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Macroeconomic and Distributional Impacts of Downsizing Fiscal Deficits

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This paper analyzes the price, growth, and distributional changes in a developing economy under domestic fiscal reform to narrow a fiscal deficit. We take the case of the South Asian developing economy of Nepal, which has been less covered in policy studies. Our approach is the Computable General Equilibrium (CGE) method applied to the Social Accounting Matrix (SAM) data. We conducted a simulation analysis with an approximately 10 percent reduction in the fiscal deficit of the government from domestic measures. This simulation exempted the agricultural sector from imposition of the additional tax, as an effort to protect the welfare of the poor. Our results show that under this policy the industrial and agricultural sectors expand, whereas the services sectors contract. However, basic macroeconomic fundamentals hardly change. Households that basically draw their livelihood from the industrial and agricultural sectors are benefited, whereas those that draw basically from the service sectors lose. Therefore, the study warrants the policy implication that the potential expansions and contractions of different activities must be envisaged beforehand when implementing this type of policy reform. Otherwise, poor who are working in the potential contractionary sectors may become even poorer after the implementation of this policy.

JEL Classification: C15, D33, D58, E62, H62
Keywords: CGE model, Simulation analysis, Growth, Macroeconomic features, Household welfare

1. Introduction

Some earlier studies on internal liberalization reforms in developing countries such as Thiele (2001), Psacharopouls et al. (1992) revealed the anti-poor effects of structural reforms, at least in the short-run. Furthermore, Musinguzi and Smith (1993) demonstrated continuing poverty for a large portion of the population in developing countries from an effort to cut down government expenditures in order to narrow the fiscal deficit. Furthermore, downsizing the government's regular expenditures in conjunction with devaluation of the domestic currency as an effort to integrate traditional developing economies

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with the industrial world — generally termed as globalization — is known to make the lives of the poor even poorer in the developing world. Despite these anti-poor effects of earlier structural reforms, developing countries had little policy autonomy due to extensive foreign debt and assistance not only from the developed world but also from the global financial institutions that basically support liberal economic policies. Moreover, a non-globalizing country not only fails to participate in the benefits of an expanding volume of world trade, it actually sees a deterioration in its position compared with the pre-globalizing era, (Milanovic and Squire (2005), p. 4).

In addition to trade reform, fiscal and labor market reforms are also emphasized as part of the major policy agenda in many developing countries, and assessing their effects on unemployment and poverty is a key issue in the designing and sequencing of adjustment programs. In turn, assessing these effects requires understanding not only how the labor market operates, but also how fiscal variables (taxes and expenditure) interact with the labor market. The reason is that most taxes not only have an impact on the functioning of the economy, but also affect the labor market, both directly and indirectly, through changes in the level and distribution of wages, labor supply decisions, and the level and composition of employment. For instance, taxing the profits of small firms (which tend to be more labor intensive) may affect their ability to create jobs, whereas income taxation and the existence of an unemployment benefit system may affect the propensity of the unemployed to seek employment (Agénor (2003), p. 1).

The levels of government income, expenditure, and the resource gap (or surplus) provide important information for studying the effects of government budgets on capital formation, growth, and distribution. Much empirical work exists that examines the effect of government expenditure on economic growth. Kormendi and Meguire (1985), Grier and Tullock (1989), and Landau (1983) employ government consumption expenditure as a share of GDP from the Summers and Heston data base, see Heston and Summers (1996), and find either a negative effect or no effect on the growth of real per capita GDP. Barro (1991) finds that government consumption expenditure has a negative and significant effect on the growth of real per capita GDP, but that government investment expenditure does not have a significant effect, although the sign is positive.

Several recent papers, including Devarajan, Swaroop and Zou (1996), and Miller and Russek (1997), have examined the effects of government expenditure on the growth of real per capita GDP without assigning the components into productive or unproductive categories. Devarajan, Swaroop and Zou (1996) considered a sample of developing countries from 1970 to 1990 and found that all candidates for unproductive government expenditure either have no effect or a negative effect on the growth of real per capita GDP; only current expenditure has a positive effect. Miller and Russek (1997) considered a sample of developed and developing countries from 1975 to 1984 and found that both the component of government expenditure and the method of financing do have different effects. Moreover, according to their findings the debt-

financed public expenditure growth in defence, health, and social security and welfare have negative effects on the growth of real per capita GDP in developing countries, while debt-financed growth in education expenditure has a positive effects. Easterly and Rebelo (1993), however, showed that public transportation and communication investment in developing countries leads to higher growth in real per capita GDP along with a crowding-in effect. The findings seem to support the work of Aschauer (1989) on the linkage between public and private investment.

Some empirical studies consider the effects of fiscal variables on investment, typically using aggregate fiscal measures. For example, Levine and Renelt (1992) concluded that none of the fiscal variables possesses a robust correlation with investment. Fischer (1993) performed cross-section and pooled cross-section time-series regressions and found that a budget surplus associates with greater capital formation.

On the other side, in the closed-economy as shown by Mankiw (2003), using the IS-LM model suggests that greater government spending will boost real interest rates and discourage private investment. Greater government spending raises planned aggregate expenditure, which stimulates output, increases the real demand for money, and reduces the demand for bonds, which depresses bond prices and elevates interest rates. The simple IS-LM model makes no distinction between government spending on consumption and investment.

Reducing the public deficit is one of the important components in the orthodox model of stabilization.[i)] Not only in Nepal, but also in many developing countries, public budget cuts have become one of the important fiscal variables under economic stabilization. But, there is growing evidence as discussed above that a decline in public expenditure on health and education causes a severe slowing down of the economic activities in developing countries in the long-run. In our study, we approach the public deficit somewhat differently. We shall analyse the growth and distribution effects of reducing the public deficit, whereby reduction of the public deficit is accomplished simultanously by increasing revenue rather than by cutting expenditure.

In this simulation, budget deficit as a percentage of GDP is lowered, with government consumption and investment the same but government revenue parameters set higher. Here we increase the domestic tax rates, both on income and consumption. The direct tax is the income tax upon households and firms (ty_h and tyf), and the indirect tax (tq_c) is the tax on domestic production/sales. Although scaling-up the indirect tax rates creates many distortions in the commodity markets because they are not neutral to tastes and preferences, the alternative avenues are not strong enough to raise public revenue from internal sources. This is because direct tax revenue accounts for less than one-fourth of the total public revenue in many developing countries; that is the case of Nepal also. Because indirect taxes are shifted and ultimately they rest on the final consumer, from the perspective of protection of the poor's welfare we should be cautious when raising such rates.

From the mid-1980s, there were several attempts to reduce the fiscal deficits

in developing countries as a part of the structural adjustment program of the World Bank and the IMF. There are some partial analyses of the impacts of these efforts; however, so far these works have not covered South Asian poor economies. This paper seeks to address this gap. Against this background, the features of this paper are two-fold. First, it uses the general equilibrium method while studying the impacts of narrowing the fiscal deficit. Second, it mainly focuses on macroeconomic and distributional changes of such fiscal reform.

The remaining sections are organized as follows. Section 2 presents the computable general equilibrium model used in this study. This is neo-classical in nature. Section 3 implements a simulation analysis and measures its overall impacts in the economy. The average/marginal propensity of food consumption is very high among the poor as compared to the non-poor. Therefore, to protect the welfare of the poor we impose the mark-ups in the indirect taxes only on non-agricultural commodities and services. However, in case of the direct tax, there is no problem in scaling-up the rate because the poor households are outside the income tax net. Section 4 analyzes the changes in basic macroeconomic features. Section 5 summarizes the conclusions.

2. The model

Our model is specified in 30 equational sets, divided into "blocks" for prices, production and commodities, institutions, poverty and system constraints. Notations used and model specifications are displayed in the Appendix. The model contains four activities and four corresponding commodity types (agriculture, industry, commercial services, and other services), three factors of production (low skilled labor, high skilled labor, capital) and, four household groups (UHH, LRHH, SRHH, LLRHH).[ii] For the detailed description of the model equations, see the Appendix.

3.2 The closure rules

Our Nepal CGE model belongs to the neo-classical group; therefore, we selected the adjustment rules accordingly. We have four market closures in our model: government balance closure, factor market closure, foreign exchange closure, and saving-investment closure. Tax rates are fixed; whereas government saving is flexible in the government balance. In the factor market, total factor supplies are fixed whereas returns to factors are flexible. Likewise, in the case of the external balance, the nominal exchange rate is fixed whereas foreign saving is flexible. Lastly, in the case of the saving-investment balance, average propensities to save (*aps*) of all the non-government institutions are fixed and the level of capital formation is flexible.

Returns to the factors are flexible to clear the respective factor markets. Factors are assumed to face flexible returns in a market characterized by full employment. Moreover, we consider homogenous factors and no distortions in the factor market. The same principle applies to the commodity market, where the flexible market prices of the commodities clear their respective markets.

Completion of model formulation requires balancing the number of variables

and equations. The proposed model counts 158 variables in 128 single equations. In order to make a unique solution to the model, 30 variables are required to be exogenous. These are variables belonging to factor supplies $(QFS)_f$, and total population (TPN); and variables under control of government and the rest of the world, which include EXR, PWE_c, PWM_c, GC_c, $QE_{os\text{-}c}$, GI, TR_{hr}, TR_{hg}, TR_{gr}, and $TR_{fi,g}$. Finally, we select $PD_{ind\text{-}c}$ as a numeraire. As a result the number of endogenous variables and single equations are equal at 128. Equations 31 and 32 are not counted in the system of model as they are the balancing equations to confirm the validity of the solution.

The major database to this study is the Social Accounting Matrix (SAM) of Nepal for the year 1996 at this year's constant prices. For the Nepal SAM and its construction procedures see Acharya (2006).

3. Simulation results

In this simulated reform, we have raised the non-agricultural domestic indirect tax rates by 14 percent, the household income tax by 20 percent and the corporate income tax by 19 percent. Because this scheme definitely increases government revenue, it narrows the fiscal deficit both as a percentage of government expenditure and also as a percentage of GDP. These rates have been chosen in such a way as to reduce the budget deficit by approximately 10 percent.

Raising the domestic indirect tax rate causes an overall increase in domestic supply prices and composite commodity prices (Table 1). In industrial commodities, however, the composite price shifts downwards because of the increase in imports of industrial commodities (Table 2) following the heavy domestic indirect tax. As Nepalese imports are basically dominated by industrial commodities, and there is a high import elasticity coefficient for industrial commodities in our model[iii], this change can be expected. Due to the overall increase in domestic supply prices, the activity prices, PA, also go up. The rises in the activity prices induce the value added prices, PVA, to move upward (see the relationship in equation 6 in the Appendix).

The proposed increase in domestic tax rates produces some changes in domestic production, supply, import, and export of commodities and services. The agricultural and industrial sectors produce, supply, import and export

Table 1: Effects on prices of commodities and activities

Sectors	Baseline values (in index)					Simulated values (in index)				
	PM	PE	PQ	PA	PVA	PM	PE	PQ	PA	PVA
Agri	1.132	1.0	1.015	1.0	0.725	1.132	1.0	1.017	1.002	0.727
Ind	1.103	1.0	1.042	1.0	0.411	1.103	1.0	1.033	1.000	0.412
ComSer	1.146	1.0	1.021	1.0	0.678	1.146	1.0	1.022	1.002	0.68
OthSer	1.204	1.0	1.019	1.0	0.626	1.204	1.0	1.023	1.002	0.629

Note: Agri, Ind, ComSer, and OthSer in this and following tables refer to agriculture, industry, commercial services and other services, respectively.

more; whereas service sectors do less in all these respects (Table 2). The results are logical because this simulation has kept the indirect tax rate on domestic agricultural products constant, whereas the rates on other products are raised. This enhances agricultural activities, and because agricultural intermediate deliveries share a significant proportion in industrial activities (see Appendix Table B1), industrial production is enhanced as well. The increase in activities in these two sectors could only be possible by reallocating some factors of production from the service sectors; consequently, service activities contract (Table 2). These changes in the activity structures cause similar changes in domestic supplies (QD), and exports (QE). The change in import structure, however, should be understood in a somewhat different way. The overall increase in the prices of domestic supplies makes imports relatively cheaper because import prices do not increase in this scenario. Therefore, imports (QM) increase; but they cannot increase without control in all sectors. The elasticity of substitution between import and domestic supplies are higher in agricultural and industrial commodities;[iv] therefore, rises in their imports can be expected. In case of services, the decline in the domestic production releases intermediate deliveries to the final consumption; and that leads to a decline in the import of services (Table 2).

The net effect on GDP by these internal reforms is positive as it grows by 0.26 percent (Table 3). Likewise, gross fixed capital formation (GFCF) also increases marginally. The balancing factor in the commodity balance equation — the change in stocks (CHST) (see equation 29) — declines marginally because of the rise in demand of intermediate deliveries, and investment. Because of the slightly higher growth in exports than imports, the foreign savings (FSAV)

Table 2: Impact on quantities of commodity and activity

Sectors	Baseline values (*values in billion Rupees*)					% change from baseline				
	QM	QE	QQ	QD	QA	QM	QE	QQ	QD	QA
Agri	8.1	5.8	128.3	119.2	125.0	1.23	0.01	1.01	1.01	1.04
Ind	16.5	33.7	105.6	86.7	120.4	3.64	3.26	3.22	3.34	3.32
ComSer	12.7	15.9	98.8	84.2	100.1	-3.15	-3.14	-3.34	-3.33	-3.30
OthSer	13.3	–	53.8	38.1	38.1	-0.75	–	-1.12	-1.31	-1.31

Table 3: Gross domestic product, investment and change in stocks (values in million Rupees)

GDP	Baseline values	% change from baseline
	231901.0	0.26
Total consumption	214487.0	0.01
Households	191469.0	-0.05
Government	23018.0	0.46
GFCF	56081.0	0.76
CHST	11937.0	-2.85
FSAV	24299.0	-0.22

Table 4: Baseline and simulated values in the factor market

	Baseline levels	% change from baseline	Total remuneration of factors in baseline $= (W_f).(QF_{fa})$	% change from baseline
Wages in Rupees and profit rate in %				
W_f (LSL)	8068.79	0.28		
W_f (HSL)	15255.23	0.53		
W_f (CAP)	21.0	-0.95		
QF_{fa} *Factor use by activity (labor in millions, capital in million Rupees)*				
LSL-AGR	4.946	0.97	39905.0	1.27
LSL-IND	1.265	3.24	10204.0	3.55
LSL-CS	2.167	-3.37	17482.0	-3.10
LSL-OS	1.566	-1.09	12637.0	-0.79
HSL-AGR	0.498	0.80	7599.0	1.27
HSL-IND	0.577	3.12	8809.0	3.55
HSL-CS	0.354	-3.39	5407.0	-3.10
HSL-OS	0.627	-1.28	9565.0	-0.79
CAP-AGR	207860.35	1.08	43129.0	1.27
CAP-IND	146961.11	3.36	30493.0	3.55
CAP-CS	216974.04	-3.28	45020.0	-3.10
CAP-OS	7957.00	-0.97	1651.0	-0.80

also goes down (Table 3), (see equation 31).

There is a less than one percent increase in the rate of remuneration to the factors of production. However, the growth in the profit rate is marginally negative and the growth rate of wage rate of high-skilled labor is relatively higher than that of low-skilled labor (Table 4).

Internal reform measures used in this simulation result in changes in household incomes by varying rates. Urban households benefit the most with highest rate of growth in income (0.91 percent), and small rural households benefit least (-0.56 percent). The growth in per capita income of landless rural households is more than the national average (0.37 percent). Relative benefit to urban households and landless households in this internal reform is due to the expanding industrial and agricultural sectors through which these two household categories respectively draw their livelihood to a significant extent. Moreover, the tax incentive to agricultural activities also benefits large rural households and landless rural households. These two household categories draw their income basically from agriculture, one from agricultural capital and the other from agricultural labor.[v] Small rural households lose under this reform because their activities are spread to all sectors. Although they benefit from the agricultural and industrial growth, they equally lose as well from the contracting service sectors (Table 5). See also Appendix Table B3 that presents the household and corporate income structure in Nepal.

In this internal reform, government revenue grows by about four percent. With about less than one percent increase in expenditure, the government budget deficit enjoys a predetermined reduction of approximately 10 percent

Table 5: Impact on household and firms' income

Household and firms' income	Baseline values (*in million Rupees*)	% change from baseline
YH (U-HH)	69869.0	0.91
YH (LR-HH)	49367.0	0.60
YH (SR-HH)	65488.0	−0.56
YH (LLR-HH)	37856.0	0.68
PCI_{LLR-HH}	4005.2	0.68
PCI (N)	10690.7	0.37
Firms' income (YFIR)	22463.0	−0.92

Table 6: Impact on government variables

	Baseline values (*in million Rupees*)	% change from baseline
GY	32718.0	3.59
GE	43629.0	0.24
GS	−10911.0	−9.81

(Table 6).

Summarizing, the stipulated internal reform leads to growth in GDP and household incomes but a marginal decline in the real volume of consumption expenditure of household groups as a result of price effects. As the formulated internal reform favored agriculture, the growth rate of land-less rural household income is marginally higher than the national average. However, the richest household group, the urban household (U-HH), benefits the most.

4. Changes in Macroeconomic Features

There are different ways of approaching and modeling macroeconomic constraints in the context of a developing country. Some economists like to call them resource gaps — which constrain investment. The most important constraint is, of course, domestic savings, given the fact that the difference between savings and investment directly widens the current account deficit and could increase external vulnerability. In a country such as Nepal, domestic saving is the main bottleneck for investment and growth. In contrast to investment, savings never improved distinctly but remained around 10 percent of GDP for the last two decades. A second constraint is the import-export gap, which can constrain the import of capital goods in countries such as Nepal. The third constraint is the revenue-expenditure gap of the government. The wide fiscal deficit financed by increasing the money supply mostly translates into inflation followed by changes in income distribution and unfavorable foreign trade.

Here we calculate three major macroeconomic constraints: the domestic saving-investment ratio, the export-import ratio, and the budget deficit-public expenditure ratio. For better macroeconomic stability, the first two constraints are desired at a higher level; whereas the third one at a lower level. The following table shows comparative pictures of these macroeconomic constraints

Table 7: Comparison among some macroeconomic indicators

Scenarios	Selected macroeconomic indicators		
	Dom. saving/Investment	Export/Import	Budget deficit/Public exp.
Simulation	0.642	0.578	0.225
Baseline	0.643	0.575	0.250

under the base-run and simulation.

Table 7 shows that upon reduction of the fiscal deficit — i.e., the budget deficit to public expenditure ratio — by 10 percent, major macroeconomic indicators such as domestic saving to total saving ratio and export to import ratio do not change significantly.

5. Conclusion

Internal reform by the government to narrow down the fiscal deficit brings price, growth and distributional changes in the economy. Scaling-up the domestic tax rates pushes the general price level upward in the economy. However, in the Nepalese case, the prices of industrial supplies do not rise as we expect under this scenario. This is because industrial imports account for a large portion of Nepal's overall imports — almost 40 percent of competitive imports and 45 percent of non-competitive imports. Therefore, a rise in the price level of domestically produced industrial products has a limitation for sustenance because of the huge flow of these products as imports. This even causes a decline in the price level of the composite industrial products.

Quite often in internal tax reform, agricultural products are exempted from the mark-up in order to protect the welfare of farmers, who are mostly poor. The tax incentive to agricultural activity causes this sector to expand; and because of the strong input-output linkages, the industrial sector also expands. Due to factor constraints, the service sectors contract. The factor reallocations also follow the same pattern. The factors of production reallocate from services activities towards the expanding industrial and agricultural activities. Furthermore, industrial activities require more skilled laborers as compared to other activities; therefore, under this policy, the wages of skilled laborers increase faster than those of low-skilled laborers. Because Nepalese services activities are mostly capital intensive, their contraction pushes the overall return to capital slightly downwards.

Regarding the distributional changes, urban households are the group that benefits most under this internal fiscal reform. This is because their major factor income comes from the industrial sector that is expanding under this scenario. Next to this, landless rural households also are benefited because they depend solely on agricultural activities that also expand along with industrial activities. Those households whose factor incomes come significantly from commercial services, however, become the losers under this policy. In our case they are the small rural households. The large rural households are also in the benefited group because they depend more on agricultural income and secondly on public services; however, the latter income contracts under this internal tax

reform.

Fiscal performance of the government is according to the expectation. The rise in the domestic tax rates narrows the fiscal deficit because of the rise in public revenue. However, because of the rise in the prices of the public services, government expenditure also rises marginally, which causes the narrowing of the fiscal deficit to be slightly less than expected. The macroeconomic fundamentals, however, hardly change under this policy.

One important policy implication concernings the distributional effect follows from this simulation. The poor who are working in the sectors that are expected to contract under domestic tax revision must be envisaged before implementing this type of reform. Otherwise, these poor may lose their income and become even poorer.

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Endnotes:

i) Since the inception of the first phase of structural adjustment in Nepal in 1987, there is strong emphasis on the government budget cuts to reduce the fiscal deficit from 10 percent to less than one percent of GDP. Although there has been no success to reach this limit so far, the budget deficit was stabilized around 7 percent of GDP within 10 years.

ii) This sub-division of households is based on various socio-economic characteristics, regional attributes and other endowment characteristics applicable to Nepal. The first two groups — Urban Households (U-HH) and Large Rural Households (LR-HH) — are rich households whereas Small Rural Households (SR-HH) and Landless Rural Households (LLR-HH) are poor with LLR-HH being the poorest.

iii) The model calibration fixes their values 0.6 for industrial commodities and 0.2 for all other commodities.

iv) Appendix Table B2.

v) Appendix Table B3.

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APPENDIX:

Appendix A: Model notations and equations

Notations:

Sets

$a \in A$ activities (agriculture, industry, commercial services, other services)
$c \in C$ commodities (agriculture, industry, commercial services, other services)
$c \in CM\ (\subset C)$ imported commodities
$c \in CNM\ (\subset C)$ non-imported commodities
$c \in CE\ (\subset C)$ exported commodities
$c \in CNE\ (\subset C)$ non-exported commodities
$f \in F$ factors (low skilled labor, high skilled labor, capital)
$h \in H\ (\subset I)$ households (UHH, LRHH, SRHH, LLRHH)
$i \in I$ institutions (households, government, firms)
$r \in$ rest of the world

Parameters

ad_a	production function calibration parameter
aq_c	shift parameter for composite supply (Armington) function
at_c	shift parameter for output transformation (CET) function
ica_{ca}	quantity of c as intermediate input per unit of activity a
aps_h	share of disposable household income to savings
$apsf$	share of disposable firms' income to savings
$qinsh_c$	share of investment goods in different commodity markets
$chsts_c$	share of the change in stock in different commodities
$shry_{h,fa}$	share of household h in the income of factor f in activity a
$shry_{fi}$	share of factor income going to firms
te_c	export tax rate
tm_c	import tariff rate
tq_c	sales tax rate
$tr_{ii'}$	transfer from institution i' to institution i
ty_h	rate of household income tax
α_{fa}	value-added share for factor f in activity a
β_{ch}	share of commodity c in the consumption of household h
$\delta_c^{\,q}$	share parameter for composite supply (Armington) function
$\delta_c^{\,t}$	share parameter for output transformation (CET) function
θ_{ac}	yield of commodity c per unit of activity a
$\rho_c^{\,q}$	exponent $(-1<\rho_c^{\,q}<\infty)$ for composite supply (Armington) function
$\rho_c^{\,t}$	exponent $(1<\rho_c^{\,t}<\infty)$ for output transformation (CET) function
ec_c	export calibration constant
eec_c	export elasticity constant
im_c	import calibration constant
ime_c	import elasticity coefficient
$ncir_{ra}$	non competitive import coefficient from ROW to activities
tyf	rate of income tax to firms

ε_O	private investment calibration constant
μ	public investment exponent parameter
φ	profit rate exponent parameter
nd_{llr}	number of dependents per land-less household worker

Variables

GE	government expenditure
GS	government budget deficit/surplus
GI	public investment
GC_c	quantity of government demand for commodity c
GY	government revenue
EXR	foreign exchange rate (domestic currency per unit of foreign currency)
$FSAV$	foreign savings
$GFCF$	gross fixed capital formation in the economy
$CHST$	total change in the stock in the economy
PA_a	activity price
PD_c	domestic price of domestic output
PE_c	export price (domestic currency)
PM_c	import price (domestic currency)
PQ_c	composite commodity price
PVA_a	value-added price
PX_c	producer price
PWE_c	export price (foreign currency)
PWM_c	import price (foreign currency)
QA_a	activity level
QD_c	quantity of domestic output sold domestically
QE_c	quantity of exports
QF_{fa}	quantity demanded of factor f by activity a
QFS_f	supply of factor f
QH_{ch}	quantity of consumption of commodity c by household h
$QINT_{ca}$	quantity of intermediate use of commodity c by activity a
$QINV_c$	quantity of investment demand
QM_c	quantity of imports
QQ_c	quantity supplied to domestic commodity demanders (composite supply)
QX_c	quantity of domestic output
TR_{hg}	transfer to household from government
TR_{hr}	transfer to household from rest of the world
TR_{gr}	transfer to government from rest of the world
$TR_{fi,g}$	transfer to firms from the government
WF_f	average wage (rental rate) of factor f
YF_{fa}	remuneration of factor f in activity a
YH_h	income of household group h
YFF	income of firms from factors
$YFIR$	total income of firms
GDP	Gross Domestic Product of the economy

PCI_{llr}	per capita income of the land-less rural household
$PCIN$	per capita income in Nepal
TP	total population in Nepal

Equations:

Price block

$$PM_c = (1+tm_c)\cdot EXR\cdot PWM_c \qquad c \in CM \cdots\cdots(1)$$

$$PE_c = (1-te_c)\cdot EXR\cdot PWE_c \qquad c \in CE \cdots\cdots(2)$$

$$PQ_c\cdot QQ_c = PD_c.QD_c.(1+tq_c) + PM_c\cdot QM_c \qquad c \in C \cdots\cdots(3)$$

$$PX_c\cdot QX_c = PD_c\cdot QD_c + (PE_c\cdot QE_c) \qquad c \in C \cdots\cdots(4)$$

$$PA_a = \sum_{c\in C} PX_c.\theta_{ac} \qquad a \in A \cdots\cdots(5)$$

$$PVA_a = PA_a - \sum_{c\in C} PQ_c\cdot ica_{ca} \;\; - ncir_{ra}.PA_a \qquad a \in A \cdots\cdots(6)$$

Production and commodity block

$$QA_a = ad_a\cdot\prod_{f\in F} QF_{fa}^{\alpha_{fa}} \qquad a \in A \cdots\cdots(7)$$

$$WF_f = \frac{\alpha_{fa}.PVA_a.QA_a}{QF_{fa}} \qquad f \in F,\ a \in A \cdots\cdots(8)$$

$$QINT_{ca} = ica_{ca}\cdot QA_a \qquad c \in C,\ a \in A \cdots\cdots(9)$$

$$QX_c = \sum_{a\in A} \theta_{ac}\cdot QA_a \qquad c \in C \cdots\cdots(10)$$

$$QQ_c = aq_c.(\delta_c^q QM_c^{-\rho_c^q} + (1-\delta_c^q).QD_c^{-\rho_c^q})^{\frac{-1}{\rho_c^q}} \qquad c \in C \cdots\cdots(11)$$

$$\frac{QM_c}{QD_c} = im_c\left[\left(\frac{PD_c}{PM_c}\right)^{ime_c}\cdot\frac{\delta_c^q}{1-\delta_c^q}\right]^{\frac{1}{1+\rho_c^q}} \qquad c \in CM \cdots\cdots(12)$$

$$QX_c = at_c.(\delta_c^t.QE_c^{\rho_c^t} + (1-\delta_c^t).QD_c^{\rho_c^t})^{\frac{1}{\rho_c^t}} \qquad c \in CE \cdots\cdots(13)$$

$$QX_c = QD_c \qquad c \in CNE \cdots\cdots(13.1)$$

$$\frac{QE_c}{QD_c} = ec_c\left[\left(\frac{PE_c}{PD_c}\right)^{eec_c}\cdot\frac{1-\delta_c^t}{\delta_c^t}\right]^{\frac{1}{\rho_c^t-1}} \qquad c \in CE \cdots\cdots(14)$$

Institution block

$$YF_{fa} = QF_{fa}.WF_f \qquad a \in A,\ f \in F \cdots\cdots(15)$$

$$YH_h = \sum_{fa} shry_{h,fa}.YF_{fa} + TR_{hg} + EXR.TR_{hr} \qquad a \in A,\ h \in H,\ f \in F \cdots\cdots(16)$$

$$QH_{ch} = \frac{\beta_{ch}.(1-aps_h).(1-ty_h).YH_h}{PQ_c} \qquad c \in C,\ h \in H \cdots\cdots(17)$$

$$YFF = shry_{fi} \cdot \sum_{a \in A} QF_{fa} \cdot WF_f \qquad f \in F,\ a \in A \cdots\cdots (18)$$

$$YFIR = YFF + TR_{fi,g} \cdots\cdots (19)$$

$$GFCF = GI + \varepsilon_0 (GI)^{\mu} (WF_{cap})^{\phi} \qquad WF_{cap} \in WF\ (F) \cdots\cdots (20)$$

$$QINV_c = \frac{qinsh_c . GFCF}{PQ_c} \qquad c \in C \cdots\cdots (21)$$

$$GY = \sum_{h \in H} ty_h \cdot YH_h + \text{tyf.YFIR} + \sum_{0 \in C} tq_c \cdot (PD_c \cdot QD_c) +$$

$$\sum_{c \in CM} tm_c \cdot EXR \cdot PWM_c \cdot QM_c + EXR \cdot TR_{gr} \qquad c \in C,\ h \in H \cdots\cdots (22)$$

$$GE = \sum_{0 \in C} PQ_c . GC_c + \sum_{h \in H} TR_{hg} + TR_{fi,g} + GI \qquad c \in C,\ h \in H \cdots\cdots (23)$$

$$GS = GY - GE \cdots\cdots (24)$$

$$PCI_{llr} = \frac{YH_{llr}}{\dfrac{\sum_{fa} shry_{llr.fa} . YF_{fa}}{WF_f}} . nd_{llr} \qquad f \in F,\ a \in A \cdots\cdots (25)$$

$$PCIN = \frac{\sum_h YH_h}{TP} \qquad h \in H \cdots\cdots (26)$$

$$GDP = \sum_{a \in A} PVA_a . QA_a \qquad a \in A \cdots\cdots (27)$$

System constraints block

$$\sum_{a \in A} QF_{fa} = QFS_f \qquad f \in F,\ a \in A \cdots\cdots (28)$$

$$QQ_c = \sum_{a \in A} QINT_{ca} + \sum_{h \in H} QH_{ch} + GC_c + QINV_c + chsts_c . CHST / PQ_c$$
$$a \in A,\ h \in H,\ c \in C \cdots\cdots (29)$$

$$\text{FSAV} = \sum_{c \in C} PWM_c \cdot QM_c + \sum_{a \in A} (PA_a \cdot ncir_{ra} . QA_a) / EXR - \sum_{c \in C} PWE_c \cdot QE_c - \sum_{i \in I} TR_{ir}$$
$$c \in C,\ i \in I \cdots\cdots (30)$$

$$\sum_h YH_h . aps_h . (1 - ty_h) + YFIR . apsf . (1 - tyf) + (GY - GE) + FSAV . EXR =$$

$$\sum_c PQ_c . QINV_c + WALRAS \qquad h \in H,\ c \in C \cdots\cdots (31)$$

$$\sum_{c \in C} PQ_c \cdot cwts_c = CPI \qquad c \in C \cdots\cdots (32)$$

Appendix B

Table B1: Quantities of commodities/services (c) as intermediate inputs per unit of activity a (ica_{ca})

commodities/services	Activities			
	AGR-A	IND-A	CS-A	OS-A
AGR-C	0.119	0.176	0.0001	0.002
IND-C	0.002	0.181	0.045	0.112
CS-C	0.069	0.041	0.151	0.139
OS-C	0.006	0.022	0.051	0.031

Source: Acharya (2006).

Table B2: Market interaction in the model relating to commodities

parameters	Commodities			
	AGR-C	IND-C	CS-C	OS-C
elasticity of substitution between domestic vs. import goods (σ_c^q)	1.6	0.8	0.4	0.4
elasticity of transformation between domestic vs. export goods (σ_c^t)	2.0	2.0	2.0	2.0
armington function exponent to import commodity (ρ_c^q)	-0.375	0.25	1.5	1.5
armington function exponent for export commodity (ρ_c^t)	1.5	1.5	1.5	1.5
armington import share of composite commodity (δ_c^q)	0.063	0.156	0.129	0.247
armington export share of composite commodity ($\delta_c{}^t$)	0.046	0.280	0.159	–
armington function shift parameter for supply of c (aq_c)	1.201	1.658	2.476	2.205
armington function shift parameter for demand of c (at_c)	1.082	1.628	1.321	–
non-competitive import coefficient from ROW ($ncir_{ra}$)	0.076	0.158	0.068	0.08
import elasticity coefficient (ime_c)	0.2	0.6	0.2	0.2
export elasticity coefficient (eec_c)	0.4	0.6	0.2	0.0
import calibration constant (im_c)	5.294	0.768	0.328	0.554
export calibration constant (ec_c)	0.0001	0.059	0.007	0.0

Source: Acharya (2006).

Table B3: Share of income by factor and activity going to households ($shry_{hf}$) and firms (shryf)

Household type	Factor incomes from											
	LSL in activities				HSL in activities				Capital in activities			
	AGR	IND	CS	OS	AGR	IND	CS	OS	AGR	IND	CS	OS
U-HH	0.18	0.35	0.34	0.35	0.11	0.36	0.66	0.50	0.10	0.54	0.29	1.00
LR-HH	0.13	0.16	0.15	0.15	0.37	0.26	0.16	0.27	0.40	0.13	0.17	0.00
SR-HH	0.50	0.37	0.18	0.09	0.29	0.15	0.18	0.23	0.25	0.17	0.28	0.00
LLR-HH	0.19	0.12	0.33	0.41	0.22	0.24	0.00	0.00	0.25	0.00	0.00	0.00
FIRM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.26	0.00

Source: Acharya (2006).