

## **Macroeconomic Impact of a Tariff Reduction: A Three-Gap Analysis with Model Simulations**

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### **Abstract**

*Using a three-gap model it can be shown that a reduction in the tariff level will lead to an unambiguous decline in the GDP growth rate if it results in a reduction of the surplus of the government's primary account. Empirical results using Philippine data show that this condition is satisfied. Since foreign direct investment (FDI) is crucial in breaking the economic gridlock brought about by capital inflows, policymakers should determine whether greater macroeconomic instability that results from larger fiscal and trade deficits can be offset by the more liberalized economic environment in attracting FDI. It may also be the case, however, that greater macroeconomic instability will eventually countervail any benefits from microeconomic reform.*

### **I. INTRODUCTION**

Philippine development policy in the past decade has been inexorably linked to the framework popularly known as the Washington consensus, a term coined after the world's de facto capital. This framework, which was given a sense of formality by Washington-based think tanks and multilateral agencies, is grounded on the belief that Victorian virtue in economic policy – free markets and sound money – is the key to economic development (Krugman 1995). The clearest evidence of this policy thrust

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is the intention of the government to slash tariffs to a uniform 5 percent level by the year 2004. This timetable is contained in our commitment to AFTA and also in the recent Manila Action Plan presented during the APEC leaders meeting in November 1996.

The arguments for liberalizing trade have been largely confined in the microeconomic sphere, with efficiency considerations being the primary focus. Comprehensive discussions on the potential macroeconomic effects are limited. One of the earlier studies, Blejer and Cheasty (1990), lays down the key issues involved. On the other hand, Bevan (1995) examines the impact of trade liberalization in a more robust manner by applying a computable general equilibrium model. The present paper looks more closely at the Philippine case and considers the possible tradeoff between a more liberalized economic environment and greater macroeconomic instability.

The aggregate impact of trade liberalization revolves around its effect on macroeconomic balances. Thus it would be useful to situate our analysis within the three-gap framework as formalized by Bacha (1990) and applied to the Philippine case by Lim (1990). A more elaborate treatment is provided by Taylor (1994). The interplay of a savings constraint, foreign exchange constraint and fiscal constraint will determine the macroeconomic effects of a reduction in tariffs.

In the next section we develop the model of the three gaps following closely the methodology of Bacha. Using the model we discuss the potential macroeconomic effects of a tariff reduction in Section III. We then attempt to quantify these effects in Section IV using a smaller version of the PIDS Annual Macroeconometric Model. Section V concludes the paper.

## II. THE THREE GAPS<sup>1</sup>

Bacha's model is an exercise in the maximization of investment (as a proxy for the output growth rate), in a fix-price, one-period model, subject to a number of equality and inequality

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1. The derivation of the three gaps is largely lifted from Bacha (1990, pp. 280-86).

constraints. The equality constraints are the balance between income and absorption, the balance-of-payments identity, the government budget constraint, and the equality between the flow supply and the flow demand of money. These give rise to the incorporation of the various macroeconomic gaps into the analysis.

### Savings Gap

From the basic national accounting identity which shows the equality between income and absorption, we can write:

$$I = (Y - C) + (M - X) \quad (1)$$

where  $I$  is fixed capital formation,  $Y$  is domestic output (GDP),  $C$  is (private plus government) consumption,  $M$  is imports of goods and nonfactor services, and  $X$  is exports of goods and nonfactor services.

From the balance of payments, the excess of imports over exports is equal to foreign transfers, i.e., the difference between net capital inflows,  $F$ , and net factor services to abroad,  $J$ :

$$M - X = F - J \quad (2)$$

Replacing (2) and (1),

$$I = (Y - C) + (F - J). \quad (3)$$

When income is at its potential level,  $Y^*$ , and private consumption is given exogenously, equation (3) yields the savings constrained level of investment—written as  $IS$ —and, hence, the savings-constrained potential growth rate of output, if ICORs are assumed to be constant.

The savings gap is thus written as

$$IS = (Y^* - C) + (F - J) \quad (4)$$

The sources of potential investment are “internal savings” and foreign transfers. If equation (4) is written as

$$IS = (Y^* - C - J) + F \quad (5)$$

then we have national savings and foreign savings. Bacha chooses to use (4) and not (5) for the reason that interest rate variations and workers' remittances, which are the main source of changes in  $J$  in the short run, are not under the control of the government. These variations are exogenous to the policy making process of the developing country, the same as with capital inflows. Thus, foreign transfers,  $F - J$ , are a decision variable beyond the control of policymakers.

The right-hand side of (4) can further be decomposed as:

$$IS = S_p^* + (T - G) + (F - J) \quad (6)$$

where  $S_p^*$  is potential private savings and  $(T - G)$  is the primary budget surplus in the current account.

### Foreign Exchange Gap

To derive the foreign exchange constraint, we start from (2). Assume that imports can be divided into two types: complementary capital goods imports,  $M_k$ , and other imports,  $M_o$ . Define net exports,  $E$ , as the difference between exports and other imports:

$$E = X - M_o \quad (7)$$

and let  $M_k$  be given by:

$$M_k = m I, \quad (8)$$

where  $0 < m < 1$  is the import content of investment.

Replacing (7) and (8) into (2) and reshuffling terms, one gets

$$I = (1/m)[E + (F - J)]. \quad (9)$$

Introducing the critical assumption that the level of net exports,  $E$ , cannot surpass a critical value,  $E^*$ , given by world demand, the foreign exchange constrained level of investment—which is written as  $IE$ —is given by:

$$IE = (1/m)[E^* + (F - J)]. \quad (10)$$

Since  $m < 1$ , a comparison of (6) with (10) immediately yields the Chenery result that foreign transfers have a bigger impact on the growth rate of foreign exchange constrained economies than on savings-constrained ones.

### Fiscal Gap

The basis of this constraint is the dependence of private investment on government investment in such a way that as a maximum its value is

$$I_p = k \cdot I_g, \quad k > 0. \quad (11)$$

Equation (11) expresses the idea that latecomer development is characterized by a central role for government investment, in infrastructure and basic industries, which sets an upper limit for profitable private investment to occur. If we let

$$I = I_p + I_g \quad (12)$$

and substitute (12) and (11) into (3) and decompose total savings we obtain

$$I_g = (S_p - I_p) + (T - G) + (F - J). \quad (13)$$

Bacha then makes the critical assumption that there does not exist a market for government bonds which leaves money expansion as the only alternative for domestic financing of government budget deficits. In particular this means that if private savings is a slack variable then it is only through seigniorage that the government is able to capture this excess savings. Seigniorage is assumed to be a function of two variables: the rate of inflation,  $p$ , and the propensity to hoard,  $h$ . We thus have:

$$S_p - I_p = dH/P = f(p, h) \quad (14)$$

where  $dH$  is the variation in nominal money holdings and  $P$  is the price level.

Replacing (14) in (13) and the result in (12) and also replacing (11) in (12) the fiscally-constrained level of investment—written as  $IT$ —is given by

$$IT = (1 + k)[f(p,h) + (T - G) + (F - J)] \quad (15)$$

Equations (6), (10) and (15) represent the savings constraint, foreign exchange constraint and fiscal constraint, respectively.

### III. POLICY ANALYSIS

To facilitate the analysis of specific policy issues we graph the constraints in  $I$  and  $(F - J)$  space. It is clear that  $1/m$  and  $(1 + k)$  are both greater than one and thus  $IT$  and  $IE$  have steeper slopes than  $IS$ . The relative positions of  $IT$  and  $IE$  are then determined based on  $m$  and  $k$ .

$m$  is the capital goods import content of investment while  $1/(1 + k)$  is the government share of investment. Thus if the capital goods import content of investment is greater than the government share of investment ( $m > 1/[1+k]$ ) then  $1/m < (1+k)$  and vice versa.

Over the past five years  $m$  ranged from 0.3 to .45 while  $1/(1+k)$  ranged from .2 to .25. Hence we can safely set  $1/m$  to be less than  $(1 + k)$  making  $IT$  steeper than  $IE$ . Bacha states that this condition applies to a small private-oriented developing economy like Taiwan while the case where  $1/m > (1 + k)$  corresponds to a large developing country where industrialization is both state-led and relatively advanced, such as Brazil. Our results are consistent with this characterization.

Figure 1 shows the relative positions of  $IS$ ,  $IE$  and  $IT$ . For values of  $(F - J)$  greater than  $(F - J)'$ , the savings constraint is binding while for values less than  $(F - J)''$ , the fiscal constraint is binding. The foreign exchange constraint is binding for  $(F - J)'' < (F - J) < (F - J)'$ . It is clear that the effects of a tariff reduction would depend on the initial value of  $(F - J)$ .

What is the macroeconomic impact of a reduction in tariffs? First, we have to determine the reaction of the surplus in the primary account  $(T - G)$  particularly the level of taxes  $T$ . Blejer and Cheasty (1990) point out that this is largely an empirical issue that depends on the price and income elasticities of the demand for imports. A price elasticity which exceeds unity should generate a net revenue gain, since the increase in imports demanded will

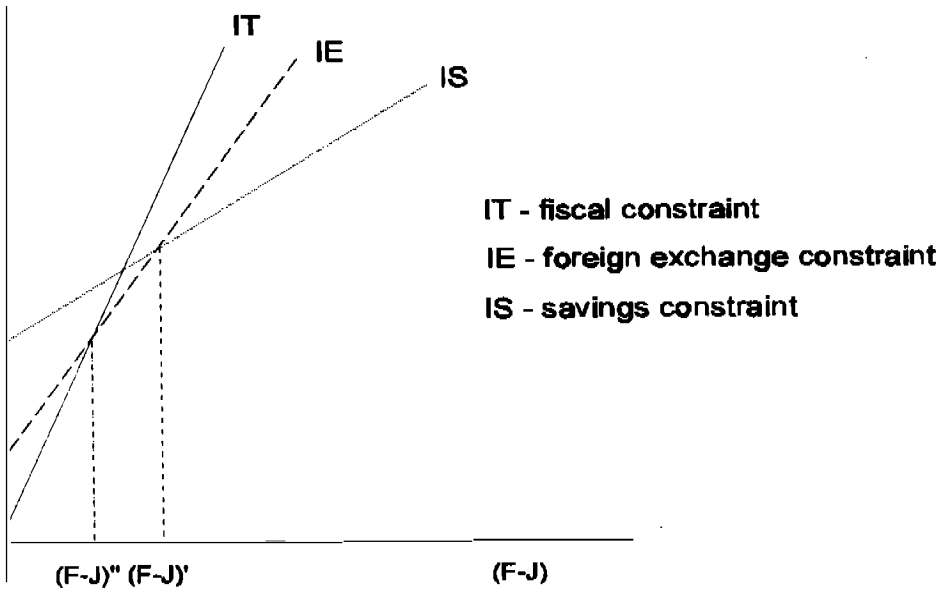


FIGURE 1  
*Diagram of Three-Gap Model*

raise the tax base to more than compensate for the reduction in the tax rate. They expect though that the price elasticity will be low in the short run which is also the likely case in the Philippines and hence  $(T - G)$  is assumed to decline. The fall in  $(T - G)$  shifts both IS and IT downward (Figures 2 and 3) leading to a decrease in  $I$  for all relevant values of  $(F - J)$ .

Meanwhile, in the case of the foreign exchange constraint, a reduction in tariffs should lead to an increase in  $m$ . This results in a clockwise rotation of IE (Figure 4) to  $IE'$  for  $(F - J) > 0$  which causes a fall in  $I$  for all relevant values of  $(F - J)$ . The value of  $E'$  also declines due to an increase in  $M_0$  and IE settles down to  $IE''$ . A larger trade deficit results because of the greater propensity to import.

In all three cases, lower aggregate domestic savings limit investment activity unless this is compensated for by additional foreign savings. The more restrictive macroeconomic constraints lead to an unambiguous fall in investment and consequently a lower GDP growth rate. Other notable results are:

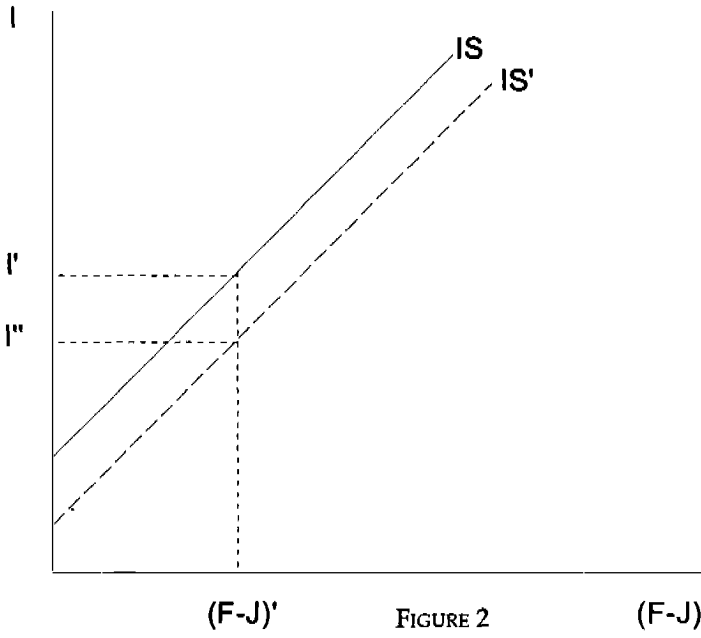


FIGURE 2  
*Effect of a Reduction in (T-G) on I Under a Savings Constraint*

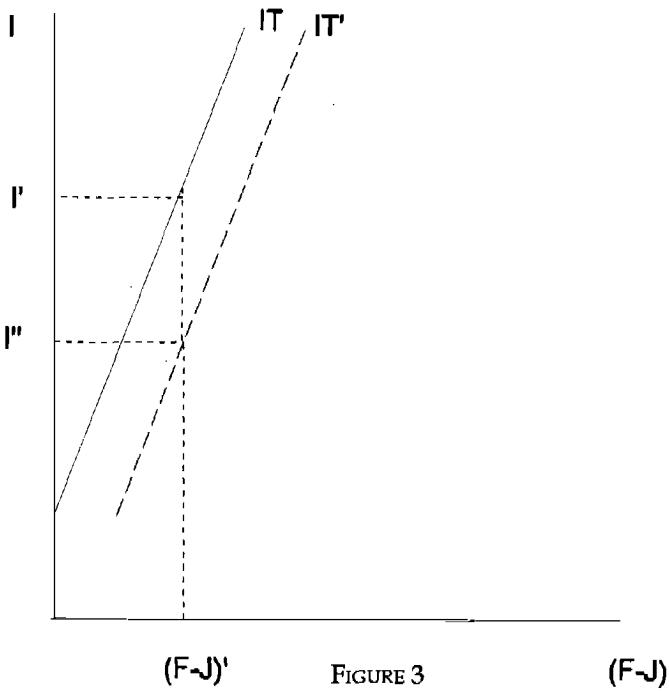


FIGURE 3  
*Effect of a Reduction in (T-G) on I Under a Fiscal Constraint*



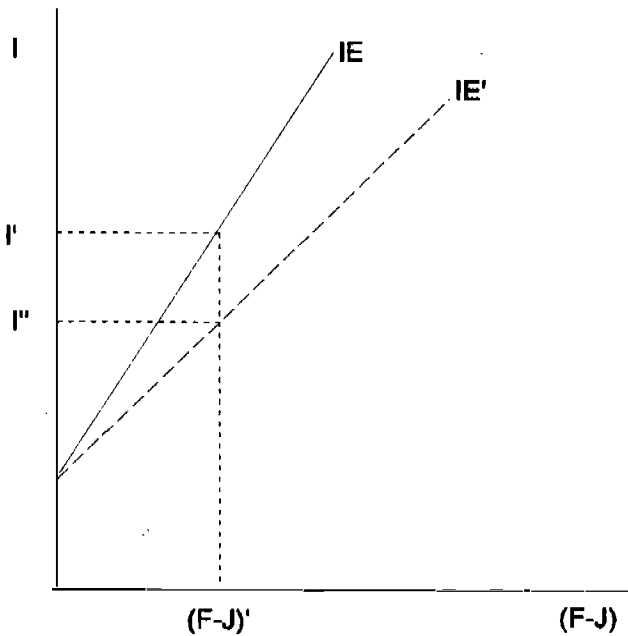


FIGURE 4  
*Effect of a Tariff Reduction on I  
 Under a Foreign Exchange Constraint*

1. The range where the foreign exchange constraint is binding widens after the reduction in tariffs. This result is intuitive since the increase in imports will put a strain on existing foreign exchange resources. Thus the focus of policies should shift towards the trade sector away from increasing domestic savings mobilization and enhancing the efficiency of public investment. Most likely there will be pressure on the exchange rates and the BSP must move decisively to prevent debilitating, speculative attacks on the peso.

2. The decline in investment is smallest when the economy is under a savings constraint. This follows from the relative slopes of the various constraints. The comparative fall in investment when the economy is under a fiscal constraint and foreign exchange constraint is an empirical question, but because of the double movement in the foreign exchange constraint the reduction in investment is likely larger under the latter.

3. At relatively high levels of foreign transfers, the savings constraint is binding, and this seems to be the case for the Philippines at present.

What are the possible policies to counteract the fall in investment?

The most obvious remedy would be to compensate for the loss of tariff revenue. This increases the importance of the Comprehensive Tax Reform Package of the Philippine government especially in the area of tax administration.

Even if there is no compensation for the loss in tariff revenue, the level of investment can be maintained if there is an increase in foreign transfers. Again based on the relative slopes of the constraints, the required increase in  $(F - J)$  is largest when the savings constraint is binding and smallest when the fiscal constraint is binding.

The composition of foreign transfers, however, is quite important. Less emphasis should be placed on increasing the inflow of OCW remittances because of its attendant social costs, and of portfolio investment, because of its volatility. Instead foreign direct investment should be encouraged. Hopefully the move towards a low uniform tariff will improve the business climate, thus attracting more foreign direct investment.

The determinants of foreign direct investment become critical in this case. If macroeconomic stability is the most important consideration of foreign businessmen, as some studies show [see De Jong and Vos (1994) for a survey] then the widening trade and fiscal deficits should be a great cause of concern. It may be that the deterioration in macroeconomic imbalances will offset the positive signals of the tariff reduction.

Another key assumption of the three-gap model is the constancy of the ICOR. The reduction in tariffs is aimed at enhancing the efficiency of the economy, and this assumption may be unrealistic. Thus, instead of remaining a constant the ICOR may fall following the program of trade liberalization.

If the value of ICOR depends more on the uniformity of tariff rather than the level itself, then the government must rethink its choice of 5 percent given the revenue implications. It may be that

the ICOR is invariant within a specified range of tariff levels (say below 15 percent) and in that case the government can push for the limit and opt for a higher level of uniform tariffs.

#### IV. MODEL SIMULATIONS

A small macroeconometric model was estimated for this paper. The objective of the simulation exercises is not to determine the precise macroeconomic effects of the reduction in tariffs but whether the conditions for a decline in investment are satisfied after a change in the tariff structure. These center on the impact of a reduction in tariffs on the government deficit and the trade balance.

The details of the model are presented in the Appendix. It is a standard demand-driven model estimated using annual data from 1967 to 1994. The main policy variables are the exchange rate, money supply and government spending. The latter two variables feed mainly through the interest rate.

It was rather difficult to introduce a tariff variable into the model due to the unavailability of time series for tariffs for commodity imports reported in the National Income Accounts. Hence an improvised variable was created using data on trade taxes and merchandise imports. An aggregate tariff  $t$  was generated using trade taxes,  $TT$ , which are assumed to be equal to the aggregate tariff rate  $t$  multiplied by import prices  $P_m$  and imports of goods in real terms,  $M$ :<sup>2</sup>

$$TT = t \cdot P_m \cdot M \quad (16)$$

The tariff variable was calculated using available historical data from 1975 to 1995. A graph of  $t$  is shown in Figure 5.<sup>3</sup> The behavior of  $t$  is erratic although there is a distinct decline in its value in 1995 from its value in 1975. One reason for the erratic movement may be the use of the HCV system for valuing our imports which leads to a certain degree of arbitrariness in computing the value of

2. The aggregate tariff  $t$  is equivalent to the variable TARS in the macroeconometric model.

3. There is a question raised that the fall in  $t$  is largely due to an increase in duty free imports. The data show, however, that the effective tariff based only on dutiable imports has also declined sharply since 1992.

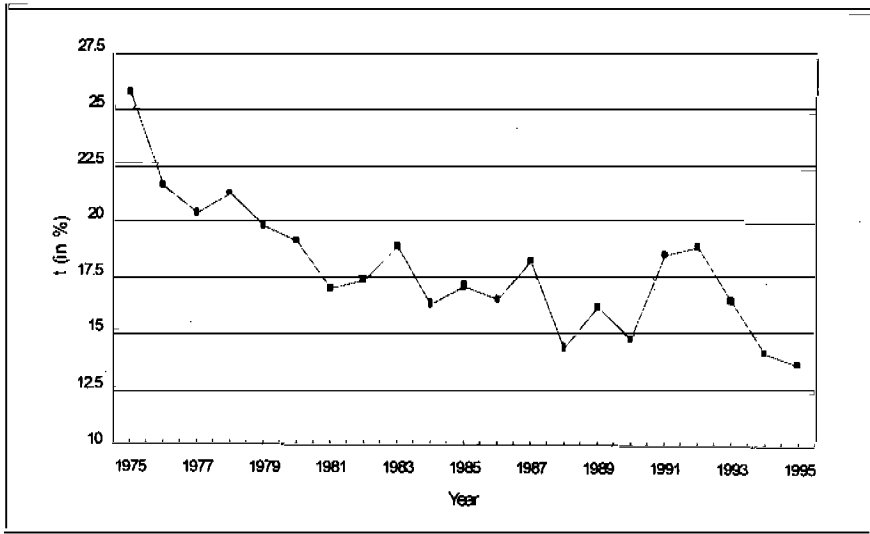


FIGURE 5  
*Behavior of Aggregate Tariff Variable (1975 to 1995)*

taxes on imports. With the scrapping of HCV in favor of a intermediate transaction value system, we can assume  $t$  to decline at a uniform rate towards 5 percent in the year 2004.

The variable  $t$  appears in three equations of the model. It affects the wholesale price index by adding to the cost of imports,  $P_m$  (see equation 6 of the appendix). The aggregate tariff thus influences both the price level and the rate of inflation. By affecting the cost of imports it also impacts on the level of import demand and the trade deficit (equations 4 and 5 of the appendix). The partial elasticity of import demand with respect to price is calculated to be 0.5.

Equation 16 shows how  $t$  will affect the government deficit in the macroeconomic model since the variable  $TT$  is used in determining total tax revenue of the government (equations 20 and 26 of the appendix). A decline in  $t$  will thus lead to opposing effects on  $TT$ , upward due to an increase in  $M$  and downward due to the fall in  $t$  itself.

In the simulation process we assume  $t$  to be maintained between 10 percent and its 1995 value of 13.5 percent for the period 1996-2004. This represents the baseline solution. For the

"shock" run,  $t$  is allowed to decline at a uniform rate toward 5 percent in 2004.

The results for key variables are shown in Figures 6 to 8. A reduction in the tariff level leads to greater demand for imports (Figure 6) justifying the movements of the IE constraint. As a consequence, the trade deficit widens (Figure 7), putting pressure on the exchange rate.

The rise in the volume of imports does not compensate for the reduction in the tariff level and as a result the fiscal balance also deteriorates as shown in Figure 8. (In the actual simulations the surplus in the primary account is reduced.) This implies that the condition for more restrictive IT and IS constraints is satisfied and all the issues discussed in Section 3 become relevant.

It could be argued that the three-gap framework is a one-period model and is not consistent with the dynamic structure of the macroeconomic model. The latter, however, is a series of one-period adjustments and the simulation results show that the fiscal balance deteriorates on a consistent basis following the fall in the tariff level.

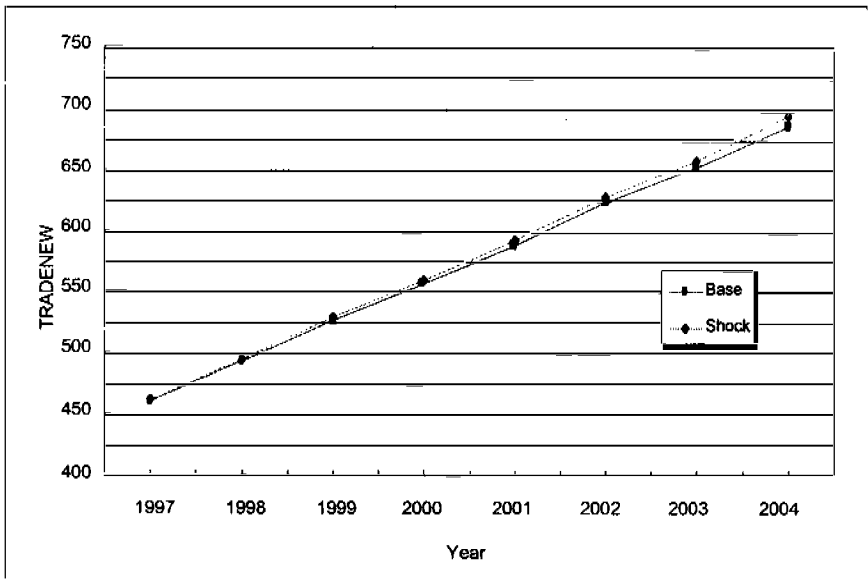


FIGURE 6  
Simulation Results For  
Merchandise Imports (1997 to 2004)

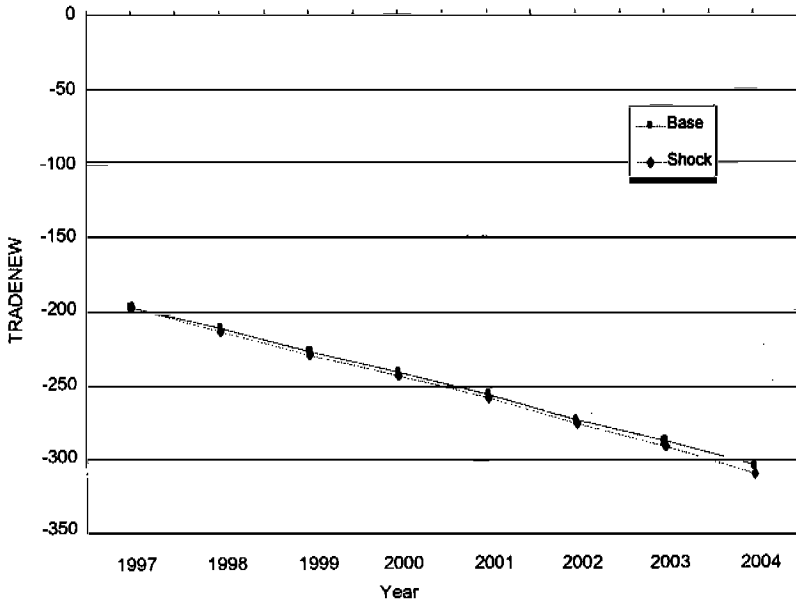


FIGURE 7  
*Simulation Results For  
Trade Deficit (1997 to 2004)*

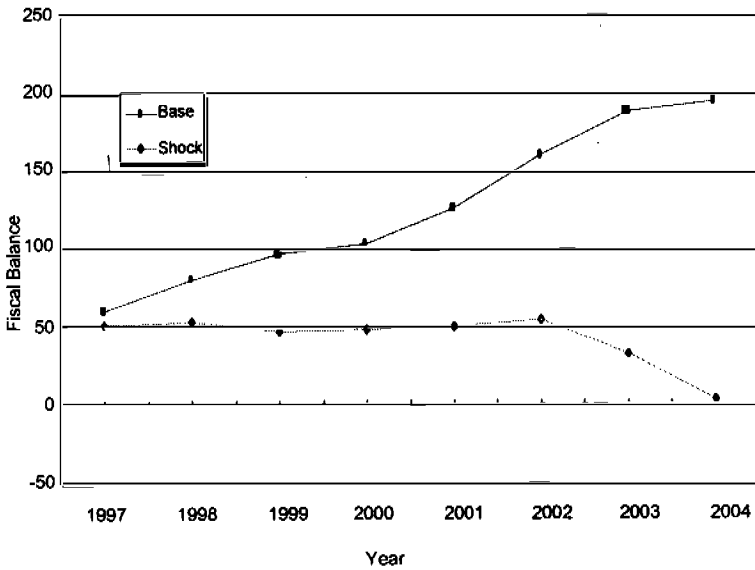


FIGURE 8  
*Simulation Results For  
Fiscal Balance (1997 to 2004)*

## V. CONCLUDING REMARKS

Efficiency considerations could be incorporated in the empirical analysis by adding the production sector which is present in the full version of the macroeconometric model. To account for the microeconomic effects of a reduction in the tariff level the coefficients of key variables (presumably the price indices) must be adjusted. This is equivalent to modifying the ICOR. The degree of adjustment, however, requires further research beyond the scope of the present study.

The BOP sector is also important since it was shown that an influx of foreign capital could compensate for the fall in tariff revenue. An equation for foreign direct investment should be estimated which would include variables representing macroeconomic stability and the potential returns to investment (that would vary with the tariff level), the familiar risk-return trade-off. It can then be determined whether the increase in potential profit following the more open trade regime will offset the effects of greater macroeconomic instability and induce a greater flow of foreign direct investment.

Even without more precise empirical results, several important issues arise from the previous discussion. For one, policymakers must be cautious about the impact of economic reform on macroeconomic stability. There have been many instances when economic failures were attributed to microeconomic policies (e.g., protection, high tariffs) when their sources lay with unsustainable macroeconomic policies (Rodrik 1996). In their anxiousness to "get prices right," authorities may end up exacerbating macroeconomic imbalances which will eventually offset any benefits from the reform program.

The government must take measures to compensate for the reduction in tariff revenue by increasing tax effort in other areas and improving tax administration. Third, the exchange rate policy will become extremely important following the fall in the tariff level. Finally, the government must develop a more coherent program to increase the level of foreign direct investment.

## APPENDIX

The estimated equations for the macroeconometric model are shown in Table A.1. The specifications follow closely those of the larger model; hence, for a more detailed discussion of the equations one could refer to Reyes and Yap (1993) or Constantino, Yap et al. (1990).<sup>4</sup>

OLS estimation was used and the residuals were checked for stationarity using the Augmented Dickey-Fuller statistic. This is a rather weak test considering the small number of observations but no alternative is available. Those equations where the ADF statistic is not reported are those where the null hypothesis of a unit root could not be rejected.

Meanwhile, the goodness-of-fit measures are presented in Table A.3. In general, the ADF statistics indicate that the key behavioral equations are valid regressions while the statistics of fit show that the model tracks the variables rather well. The mean absolute percentage error and the RMSPEs are below 5 percent for the important variables like GDP, CP and prices. One notable observation is that the statistics-of-fit are only marginally better for the smaller model when compared with the larger model.

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4. Reyes, C., M. and J. T. Yap (1993), "Re-estimation of the PIDS Macroeconometric Model" Manuscript.

Constantino, W. M.; J. T. Yap; R. Q. Butiong; and A. S. dela Paz (1990) "An Annual Macroeconometric Model for the Philippines," In *ASEAN Link - An Econometric Study*, edited by Y. Nakamura and J. T. Yap. Singapore: Longman, 1990.



**TABLE A.1**  
**List of Behavioral Equations**  
 (Figures in parentheses are relevant T-statistics)

**1. Private Consumption Expenditures**

$$\begin{aligned}
 CP &= -109721.4 + 0.099 * (GNP - TOTTA X / (CPI / 100)) + \\
 &\quad (7.79) \quad (3.90) \\
 &\quad 5488.22 * POP + 1.033 * (MS + LAG1( MS )) / (2 * (CPI / 100)) + \\
 &\quad (7.08) \quad (7.43) \\
 &\quad 0.350917 * LAG1( CP ) \\
 &\quad (3.84) \\
 R^2 &= 0.9989 & \text{ADF Test Stat:} & -3.09 \\
 DH &= -0.27941 & \text{5\% critical value:} & -2.997 \\
 F\text{-stat} &= 6179.85 & \text{YEAR:} & 1968 - 1994
 \end{aligned}$$

**2. Investment in Durable Equipment**

$$\begin{aligned}
 IDER &= 9836.66 + 0.148 * MGDS - 610.17 * INFL - 635.62 * \\
 &\quad (2.85) \quad (5.33) \quad (3.12) \quad (2.84) \\
 &\quad (TBILL - INFL) + 0.21 * (CONSPR + CONSGO) + 0.338 * \\
 &\quad (2.81) \quad (2.14) \\
 &\quad LAG1(IDER) \\
 R^2 &= 0.944 & \text{ADF Test Stat:} & -5.55 \\
 DH &= 2.16 & \text{5\% critical value:} & -3.02 \\
 F\text{-stat} &= 81.55 & \text{YEAR:} & 1970 - 1994
 \end{aligned}$$

**3. Private Consumption**

$$\begin{aligned}
 CONSPR &= 6754.92 + 0.126 * (GDP - LAG1( GDP )) - 160.35 * \\
 &\quad (1.97) \quad (2.69) \quad (0.695) \\
 &\quad (TBILL - INFL) - 308.23 * INFL + 0.258 * CONSGO + \\
 &\quad (1.26) \quad (1.85) \\
 &\quad 0.717 * LAG1( CONSPR ) \\
 &\quad (3.96) \\
 R^2 &= 0.933 & \text{ADF Test Stat:} & -4.28 \\
 DH &= -1.53 & \text{5\% critical value} & -3.01 \\
 F\text{-stat} &= 67.81 & \text{YEAR:} & 1970 - 1994
 \end{aligned}$$

#### 4. Merchandise Imports

$$\begin{aligned} \text{MGDS} = & 105232.5 - 76109.96 * (\text{PMGDS} / \text{PGNP}) * (1 + \text{TARF}) + \\ & (2.47) \quad (3.03) \\ & 0.476 * (\text{GDP} - \text{LAG1}(\text{GDP})) + 8.27 * (\text{NFA} / \text{PGNP}) + \\ & (4.25) \quad (1.36) \\ & 0.932 * \text{LAG1}(\text{MGDS}) \\ & (1.93) \end{aligned}$$

R <sup>2</sup>	=	0.98	ADF Test Stat:	-3.55
DH	=	0.1772	5% critical value:	-3.02
F-stat	=	243.60	YEAR:	1975 - 1994

#### 5. Import of Services

$$\begin{aligned} \text{MSV} = & 1172.21 + 0.024 * \text{MGDS} + 0.820 * \text{LAG1}(\text{MSV}) \\ & (0.84) \quad (2.53) \quad (0.09) \end{aligned}$$

R <sup>2</sup>	=	0.91	F-stat:	127.22
DH	=	0.18	YEAR:	1968 - 1994

#### 6. Log of Wholesale Price Index

$$\begin{aligned} \text{LWPI} = & 2.56 + 0.406 * \text{LOG}(\text{PMGDS} * (1 + \text{TARF})) + 0.253 \\ & (1.74) \quad (2.13) \quad (1.38) \\ & * \text{LOG}(\text{TL} / \text{GNP}) - 4.03 * (\text{K46} / \text{LAG1}(\text{K46}) - 1) + 0.34 \\ & (2.71) \quad (2.23) \\ & * \text{LAG1}(\text{LWPI}) \end{aligned}$$

R <sup>2</sup>	=	0.992	F-stat:	584.71
DH	=	2.45	YEAR:	1975 - 1994

#### 7. Implicit Price Index for Gross National Product

$$\begin{aligned} \text{PGNP} = & 1.49 + 0.114 * \text{WPI} + 0.614 * \text{LAG1}(\text{PGNP}) \\ & (1.37) \quad (6.03) \quad (7.69) \end{aligned}$$

R <sup>2</sup>	=	0.997	F-stat:	4003
DH	=	2.27	YEAR:	1968 - 1994

8. Consumer Price Index

$$\text{CPI} = 0.95 + 0.085 * \text{WPI} + 0.737 * \text{LAG1}(\text{CPI})$$

(0.74) (4.29) (8.59)

$$\begin{aligned} R^2 &= 0.995 & \text{F-stat:} & 2773.25 \\ \text{DH} &= 2.37 & \text{YEAR:} & 1968 - 1994 \end{aligned}$$

9. Implicit Price Index for Government Consumption

$$\text{PCG} = -0.296 + 0.061 * \text{WPI} + 0.917 * \text{LAG1}(\text{PCG})$$

(0.23) (3.68) (16.30)

$$\begin{aligned} R^2 &= 0.998 & \text{F-stat:} & 4861.84 \\ \text{DH} &= 0.52 & \text{YEAR:} & 1968 - 1994 \end{aligned}$$

10. Implicit Price Index for Government Construction

$$\text{PCGOV} = 1.16 + 0.163 * \text{WPI} + 0.446 * \text{LAG1}(\text{PCGOV})$$

(0.83) (7.37) (5.24)

$$\begin{aligned} R^2 &= 0.995 & \text{F-stat:} & 2849.99 \\ \text{DH} &= 1.94 & \text{YEAR:} & 1968 - 1994 \end{aligned}$$

11. Implicit Price Index for Merchandise Imports

$$\text{PMGDS} = 0.643 + 104.32 * \text{PMDOL} * \text{ER}$$

(0.74) (99.81)

$$\begin{aligned} R^2 &= 0.998 & \text{F-stat:} & 9961.31 \\ \text{DW} &= 1.72 & \text{YEAR:} & 1970 - 1994 \end{aligned}$$

12. Direct Tax

$$\text{DTAX} = -2922.81 + 0.051 * \text{GNP} * (\text{PGNP} / 100) + 0.56 * \text{LAG1}(\text{DTAX}) + 21246.96 * \text{DUM94}$$

(1.55) (3.78) (3.76) (5.11)

$$\begin{aligned} R^2 &= 0.996 & \text{F-stat:} & 1514.995 \\ \text{DH} &= 0.14 & \text{YEAR:} & 1975 - 1994 \end{aligned}$$

13. Total Taxes

$$\text{TOTTAX} = 2850.57 + 0.856 * \text{TAXREV} + 0.213 * \text{LAG2}(\text{TOTTAX})$$

(2.33) (10.26) (1.89)

R <sup>2</sup>	=	0.998	F-stat:	4995.065
DH	=	1.64	YEAR:	1975 - 1994

14. Average Interest Rate on 91-day Treasury Bills

$$\text{TBILL} = -0.278 + 0.311 * \text{INFL} + 59.16 * (\text{CGN} + \text{CGOVN} -$$

(0.095) (6.18) (2.24)

$$\text{TOTTAX}) / (\text{GNP} * (\text{PGNP} / 100)) - 7.80 * (\text{TL} / \text{LAG1}(\text{TL}) - 1)$$

(1.25)

$$+ 0.442 * \text{LAG1}(\text{TBILL}) + 0.322 * \text{TIME}$$

(3.63) (3.65)

R <sup>2</sup>	=	0.80	ADF Test Stat:	-3.43
DH	=	1.095	5% critical value:	-3.004
F-stat	=	19.76	YEAR:	1971 - 1994

15. Capital Consumption Allowance

$$\text{KCAR} = -13357.42 + 0.038 * \text{GDP} + 0.013 * \text{LAG1}(\text{K46}) +$$

(3.73) (4.79) (2.10)

$$0.754 * \text{LAG1}(\text{KCAR}) - 1280.95 * \text{TIME}$$

(8.82) (2.76)

R <sup>2</sup>	=	0.992	ADF Test Stat:	-2.47
DH	=	1.80	5% critical value:	-2.99
F-stat	=	858.35	YEAR:	1968 - 1994

16. Merchandise Exports

$$\text{XGDS} = -15839.05 + 291.57 * (\text{ER} / \text{LAG1}(\text{ER}) - 1) * 100 +$$

(2.54) (2.42)

$$0.151 * \text{MGDS} + 0.096 * \text{GNPJAP} + 0.652 * \text{LAG1}(\text{XGDS}) + 31236.75 * \text{DUM80} + 0.218 * (\text{GDP} - \text{LAG1}(\text{GDP}))$$

(2.40) (1.76) (4.97) (4.03) (2.12)

R <sup>2</sup>	=	0.976	ADF Test Stat:	-3.43
DH	=	-2.25	5% critical value:	-2.99
F-stat	=	175.91	YEAR:	1968 - 1994

**LIST OF IDENTITIES**

17.  $GDP = CP + (CGN / (PCG / 100)) + IDER + CONSPR + CGOVN / (PCGOV / 100) + XGDS + XSV + IINV + BREEDR - MGDS - MSV + STATD$
18.  $GNP = GDP + NFIA$
19.  $DEFNEW = CGN + CGOVN - TOT TAX$
20.  $TRADET = TARF * MGDS * (PMGDS / 100)$
21.  $TRADENEW = XGDS - MGDS$
22.  $INFL = (CPI / LAG1(CPI) - 1) * 100$
23.  $KGR = K46 / LAG1(K46) - 1$
24.  $K46 = LAG1(K46) + (CGOVN / (PCGOV / 100)) + CONSPR + IDER + IINV + BREEDR - KCAR$
25.  $WPI = EXP(LWPI)$
26.  $TAXREV = DTAX + TRADET$

TABLE A.2  
List of Endogenous Variables

Variable Name	Variable description
CP	Personal Consumption (Real; Million P)
IDER	Investment in Durable Equipment (Real; Million P)
CONSPR	Private Construction (Real; Million P)
MGDS	Merchandise Imports (Real; Million P)
MSV	Import of Services (Real; Million P)
LWPI	Log of Wholesale Price Index (1978=100)
PGNP	Implicit Price Index for Gross National Product (1985=100)
CPI	Consumer Price Index (1985=100)
PCG	Implicit Price Index for Government Consumption (1985=100)
PCGOV	Implicit Price Index for Government Construction (1985=100)
PMGDS	Implicit Price Index for Merchandise Imports (1985=100)
DTAX	Direct Tax (Million P)
TOTTAX	Total Taxes (Million P)
TBILL	Average Interest Rate on 91-day Treasury Bill
KCAR	Capital Consumption Allowance (Real; Million P)
XGDS	Merchandise Exports (Real; Million P)
GDP	Gross Domestic Product (Real; Million P)
GNP	Gross National Product (Real; Million P)
DEFNEW	Fiscal Deficit (Million P)
TRADET	Taxes on International Trade (Million P)
TRADENEW	Trade Deficit (Real; Million P)
INFL	Inflation Rate based on CPI
KGR	Growth Rate of K46
TAXREV	Tax Revenues (Million P)
K46	Capital Stock (Million P)

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**List of Exogenous Variables**


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<b>Variable Name</b>	<b>Variable Description</b>
BREEDR	Breeding Stock and Orchard Development (Real; Million P)
CGN	Government Consumption (Nominal; Million P)
CGOVN	Government Construction (Nominal; Million P)
DUM 80	Dummy Variable for XGDS
DUM94	Dummy Variable for DTAX
ER	Exchange Rate
GNPJAP	Gross National Product of Japan (Real; Billion Yen)
IINV	Increase in Stocks
MS	Money Supply, end of year (Million P)
NFA	Net Foreign Assets (Million P)
NFLA	Net Factor Income from Abroad (Real; Million P)
PMDOL	Implicit Dollar Price for Imports (1985=100)
POP	Population (Millions)
STATD	Statistical Discrepancy (Real; Million P)
TARF	Tariff
TIME	Time Period
TL	Total Liquidity, end of year (Million P)
XSV	Export of Services (Real; Million P)

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TABLE A.3  
Model Validation (1976 to 1994)

Variable	MAPE	RMSPE	THEIL
<i>Behavioral</i>			
CP	1.65	2.13	0.0102
IDER	9.98	11.89	0.0497
CONSPR	11.03	14.46	0.0669
MGDS	8.06	10.68	0.0454
MSV	13.33	14.71	0.0780
LWPI	1.01	1.22	0.0063
PGNP	5.66	7.42	0.0307
CPI	6.49	8.86	0.0364
PCG	3.36	4.12	0.0186
PCGOV	8.13	10.13	0.0465
PMGDS	1.18	2.03	0.0140
DTAX	10.08	12.64	0.0269
TOTTAX	4.35	5.41	0.0166
TBILL	19.39	25.18	0.1237
KCAR	5.66	6.45	0.0328
XGDS	7.00	9.08	0.0415
<i>Identities</i>			
GDP	2.34	3.72	0.0172
GNP	2.38	3.82	0.173
DEFNEW	72.48	127.58	0.1468
TRADET	7.97	10.23	0.0372
TRADENEW	39.00	61.80	0.0925
INFL	187.48	648.79	0.2961
KGR	15.55	21.56	0.0578
TAXREV	5.19	6.57	0.0166
WPI	5.86	7.21	0.0408
K46	1.67	1.87	0.0087

## Notes:

(1) MAPE - Mean Absolute Percentage Error

(2) RMSPE - Root Mean Square Percentage Error



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