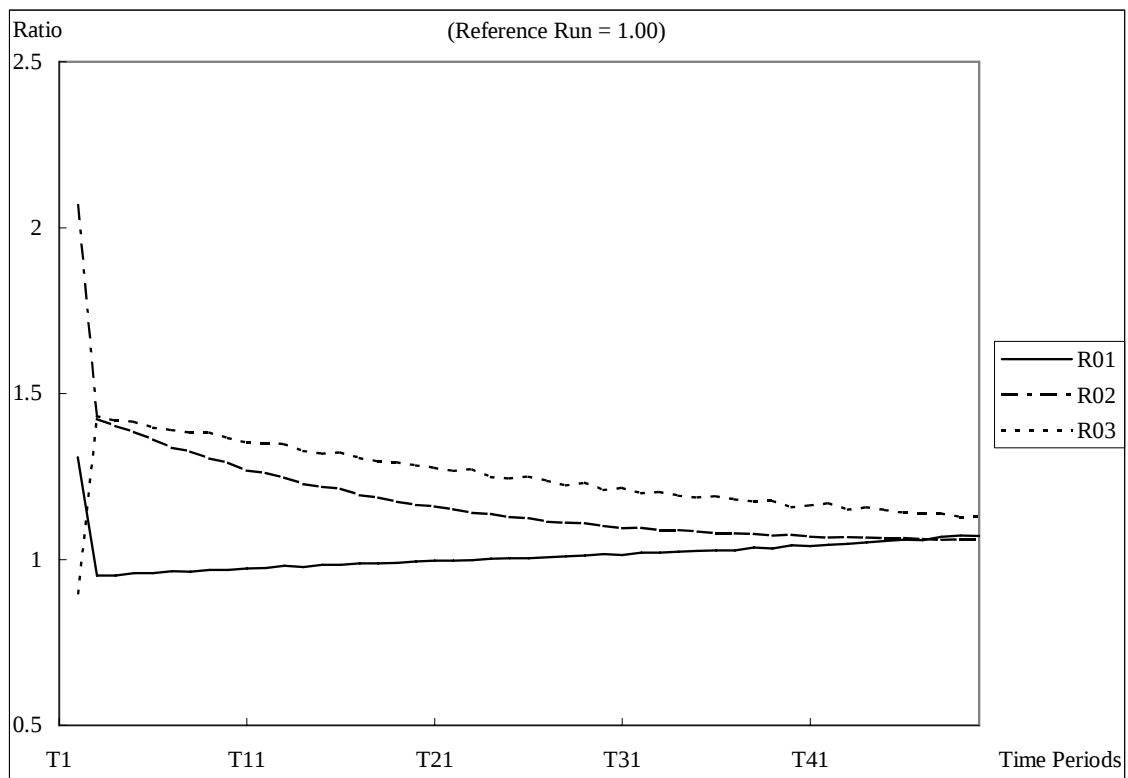


Figure 5: Effects on Per Capita GDP Growth Rate (Unannounced Trade Liberalization)

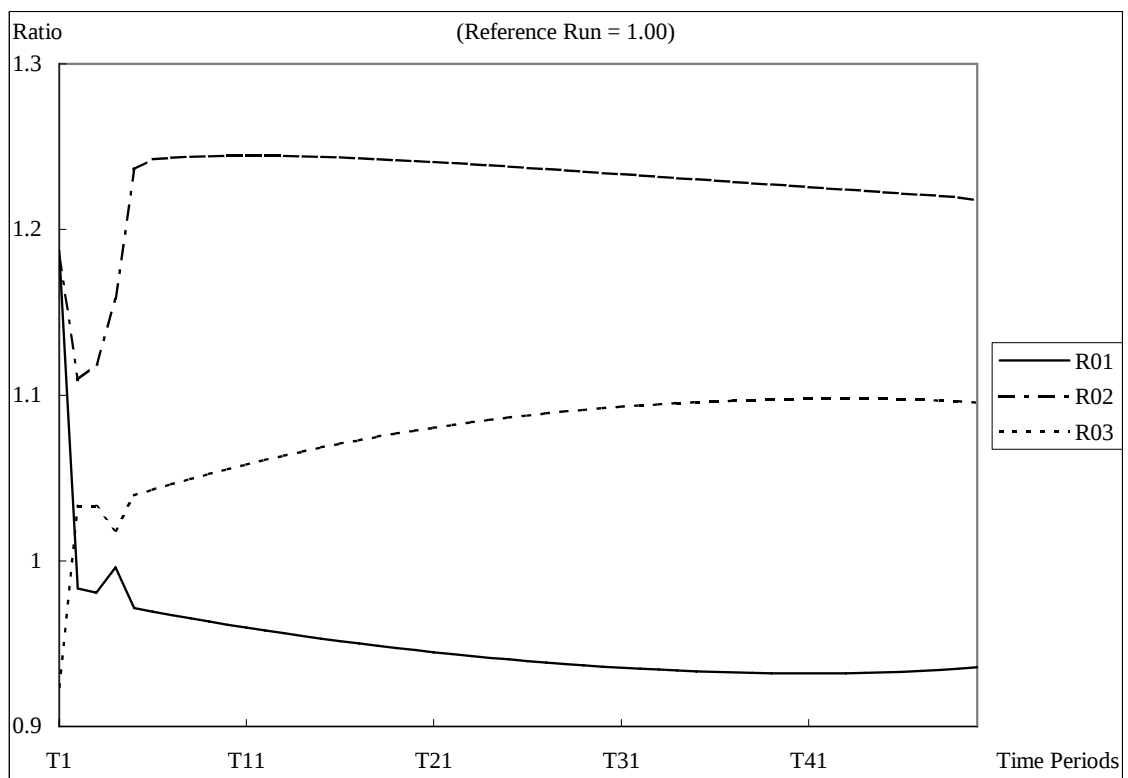


Figure 6: Effects on Private Investment (Announced Trade Liberalization)

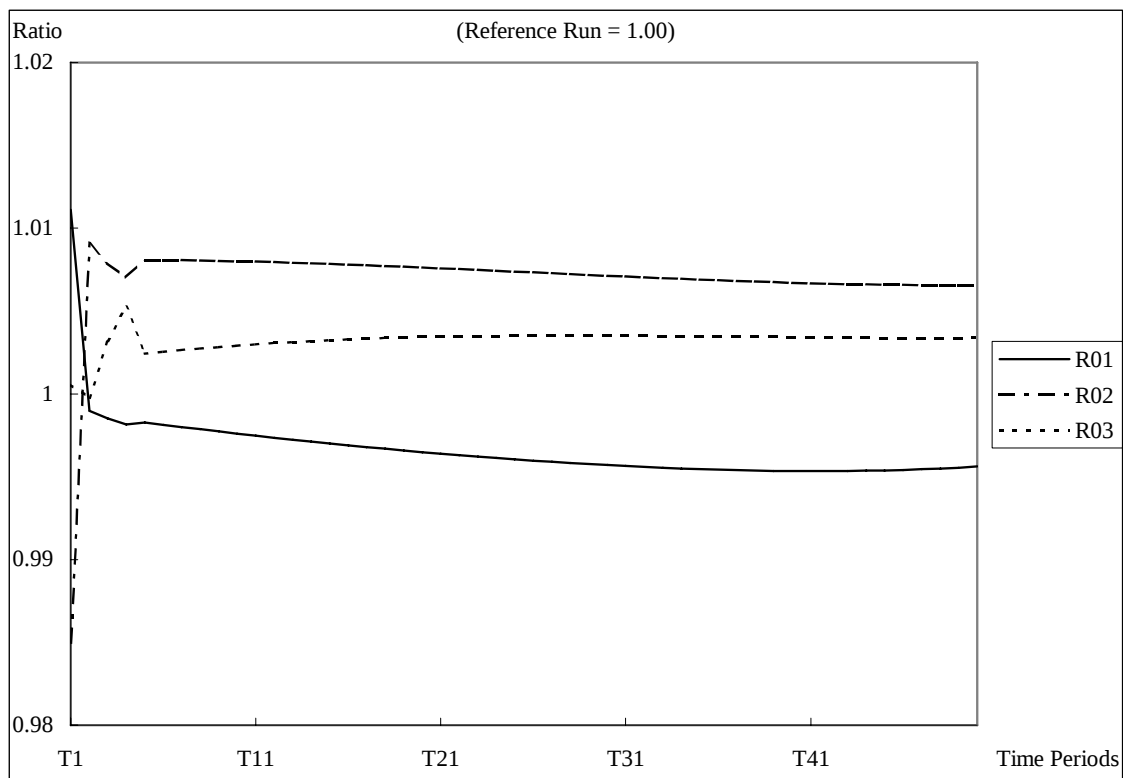


Figure 7: Effects on Private Investment (Targeted Temporary Protection)

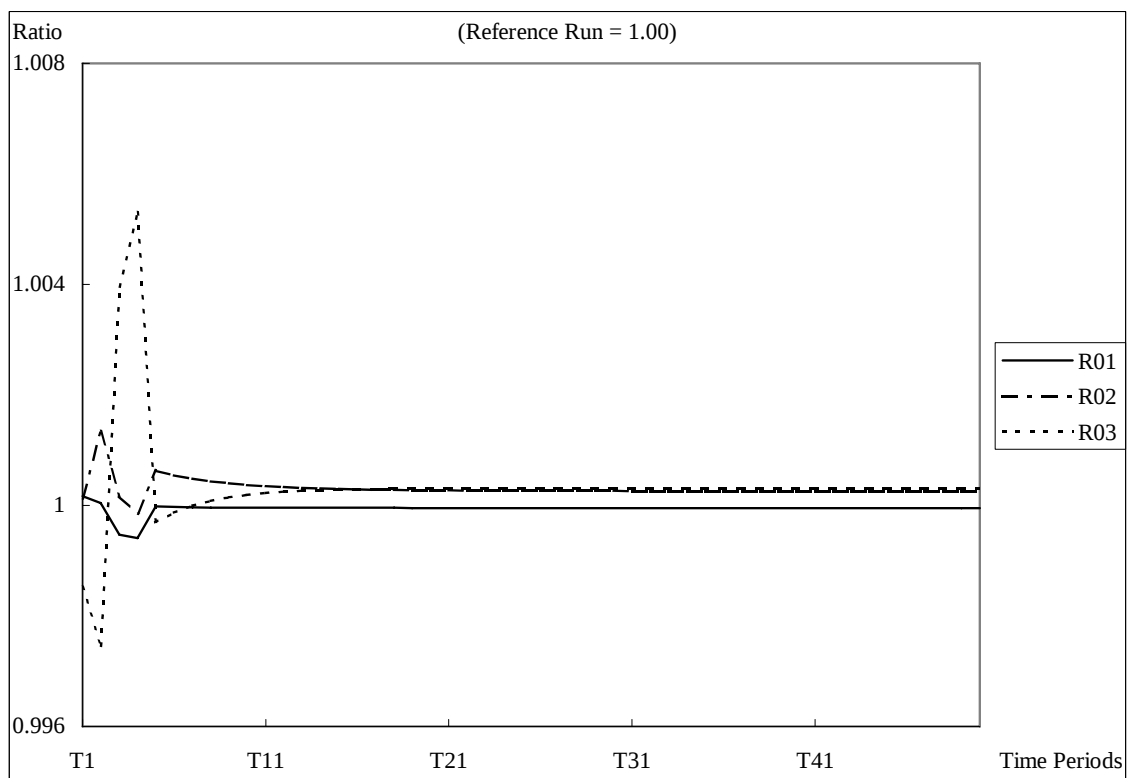


Figure 8: Effects on Gross Investment (Targeted Temporary Protection, RCK)

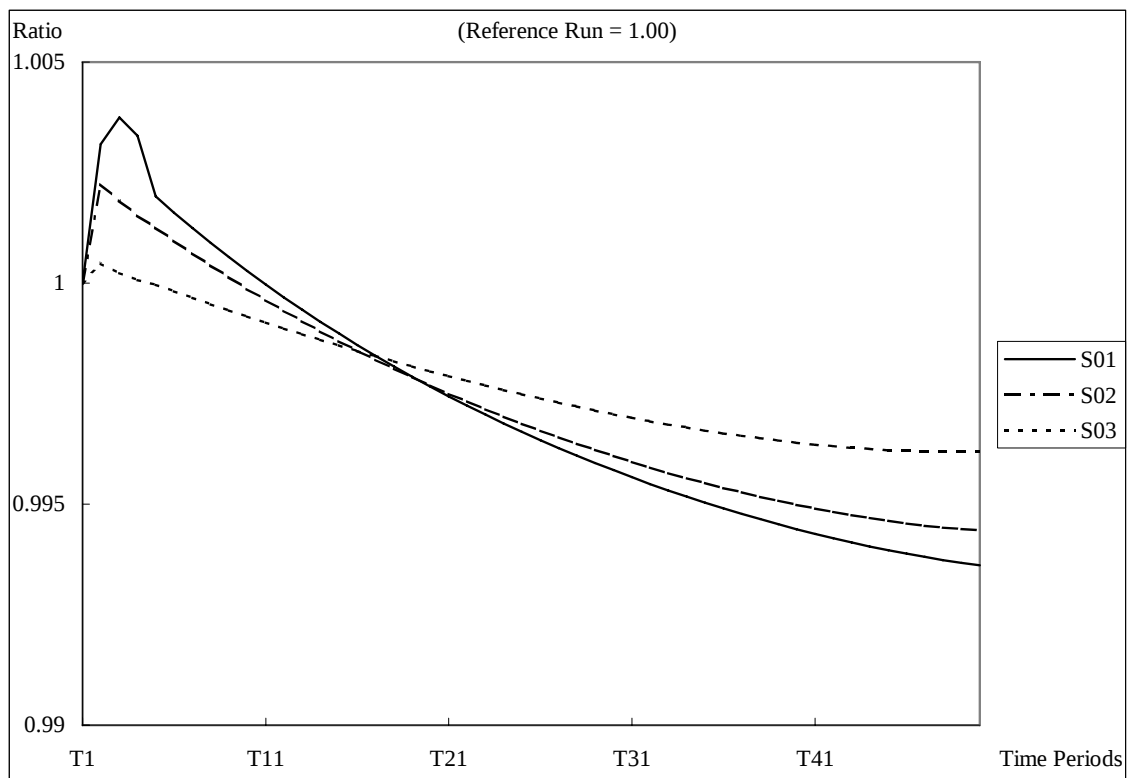


Figure 9: Effects on Private Capital Stocks (Targeted Temporary Protection)

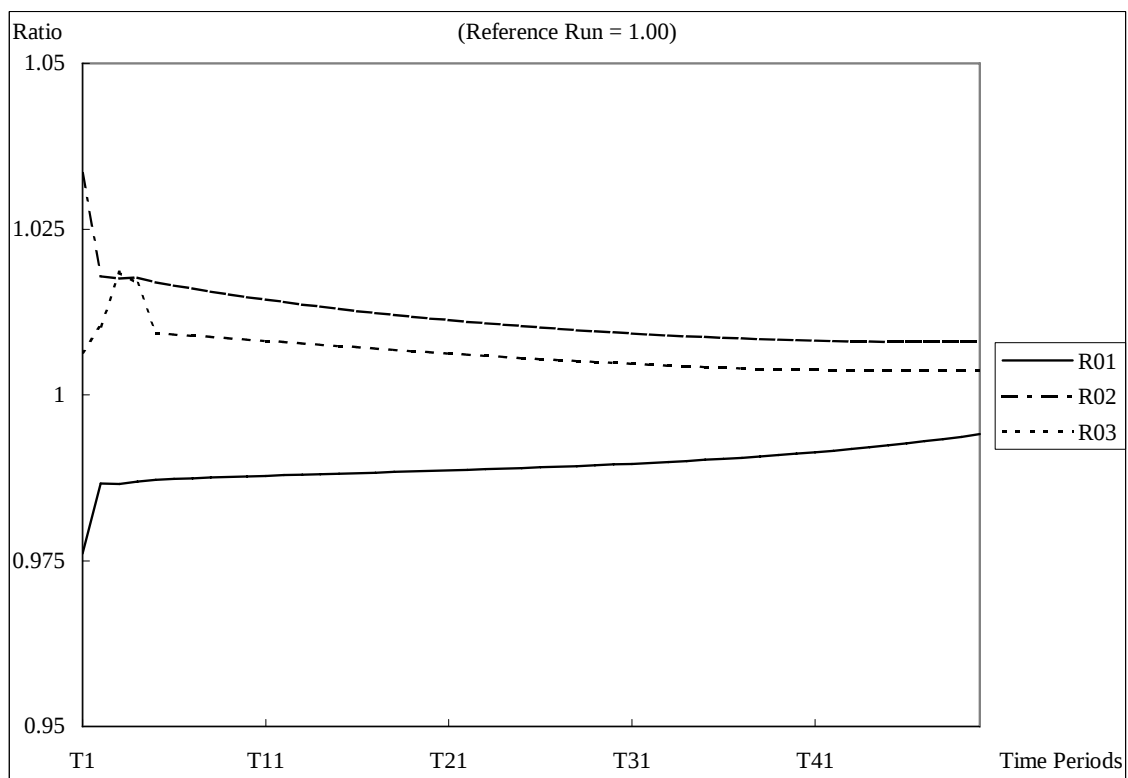


Figure 10: Effects on Public Investment (Targeted Temporary Protection)

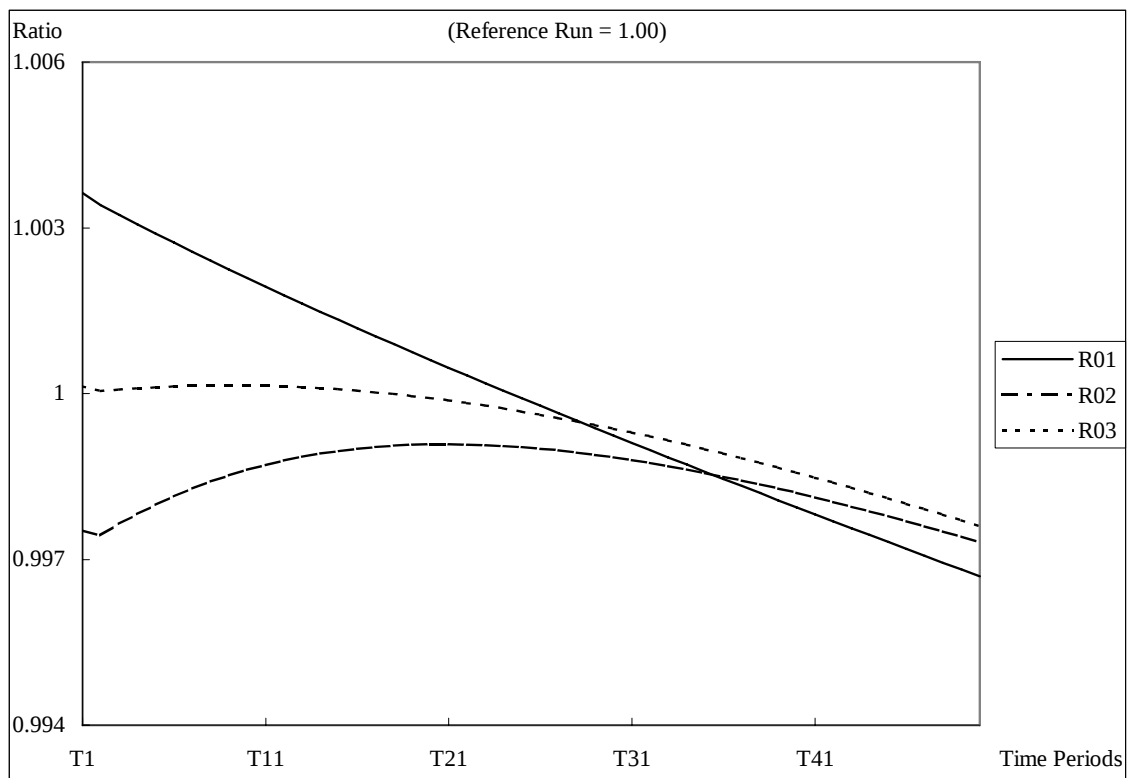


Figure 11: Effects on Private Consumption (Targeted Temporary Protection)

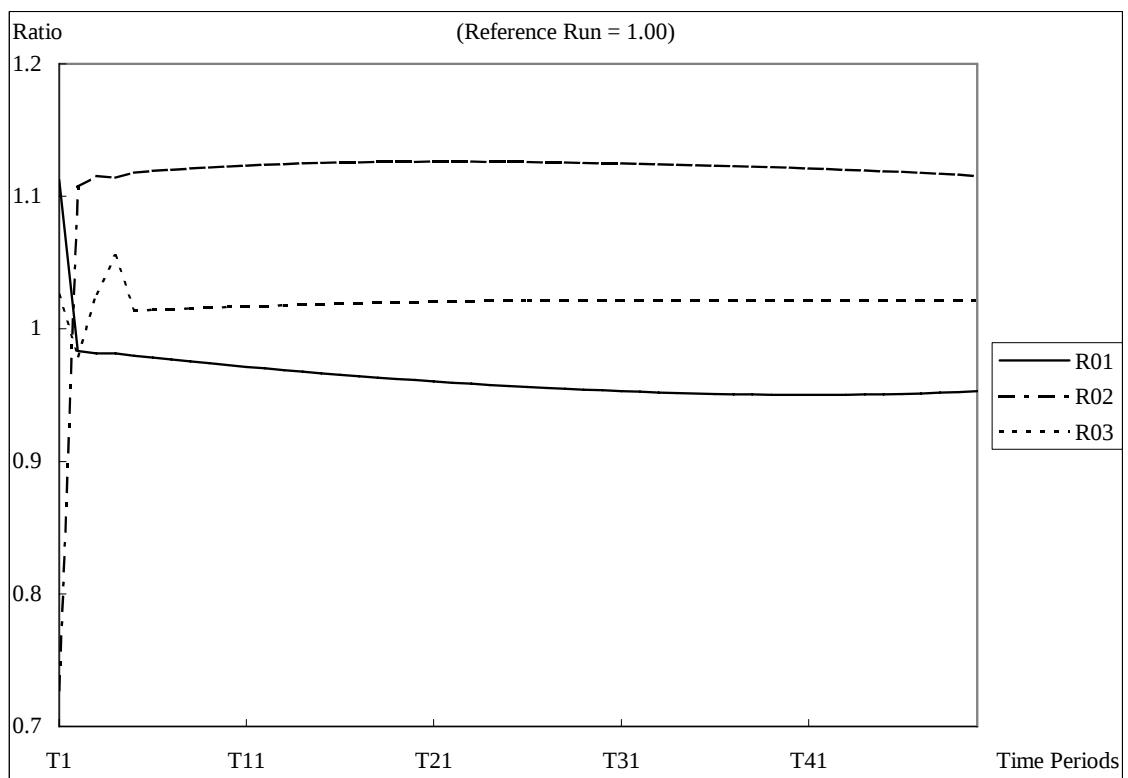


Figure 12: Effects on Private Investment (Temporary General Import Surcharge)