Human Capital Formation and Economic Growth in India : A CGE Analysis[1]

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Abstract

In this study, a multisectoral neo-classical type price driven CGE model, with the additional feature that it includes a mechanism by which public education expenditure to build human capital augments the supply of educated/skilled labour, is used to analyse the impact of an increase in the former, financed by an increase in direct tax rates, on economic growth and income distribution in the Indian economy. The simulation results suggest that it is possible to increase investment in human capital in the resource constrained fiscal environment of the Indian economy, and reap the benefits in terms of a faster economic growth and a better income distribution. The results also suggest that secondary education needs to be accorded higher priority, though, not necessarily, at the cost of higher education. Finally, to maximise the benefits in terms of economic growth it is desirable that investment in physical capital be increased simultaneously with investment in human capital.

JEL Classification : D58, H5, I2

Keywords : CGE model, Public Expenditure, Human Capital, Skilled Labour, Educated Labour, Education, Economic Growth, Income Distribution, India.

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Human Capital and Economic Growth in India - A CGE Analysis

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1. Introduction

It is well known that India's transition to an outward-looking strategy is a delayed one. Compared to, say, China, India is almost a decade behind in launching its economic reforms program, which it did in 1991 as a response to the economic crises created by the chronic fiscal and trade imbalances of the eighties, rather than as a planned shift to outward orientation. Little wonder then, that India, again unlike China, was unprepared for the greater openness of the outward-oriented strategy. It had not gone through the internal adjustments and transformations which must ideally precede trade liberalization. In fact, India is still struggling to undergo the variety of internal economic reforms that are required to be able to face the challenges of globalization. Among these reforms are (i) de-bureaucratization and deregulation of the industrial environment, (ii) restructuring of the public sector, (iii) developing the agricultural and industrial infrastructure and (iv) promoting human development. It is not a matter of chance that the last one is not an integral component of the reform package of the government, but only a sort of add-on to the policy package. The underlying view is that policies for human development or social sector development, as it is referred to in the policy-making circles, are supplementary measures required to translate economic growth into an equivalent increase in human well being. While this view is not contestable, it is clearly insufficient. More specifically, it does not take into account the obvious lessons from the experience of high performance east Asian and the Chinese economies in the last two decades. The policy makers in these economies clearly regarded the causation between human development and economic growth as bi-directional. And in operational terms, they consciously developed the human resources to achieve higher economic growth.

The present study is motivated by a view similar to the one, which underlay the strategic planning of the East Asian Economies. It may also be mentioned here that, though human capital in

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an economy includes both the state of health and the educational levels of the the people, in this study the focus is exclusively on educational capital.

In sub-sections 1.1 – 1.3 that follow, we discuss the existing literature on human capital formation and economic growth. Finally, in sub-section 1.4 we outline the main objectives of the present study.

The rest of the paper is organised as follows. Section 2 presents the overall structure of the CGE model used in the present study, with special emphasis on the intertemporal dynamics which includes a mechanism through which public education expenditure augments the stock of human capital. Section 3 presents the main features, such as, GDP growth and growth of household incomes, of the base-line or the business-as-usual (BAU) scenario. In section 4, we report the simulation results of the three policy scenarios in comparison with the BAU scenario. Section 5 concludes and suggests policy implications of our results. In Appendix 1 we present the Social Accounting Matrix (SAM) which provides the benchmark equilibrium data set for the model. Appendix 2 gives the detailed set of equations of the model.

1.1 Studies on human capital formation

The literature on human capital formation is abound with partial equilibrium analyses of production and cost functions of education (see Shri Prakash and Chowdhury (1994), Tilak (1985) and Tilak (1988), as well as of determinants of household expenditure on education (see Tilak (2001a), Tilak (2001b)), Tilak (2001c) , Tilak (2002), and Shri Prakash and Chowdhury (1994)). The studies dealing with the production function of education (say, for example, Shri Prakash and Chowdhury (1994)) measure output in terms of 'enrolments' and inputs in terms of 'number of teachers employed' and 'value of non-teaching inputs'. Such production functions are obviously useful in determining whether the "production" of education is subject to increasing, constant or diminishing returns and the relationships between the marginal productivities of the teaching and non-teaching inputs. (The cost functions of education are essentially a 'dual' of the production function and serve the purpose of merely confirming the results obtained from the production functions). However, from these essentially technical descriptions of the 'production' of education no policy conclusion of consequence is derivable. In other words, in so far as these studies determine neither the private nor social returns to education, their policy significance is limited. The studies concerned with the determinants of household expenditure on education (for example, Tilak (2002) also treat education as an end in itself and fall short of explaining expenditure on education in terms of the *expected* private returns on education. Using state-wise cross-sectional state level data for his regressions,

Tilak (2002) explains household expenditure on education in terms of household incomes, and other household characteristics such as educational level of the head of the household, occupation, caste, religion.

The 'general equilibrium' studies on educational capital formation have a broader objective, namely, assessing the impact of investment on education on productivity (growth) and/or equity (wage-inequality). All these studies are based on the underlying assumption that public investment in education is a powerful policy instrument for inducing faster economic growth with an improved or a worsening income distribution. It needs to be stressed that *a priori* it cannot be known whether investment in education leads to growth with more or less wage inequality. Not surprisingly then, most of these studies are concerned with the impact of investment in education on changes in wage inequality over time. In a general equilibrium framework, there is multi-directional causation between investment in education and changes in the relative wages of skilled labor. On one hand, the increased investments in education lead to an increase in the relative supply of skilled labor, which in turn exerts a downward pressure on the relative wages of skilled labor. On the other hand, the technological changes and the changes in international terms of trade in favor of skill intensive goods, that necessarily accompany the growth process, push upwards the skilled wage rate relative to the unskilled wage rate by creating more demand for skilled labor. In short, relative factor supply and relative product price changes are both important in explaining the change in the relative return to skilled labor, and a general equilibrium model effectively captures the net impact of these factors on the relative wages.

Pradhan (2002) finds an interesting paradox in the growth process of the Indian economy, namely, that there is not much change in income inequality even though there are large changes in the educational levels of the population over time. He tries to resolve this paradox by using an applied general equilibrium model to simulate the impact of large changes in access to education on wage inequality. The model results clearly show that even for very large increases in access to education the wage inequality remains unchanged. Apparently, the dominant effect on the skilled labor wage rate is that of the changes in the relative product prices in the world market (i.e., the trade effect), rather than that of increased relative supply of educated labor ensuing from enhanced access to education. The trade effect on the relative demand for skilled labor has been shown to be very important for India by Wood and Calandrino (2000) also in a SAM (Social Accounting Matrix) based comparative analysis of the impact of trade liberalization on human resources in India and China. Gidling and Robbins (2001) analyze the patterns and sources of changing wage inequality in Chile and Costa Rica during structural adjustment, using an econometric decomposition technique which splits the effects of enhancement of human capital into the

'education price' and 'education quantity' effects. Their exercise shows that the education price effects varied across sectors on account of the variation in the sectoral rates of growth in the demand for educated workers, and this lead to an increase in inequality in Chile despite a large equalizing education quantity effect. Duflo (2002) in his paper on the effects of educational expansion in Indonesia shows a different impact on the relative wages of skilled labor. Using a two sector - formal and informal – econometric model, he shows that the skilled labor, employed exclusively in the formal sector, suffers a downward revision of relative wages, because the faster increase in human capital is not matched by a corresponding increase in physical capital in this sector. Interestingly, this paper indicates the possibility of there being competing demands of physical and human capital on the investible resources of the government for a mixed economy like India. That is to say, the public sector, which bases its investment decisions on long-term growth rather than on short-term profitability considerations, needs to define a trade-off between augmenting physical and human capital.

Most other general equilibrium studies on the shifts in the relative wages pertain to the U.S.A. Goldin and Katz (1999), Francois and Nelson (1998), Harrigan and Balaban (1999) and Baldwin and Cain (1997) are all concerned with explaining the "paradoxical" effect of educational expansion on the wage inequality – i.e., increased availability of education increases rather than decrease the relative wages for skilled labor. And, in fact, the paradox is resolved in almost all the cases by incorporating the effects of trade and technological changes on the relative demand for skilled labor.

1.2 Education and economic growth in India

The link between public spending on education and economic growth is by now well-established in the literature. Staring with the work of Schultz (1961) education has been viewed as investment in human capital rather than considered to be a consumption good under Keynes' influence. Subsequently, Blaug *et al* (1969), Tilak (1987) and Psacharopoulos (1993) show that investment in education yields a higher rate of return than investment in physical capital. Romer (1986) and Lucas (1988) have propounded the new growth theories in which sustained long-run growth of per capita income is explained by the likelihood of investment in human capital generating constant or increasing returns. Empirical studies in the literature on education and economic growth also find compelling evidence for the hypothesis that a substantial proportion of the growth of the economies is attributable to the rise in the educational levels of the workforce. Lau *et al* (1993) attribute almost 25 percent of the economic growth in Brazil to the increase in the average education of the

workforce. The success stories of the East Asian miracle economies are also replete with references to mass primary education programmes pursued by their governments (World Bank, 1993). In India, Mathur (1993) has shown that a positive association exists between stocks of human capital and economic development and that the association becomes stronger at higher levels of education. Mathur and Mamgain (2002) find the influence of both technical and general education on per capita income to be positive with that of the former being more powerful. In agriculture, Chaudhri (1979) finds that primary schooling affects productivity positively, particularly in times of rapid technological change.

While the link between the spread of education and economic growth is regarded as undisputable, the preceding link between public education expenditure and the spreading of education has become a bit of a controversial area, especially in India. Empirical evidence in India in this regard is diverse – differing hugely across the states – and does not seem to corroborate the assumed positive linkage between public spending on education and the spread of education (Pradhan, Tripathy and Rajan (2000)). Various explanations are offered for the absence of a strong positive association between public education expenditure and educational outcome – leakages from the amount spent due to corruption, teacher absenteeism, non-motivated and discouraging teachers, ill-equipped schools and unwillingness of parents to send their children to schools due to economic or non-economic constraints. The conclusion sometimes drawn from all this is that public spending is not really instrumental in promoting education, and therefore should not be overdone. This is unfortunate especially because the diverse empirical evidence does not warrant this rather straightforward conclusion. A detailed examination of the question of the impact of public education expenditure on the quality of education and educational outcome, particularly enrolment, has been done by Pradhan and Singh (2004). Pradhan and Singh (2004) also do not find a strong influence of pubic expenditure per child and the rate of growth of expenditure on the enrolment rate for 16 major states of India. However, this is because the varying degrees of 'efficiency' of expenditure across states are not taken into account. The efficiency of expenditure is defined as the technical efficiency of the inputs – the number of schools and the number of teachers – in generating educational output, such as enrolment. Using Data Envelopment analysis (DEA), they rank the states by their levels of technical efficiency. Having thus ranked the states by their levels of technical efficiency, they a find stronger positive association between publc education expenditure and enrolment for the relatively efficient states as compared to the relatively inefficient states. In other words, once the efficiency of expenditure is taken into account, the effect of public education expenditure on enrolment is seen to be stronger. In general, it is arguable that states which employ better educational processes also demonstrate a stronger link between education

expenditure and educational outcome. By implication, the states in which the link between education expenditure and educational outcome is weak have to find ways and means to strengthen this link – i.e., control the leakage from the education expenditure, prevent teacher absenteeism improve infrastrucutre in schools, and, above all, take care of the economic and non-economic factors which are responsible for the lack of interest shown by households in providing education to their children. In short, the picture which emerges from the analysis of Pradhan and Singh (2004) is hardly the one which would undermine the importance of increasing public spending on education in India.

The share of expenditure on education in GDP in India has been continuously increasing from 1.19 percent in 1951 (not shown in table 1) to 3.98 percent in 1990-91, after which it suffered a decline till 1997-98. In 1998-99 it was restored to 3.90 percent, and in 1999-2000 it crossed the 4.0 percent mark. However, it may be noted that although education has always been given high priority by the government of India since independence, the public expenditure target of 6 percent of GDP is still nowhere in sight. Not surprisingly, even after 50 years of independence, the enrolment rates remain low in this country, particularly in case of poor and the inhabitants of rural areas. It follows that the role of public spending on education, though not complete *per se*, remains important in accelerating the growth in school enrolment. Besides, an expansion of public education expenditure is all the more desirable because of the externalities associated with education, such as, reduced population growth and better health care.

The sources of finance for education India are the central and the state governments, local bodies, consumers of education (fees etc.) and foreign aid. Primary among these are the state governments. However, as argued by Mehrotra (2004), given the serious fiscal deficits of the poorest states and the limited scope of inter-sectoral reallocation of expenditure towards education from other sectors and of intra-sectoral allocation within the education sector (from higher levels of education to lower levels), the only remaining option for financing further increases in public education expenditure is earmarked taxes for education, a source employed effectively by many countries, such as, Korea, China, Botswana and Brazil. Mehrotra (2004) also finds the successful example of Brazil, worth emulating for India. In Brazil, an education fund, FUNDEF, created by federal taxation, helps in the equalisation of expenditure capacity in education between poorer and richer states. He further recommends that in India, much like in Brazil, the central government, and not the state governments, should levy additional taxes and dedicate the revenue thus raised to the cause of education. The dedicated fund for education could then allocate resources to the states that are in greatest need and those that show the best performance. The initiative for additional taxation and the subsequent creation of the dedicated fund needs to be taken by the central government

because many of the state governments have been seen to be lacking in their commitment to elemenatry education.

Table 1 : Trends in Public Education Expenditure

	Ed. Exp./ GDPMP (in %)		Ed. Exp./ Total Govt. Exp. (in %)
1990-91	3.98		12.52
1991-92	3.84		12.15
1992-93	3.71		12.33
1993-94	3.64		12.16
1994-95	3.56		11.95
1995-96	3.57		12.58
1996-97	3.56		12.78
1997-98	3.57		12.48
1998-99	3.90		13.39
1999-00	4.44		14.21
2000-01	4.14		13.21

Source : Education expenditure : Analysis of Budget Expenditure in Education (various years). New Delhi ,MHRD
Total government expenditure : Indian Public Finance Statistics, Government of India
GDP at market prices : National Accounts Statistics (various issues), CSO, Government of India

Table 2 : Enrolment rates by place of residence and poverty category

Place of Residence	**Enrolment rate (in %)**
All-India	**76.2**
BPL	65.6
APL	84.8
Rural-India	**73.2**
BPL	63.8
APL	81.1
Urban-India	**86.7**
BPL	72.4
APL	96.4

Note : APL : Above Poverty Line
BPL : Below Poverty Line.
Source : Pradhan and Roy (2003)

1.3 CGE analysis of the linkage between public expenditure on education and economic growth

The overall goal of this study is to investigate the linkage between human capital and economic growth. However, as mentioned before, in this study our focus is concentrated on only the educational aspect of human capital. Secondly, though the household expediture on education is by no means small (see Tilak (2002)), we are not treating it as a policy variable. It is infact largely dependent, among other things, on the government expenditure on education as shown by Tilak (2002). Having made these two assumptions, we narrow down the goal of the study to an investigation of the linkage between public investment in education and economic growth.

In *a priori* hypothesizing about the linkage between educational capital investment and economic growth, one tends to argue that investment in education increases the supply of educated (skilled) labour, which, on account of its higher productivity relative to non-educated (unskilled) labour leads to higher economic growth with lower relative wage for skilled labour. This is nothing but the standard one-sector endogenous growth theory line of reasoning, and need not hold in a multi-sector, multi-factor general equilibrium framework. What this line of reasoning overlooks is the fact that educational capital accumulation will in all likelihood be accompanied by a changes in demand pattern in favour of skill intensive goods. The (exogenous) international terms of trade will also most likely shift in favour of the skill intensive goods. All this will increase the relative demand for skilled labour exerting thereby an upward pressure on its relative wage. On the production side, there will not only be a restructuring of the composition of goods produced in favour of skill intensive goods, but also some resubstituting in favour of unskilled labour in the production processes. In short, changes in both the relative factor returns and the relative product prices play a role in determining the quantam of growth. It follows then that, how much the resultant growth will be is an empirical question best answered by a computable general equilibrium model.

A CGE analysis of the linkage between public expenditure on education and economic growth is conspicuous by absence in the scanty literature on human capital formation in India. For other countries also, CGE studies on the impact of public education expenditure on human capital formation are sparse. Suwa-Eisenmann, Zonzilos and Bourguignon (1995) assess the programs implemented in Greece under the Europeon Community Support Framework (1989-1993), for promoting growth through investments in infrastructure and human capital. The model used in this study is an extended version of the standard CGE model described in Dervis, de Melo and Robinson (1982) which incorporates a semi-Keynesian closure appropriate for the Greek economy.

However, the accumulation of human capital is treated in an exogenous manner. It is assumed that the expenditure on training programs has a direct positive effect on labour participation, thereby, increasing the absolute number of skilled workers, without changing that of the other (unskilled) types of labour. There is no transformation of unskilled labour into skilled labour envisaged in the model.

More closely related to the goal of this study is the paper by Jung and Thorbecke (2003). In this paper the impact of public education expenditure on human capital, the supply of different labour skills, and its macroeconomic consequences are analysed using a recursively dynamic multisectoral CGE model for two heavily indebted poor countries (HIPCs), Tanzania and Zambia. The CGE model used here is the standard neo-classical type described in Dervis, de Melo and Robinson (1982), Thorbecke (1992) and Robinson *et al* (1999), with the additional feature that three different types of labour - non-educated, primary-educated, and higher-educated labour - are combined in two stages in the production structure of the model, to reflect different levels of substitutability. The non-educated and the primary educated labour are combined within a Cobb-Douglas type Armington aggregation to produce an aggregate of unskilled labour. This unskilled-labour-aggregate is then combined with higher-educated labour within a CES type Armington aggregation to yield a composite labour measure. Profit maximizing firms employ the optimal amount of each type of labour given wage rates and the technical and budget constraints.

Another novel feature of the Jung and Thorbecke (2003) model is that its intertemporal dynamics includes a specific mechanism through which public education expenditure augments the stock of human capital. In other words, education expenditure provides additional educational capital to those who are in the educational pipeline. As these individuals come out of the educational pipeline, they acquire improved labour skills and, thereby, add to the stock of human capital.

The business-as-usual scenario or the base run of the Jung and Thorbecke (2003) model is generated under the assumption that each of the three types of labour grows at the given population growth rate. Subsequently, three alternative policy scenarios, each envisaging a 15 percent increase in real public expenditure on education over the base-run level under three different assumptions, are simulated. In the first scenario the supply of primary-educated and higher-educated labour are determined first in the model, and the supply of non-educated labour is determined residually, in such a manner that the total work force grows at the given population growth rate. The underlying assumption in this simulation being that the non-educated labour supply is not responsive to the wage rate. In the second simulation, the more realistic assumption of elastic labour supply is made. In this case, a rise in the wage rate results in a flow of the previously unemployed non-educated

workers into the labour market, with the flow ceasing when the wage rate of non-educated labour equals that in the base run. In the third simulation, the additional assumption made is that the increase in real education expenditure is directed exclusively to the poor household groups, so that the increase in the educated labour supply over that in the base-run comes entirely from the poor groups. In other words, this simulation provides for an increase in the endowment of human capital of the poor groups relative to that of the non-poor groups .

The higher education expenditure increases the labour supply growth rates for primary educated and higher educated labour to the same extent (0.4 percentage points) in all the three simulations[7]. However, in case of non-educated labour, the labour supply growth rate increases by 0.2 percentage point in simulations 2 and 3, but decreases by 2.1 percentage points in simulation 1, where labour supply of non-educated labour is determined residually.

The growth rates of the wages for both higher educated and primary educated labour decline by 0.3 percentage points in simulations 2 and 3, while in simulation 1, the wage growth rates for higher and primary educated labour decrease respectively by 0.6 and 0.3 percentage points. For the non-educated labour, the growth in wage level remains unchanged (at the base-run level) in simulation 2 and 3 by assumption, but increases by 2.3 percentage points in simulation 1. The average wage grows at the same rate in simulation 1 as in the base run . But the growth rate of the average wage declines by 0.3 percentage points for Tanzania and 1.1 percentage points for Zambia in case of simulations 2 and 3. The extent of physical capital accumulation in Zambia is much lower than Tanzania, on account of a lower saving ratio in the former country. Hence, the increase in the number of skilled workers is not complemented by an adequate increase in physical capital limiting the growth in labour productivity and consequently in wages.

With 15 percent increase in real public expenditure on education, GDP growth rate under simulations 2 and 3 increases by 0.2 and 0.1 percentage points respectively for Tanzania and Zambia. In simulation 1, however, GDP growth rate improves by only 0.1 percentage point for Tanzania and remains the same as in the base run in for Zambia. Moreover, in all the simulations for both the countries the capital income grows faster than the wage income. This is expected, as the supply of educated labour increases as a result of the expansion in public educational expenditure, and capital consequently becomes relatively more scarce.

Income distribution changes are not uniform either across the simulations or for the two countries. Under scenario 1, the growth rate of household incomes of the urban poor improves by

[7] In the summary of results presented here, we mostly refer to the figures for Tanzania. Unless otherwise mentioned, the broad orders of magnitudes of the changes in the variables for the twocounties are the same.

0.1-0.2 percentage point, and declines by 0.1 percentage point for the 'urban non-poor' in case of Tanzania. However, it is the other way round for Zambia, where the growth rate of household incomes of the 'urban poor' declines by 0.1 percentage point, and improves by 0.1 percentage point for the 'urban non-poor'. This happens because the urban poor household group is heavily dependent upon income from educated labour. Hence, an increase in public spending on education makes this group worse off by increasing the supply of educated labour. The rural household incomes grow relatively faster for the poor *vis-a-vis* the non poor in Tanzania, but not so in Zambia. Unlike in Tanzania, in Zambia, the educated workers are not concentrated within the non poor household groups, but dispersed among non poor and poor household groups.

Under scenario 2, in Tanzania, the growth rates of incomes of both the urban and rural poor improve by 0.3 percentage point, while those of urban and rural non-poor increase by only 0.1 percentage point. That is, the poor gain more than the non poor from the increase in public educational expenditure in Tanzania, but the opposite is true for Zambia. In Zambia, the improvement in the growth rates of incomes of the urban and rural non poor is greater than that for the urban and rural poor. Evidently, Zambia, as compared to Tanzania, has a larger proportion of educated workers within the poor households.

In simulation 3, the growth rates of incomes of the poor household groups improve significantly more than those of the non poor household groups resulting in a more equal distribution of income in Tanzania. However, in Zambia the income distribution does not improve. Here, both the poor and non poor groups improve their income growth rates relatively equally among the rural households, and, among the urban households the non poor groups, in fact, improve their income growth rates relatively more than the poor groups. Clearly, the difference in the endowment of human capital of poor households between Zambia and Tanzania matters in determining the impact of an increase in education expenditure on the income distribution in the two countries.

In short, the main conclusion that emerges from the counterfactual policy simulations of the Jung and Thorbecke (2003) model is that an increase in public education expenditure *per se* can contribute positively to GDP growth. Improved labour market flexibility will enhance the positive impact of an expansion in public educational expenditure on GDP growth. Furthermore, the rise in public expenditure on education should ideally be complemented with an increase in public investment on physical capital. And, finally, the increase in educational expenditure must be better targeted to poor households if any improvement in the income distribution is to be expected.

A crucial question on which the Jung and Thorbecke (2003) paper is silent is the following : how is the increase in public education expenditure to be financed or, to put it another way, what

will be the preferred mode of financing an expanded public education expenditure programme. In fact, the suggestion that the rise in public expenditure on education be matched with an increase in public investment on physical capital begs this question. If public investment cannot be curtailed (it might have to increase !), then some other adjustment has to be made in a resource constrained fiscal environment - either government expenditure in other sectors will have to be reduced or, if that is not feasible, taxation will have to be increased as suggested by Mehrotra (2004). We have considered the latter option in the present study.

1.4 The present study

In the present study, we have used a recursively dynamic multisectoral CGE model for the Indian economy. Our model has been formulated on the lines of the Jung and Thorbecke (2003) model to capture the impact of an increase in public education expenditure on GDP growth and income distribution across four rural and five urban household groups

As is usually done in a CGE modeling analysis, we first generate a base-line (business-as-usual) scenario, and then simulate alternative policy scenarios for assessing the consequences for growth and income distribution in India of an expansion in public education expenditure. The specific policy questions to which the policy scenarios are addressed are the following :

(i) What is the impact of an increase in public education expenditure financed by an increase in direct taxes on GDP growth and income distribution ?

(ii) What is the impact of an increase in public education expenditure concentrated in the secondary education sector financed by an increase in direct taxes on GDP growth and distribution ?

(iii) What is the impact of an increase in public education expenditure concentrated in the secondary education sector complemeted with an increase in public investment financed by an increase in direct taxes on GDP growth and distribution ?

2. Model Structure

Our model is a multisectoral, neo-classical type price driven CGE model, with the additional feature that it includes a mechanism through which public expenditure on education augments the supply of human capital (i.e., educated / skilled labour). The overall structure of our model is similar to the one presented in Jung and Thorbecke (2003). However, in formulating the details of the model, we follow an eclectic approach keeping in mind the institutional features peculiar to the Indian economy.

The model has 10 production sectors and three factors of production - land, capital and composite labour, which in turn, is a nested CES aggregation of non-educated, secondary-educated and higher-educated labour[8]. At the beginning of a period, the economy is endowed with a certain level of physical capital and human capital, in the form of stocks of different types of labour. In any given period the allocation of capital across production sectors is fixed, but labour is inter-sectorally mobile. Producers act as profit maximisers in perfectly competitive markets, i.e., they take factor and output prices (inclusive of any taxes) as given and generate demands for factors so as to minimise unit costs of output. The factors of production include intermediates and the primary inputs – capital, land and different types of labour. For households, the initial factor endowments are fixed. They, therefore, supply factors inelastically. Their commodity-wise demands are expressed, for given income and market prices, through the Stone-Geary linear expenditure system (LES). Also households save and pay taxes to the government. Furthermore, households are classified into four rural and five urban categories. The government is not asssumed to be an optimising agent. Instead, goverment consumption, transfers and tax rates are exogenous policy instruments. The rest of the world supplies goods to the economy which are imperfect substitutes for domestic output, makes transfer payments and demands exports. The standard small-country assumption is made, which implies that, India is a price-taker in import markets and can import as much as it wants. However, because the imported goods are differentiated from the domestically produced goods, the two varieties are aggregated using a constant elasticity of substitution (CES) function, based on the Armington assumption. As a result, the imports of a given good depends on the relation between the prices of the imported and the domestically produced varieties of that good. For exports, a downward sloping world demand curve is assumed. Furthermore, a constant elasticity of transformation (CET) function is used to define the output of a given sector as a

revenue-maximising aggregate of goods for the domestic market and goods for the foreign markets. This implies that the response of the domestic supply of goods in favour or against exports depends upon the price of those goods in the foreign markets *vis-à-vis* their prices in the domestic markets, given the elasticity of transformation between goods for the two types of markets. The model is Walrasian in character. Markets for all commodities and non-fixed factors - capital stocks are fixed and intersectorally immobile - clear through adjustment in prices. However, thanks to the Walras' law, the model determines only *relative* prices. The exchange rate is chosen as the numeraire and is, therefore, normalised to unity. The model determines endogenously the foreign savings in the external closure. Finally, because the aggregate investment is exogenously fixed, the model follows an investment-driven macro closure, in which the aggregate savings - i.e., the sum of household, government and foreign savings - adjusts, to satisfy the saving-investment balance.

Intertemporally, the model adjusts through changes in the stock of physical capital and the stock of human capital. Physical capital is increased by investment, which is exogenously given. Human capital is augmented by the new supply of educated labour, which in turn is a function of public education expenditure.

2.1 Sectoral disaggregation

Our model is based on the following ten sector disaggregation of the Indian economy :

1. Agriculture (1 to 7),
2. Mining (8 to 11),
3. Manufacturing-1 (12 to 24),
4. Manufacturing-2 (25 to 44),
5. Construction (45),
6. Electricity, gas and water supply, (46 to 47)
7. Transport, storage etc., (48 to 51)
8. Wholesale and retail trade etc, (52 to 53)
9. Finance, insurance, real estate etc., (54 to 56)
10. Community, social and personal services, (57 to 60)

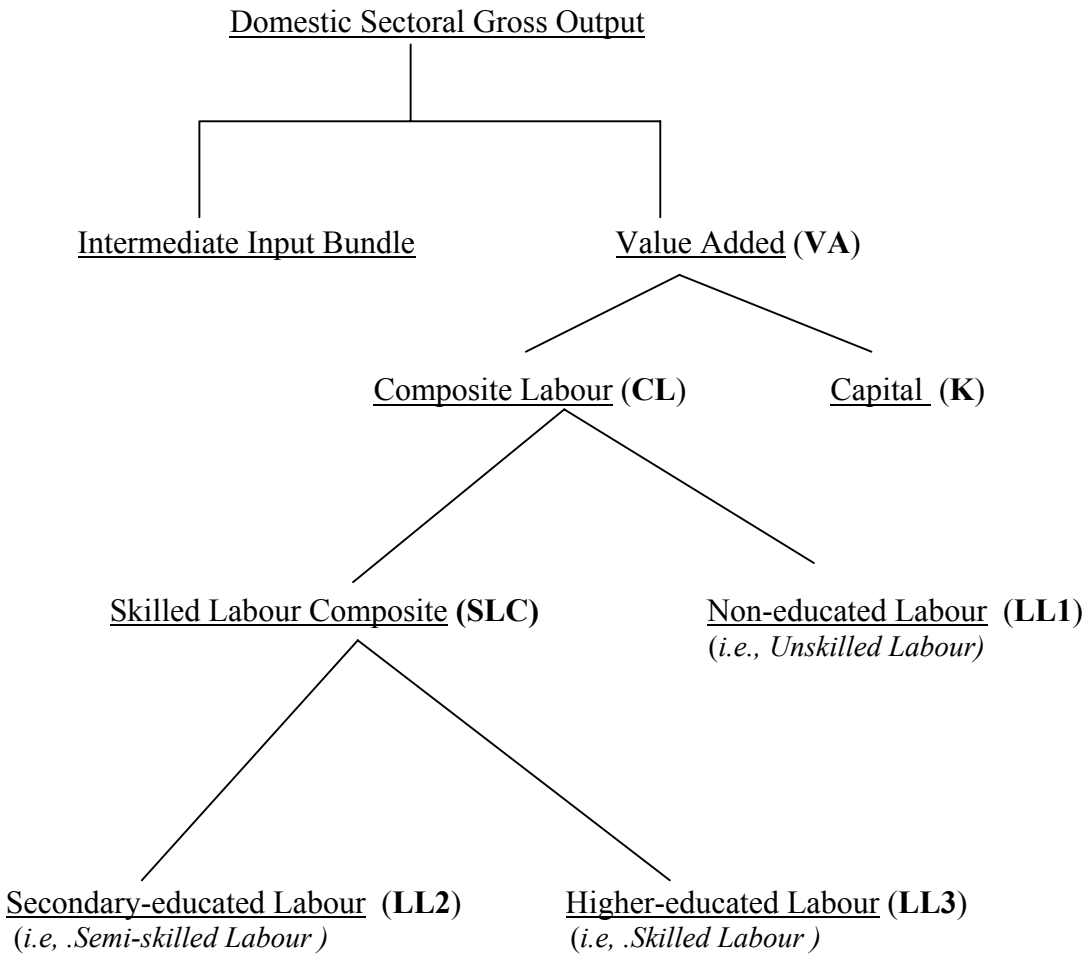
Note that for each sector the constituents in terms of the 60-sector Central Statistical Organisation Input-Output Transaction Table (CSO-IOTT) is indicated in the parenthesis. Note also that each

[8] In our classification of 3 types of labour in India, 'secondary educated' includes all those from 1st pass to 12th pass – i.e., 'elementary' + 'secondary' + 'higher secondary' educated, and 'higher educated' includes

sector has 3 types of labour inputs – unskilled or non-educated labour, semi-skilled or secondary educated labour and skilled or higher educated labour – which sum up to what is called composite labour.

2.2 The production structure

Production technologies for all sectors are defined using nested CES functions as shown below :



Note that vertical lines in the nesting diagram represent leontief combinations, while the slanting lines represent CES combinations of the inputs involved. For agriculture there is an additional branch in the nesting structure. In the agricultural sector, a cobb-douglas aggregation of land and capital produces composite capital which in turn is combined with composite labour to produce value added. At each level of the nested production function, the assumption of constant elasticity of substitution (CES) and constant returns to scale (CRS) is made. For every level , the producer's problem is to minimise cost (or maximise profit) given the factor and output prices and express

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'graduates ' + 'higher-than-graduates'.

demands for inputs. It follows that for every level, the following three relationships hold : the CES function relating output to inputs, the first order conditions, and the product exhausation theorem. For all the levels taken together, the production system thus determines the gross domestic output, the input demands, value-added as well as the demands for the various types of labour. (The capital stock in a particular period is given, so the first-order condition effectively determines the sectoral return on capital.)

2.3 Investment

Public and private investment are fed into the model as two distinct constituents of the total investment. There are fixed share parameters for distributing the aggregate investment across sectors of origin. However, the allocation mechanisms for sectors of destination are different in the two cases of public and private investment. For public investment there is discretionary allocation, and the allocation ratios are therefore set exogenously in the model in each period. On the other hand, for private investment the allocation ratios are *given* in a particular period, but are revised from period to period on the basis of the sectoral relative return on capital. The relative return on capital in any sector is given by the normalisation of the implicit price of capital in that sector to the economy-wide returns. Note that this rule does not imply full factor price equalisation, but only a sluggish reallocation of investment from sectors where rate of return is low to ones having higher rates of return.

Needless to say, all this bifurcation of total investment into its public and private components with their differing allocation mechanisms is an attempt to approximate the way investments are actually made in the Indian economy. Incidentally, it also allows for public investments to be directed towards "strategic" sectors disregarding short-run considerations of profit maximisation.

2.4 Factor markets

Labour is intersectorally mobile. Wages are flexible and adjust to equilibriate the demand and supply for each of the three types of labour – non-educated labour, secondary-educated labour and higher educated labour. There is no unemployment for any of the three types of labour. Cropping land in the agricultural sector is also fully utilised at the equilibrium rent. However, capital stocks are fixed sectorwise. The optimsing behaviour of producers therefore determines sector specific return on capital.

2.5 Household Income and consumption demand

There are nine household groups in the model - rural cultivator (**RC**), rural artisan (**RATN**), rural agricultural labour (**RAL**), rural others (**RO**), urban farmer (**UF**), urban non-agricultural self-employed, (**UNASE**), urban salaried (**US**), urban casual labourer (**UCL**), urban others (**UO**). The factor endowments for each household group are given. Households derive their income by selling the factors they own – land, labour (of 3 types) and capital. From these incomes, taxes are netted out and transfer payments by government and rest of the world are added to arrive at the household disposable incomes. The households are assumed to save a fixed fraction of their disposable incomes. The rest of it is spent on the consumption of goods. The consumption functions of the households are estimated by the most suitable Stone and Geary linear expenditure system (LES), which is widely used in India. Private corporate and public sectors do not have any consumption expenditure. They receive income from the rental values of non-land capital. Private corporate sector gets additional income from rental value of land and government transfer payments including interest payments.

2.6 Private corporate and public sector income

Private corporate sector income consists of its earning from factor incomes and transfers from government, which is equal to its savings. On the other hand, public sector income is defined as income from enterpreneurship (factor income from capital) that goes as transfers to government.

2.7 Household savings

The average propensity to save out of their disposable incomes is exogenously given for each of the four rural and five urban households. Households thus save a fixed part of their incomes. Total household savings in the economy is obtained by summing up the savings of all the nine household groups.

2.8 Government Savings

Government revenue originates from the following five sources : excise tax on production, sales tax on goods, import duties from imported goods and income tax from households. All the tax rates are exogenously given. Government income also includes the capital income and land rent from ownership of these factors, factor income from abroad and public sector income. Government expenditure takes place on account of government consumption and transfers to households and

firms, and public sector investment, all of which are exogenously fixed. Government savings is obtained as the difference between government income and expenditure.

2.9 Foreign Savings

Foreign savings in dollar terms is expressed in the model as the excess of payments for total imports over the sum of export earnings, net curent transfers and factor income from abroad. The latter two, it may be noted., are exogenously given values in the model.

2.10 Market equilibrium and macroeconomic closure

Market clearing equilibrium in the commodity markets is ensured by the condition that sectoral domestic supply must equal demand faced by that sector. The sectoral domestic supply, (i.e., domestic gross output) of a commodity is determined through the nested CES function in the production structure of the model. On the other hand, sectoral demand is a combination of domestic demand and export demand, based on a CET transformation function. In turn, the aggregate demand for a commodity – i.e., the sum of consumption, investment and government and intermediate demands - is equated to the demand for a composite commodity defined as an Armington type CES aggregation of domestic demand and imports.

The model is Walrasian in spirit with the sectoral prices being the equilibrating variables for the market-clearing equations. The Walras' law holds and the model is, therefore, homogeneous of degree zero in prices determining only relative prices. The exchange rate serves as the numeraire, and is, therefore, fixed at one.

Finally, note that although the model is neoclassical in nature, it follows investment-driven macro closure in which aggregate investment is fixed and the components of savings - household savings, government savings and foreign savings - are endogenous variables and adjust to equalize saving and investment.

2.11 Intertemporal adjustments

In the interim-period sub-model, the physical and human capital stocks are updated. Sectoral capital stocks are exogenously given at the beginning of a particular period. However, our model is recursively dynamic, which means that it is run for many periods as a sequence of equilibria. Between two periods there will be additions to capital stocks in each sector because of the investment undertaken in that sector in the previous period. More precisely, sectoral capital stocks

for any year *t+1* are arrived at by adding the investments by sectors of destination, net of depreciation, in year *t* to the sectoral capital stocks at the beginning of the year *t*.

Between two periods there will be additions to human capital stocks also because of the public education expenditure undertaken in the previous period. More specifically, the output flow of labour of education level '*m',* MS_m , is an additive function of the education expenditure and the lifetime wage differential between wages at educational level '*m*' and the next lower level '*l*'[9] . The function is specified as follows :

$$MS_{mt} = \beta_1 \text{ x } GED_{lt}^{\rho edl} + \beta_2 \text{ x } \left(\frac{W_{m(t-1)}}{W_{l(t-1)}}\right)\left(\frac{1+g_{t-1}}{1+r_{t-1}}\right)$$

where MS_m : output flow of labour of education level *m*

GED_l : government education expenditure at level *l*,

W_m : Wage rate for labour of education level *m*

g : growth rate of the economy as a proxy for the growth rate of the wages.

r : discount rate

β_1 , β_2, ρ^{edl} : positive constants[10]

ML_m : new labour supply of education level *m*

The flows of labour of different educational levels are interlinked with each other. From the pool of population growth (MS_1), some proceed to secondary school (MS_2), while others remain non-educated (ML_1), and from secondary school, some advance to higher education (MS_3), while others directly enter the labour market as secondary educated (ML_2). Finally, higher-educated workers are produced and supplied (ML_3). With the total increase of the labour force constrained to a fixed population growth rate, the new supply of non-educated labour (ML_1) is determined residually. The labour flows are explained in the figure below :

[9] For a detailed derivation of the function of the output flow of educated labour, see pages 704-708 of Jung and Thorbecke (2003).

[10] For β_1 and β_2 we have used the same values as Jung and Thorbecke (2003), which is 0.5 for each, and for ρ^{edl} we have used the values 0.44 and 0. 48 for secondary and higher education respectively.

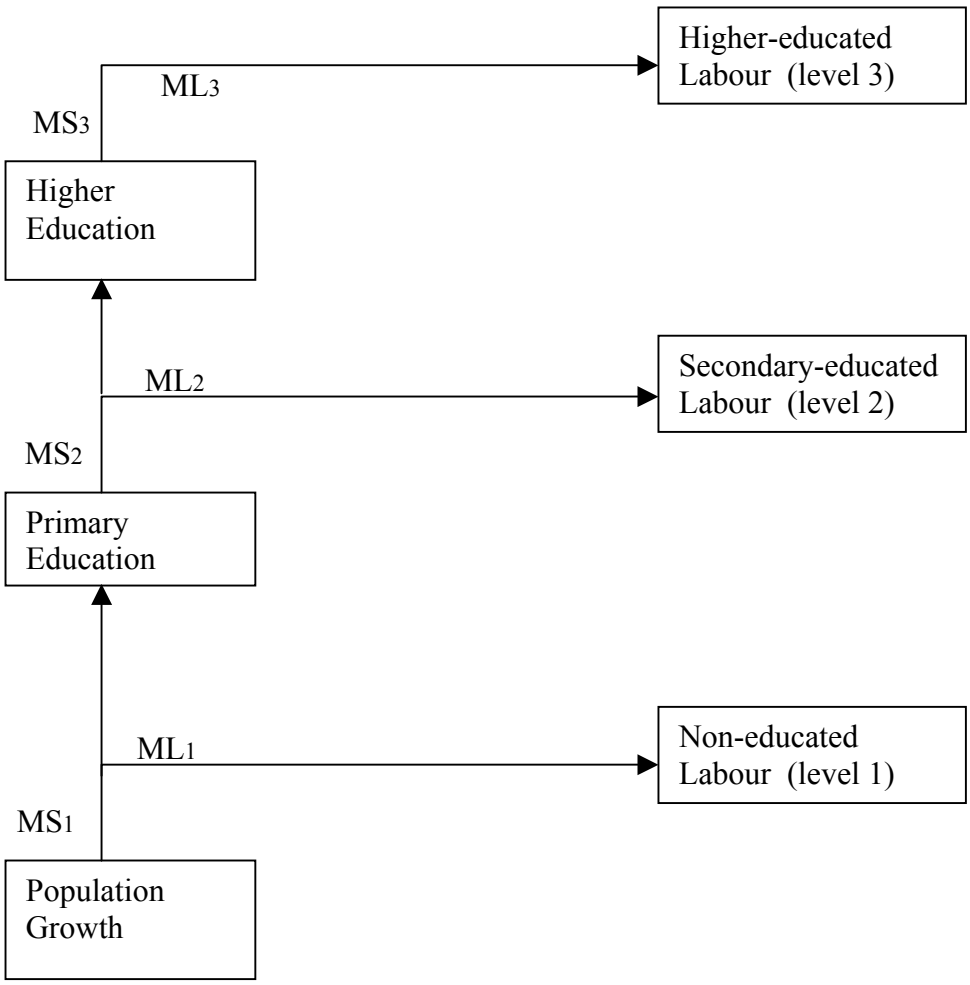

Figure 1 : The labour flows

Note that the following relationships between the flows of labour types of different educational levels hold.

$ML_{3\,t} = MS_{3\,t}$; $ML_{2\,t} = MS_{2\,t} - MS_{3\,t}$

$$ML_{1\,t} = n \times P_t + \left(\sum_{l=1}^{3} dh_l \, LS_{l\,t} \right) - \left(ML_{2\,t} + ML_{3\,t} \right)$$

$LS_{l\,(t+1)} = LS_{l\,t} \left(1 - dh_l \right) + ML_{l\,t}$; for $l = 1,2,3$.

where P = population

n = labour participation rate

dh_l = depreciation rate (retirees) of labour stock of educational level *l*

LS_l = labour stock of educational level *l*

3. The Base-Line Scenario

Our CGE model has been calibrated to the benchmark equilibrium data set represented in a SAM for the Indian economy for the year 1994-95. The SAM used for the present study is based on Pradhan, Sahoo and Saluja (1999). The SAM given here has been re-aggregated and modified to conform to the classification scheme of the production sectors, labour categories and the household groups, adopted in the model. The reaggregated and modified SAM is presented in Appendix 1.

Using the benchamark data set for the year 1994-95, we solve the CGE model first for the base-year, and, subsequently, using a time series of the exogenous variables of the model, we generate a sequence of equilibria for the period from 1994-95 to 2001-02. From the sequence of equilibria, the growth paths of selected (macro) variables of the economy are outlined to describe the base-line scenario.

3.1 Benchmark parameters

After having obtained the basic data set from the SAM, the CGE model is subjected to benchmark calibration. Calibration involves a deterministic approach to specifying parameter values in such a manner that the model solution replicates the base-year data (Shoven and Whalley (1992)). Calibration of the 'shift' and 'share' parameters of the production functions, CES aggregation function for imports and CET function for imports, however, require the elasticity parameters of these functions to be given. The elasticity parameters have been taken from different sources and are given below in table 3. Note that different types of labour are combined in two stages in the production structure to reflect different degrees of substituability. The skilled labour composite and non-educated labour are combined within a CES type Armington aggregation that has a small elasticity of substitution equal to 0.5 to yield composite labour. In turn, skilled labour composite is a CES Armington aggregation of secondary-educated and higher-educated labour based on a larger elasticity of substitution equal to 0.8. Through this labour aggregation scheme, the model is able to capture productivity growth caused by education. Note also that the higher wage income for the educated labourers results in higher share parameters for such workers in the calibration. Educated workers thereby contribute more to the composite labour. It follows that an increase in the supply of educated labour leads to a higher value for composite labour, resulting in higher production.

In table 4 we present the endowmnents of human capital across the nine household groups. It is interesting to note that most of the secondary and higher educated belong to the urban salaried

and urban non-agricultural self-employed groups. Almost 85 percent of higher-educated and 42 percent of secondary-educated workers come from these two groups. However, secondary-educated workers are more evenly spread over the urban and rural groups. Urban groups have 48.5 percent of the secondary-educated workers and rural groups have 52.5 percent of the educated workers. (It may be noted that, in our classfication of educated workers, secondary-educated includes elementary, secondary and higher- secondary educated. The disitribution of workers within these three levels of education is not shown in the table.)

Table 3 : Elasticity Parameters

		ρ_1	ρ_2	ρ_3	ρ_a	ρ_c	ε_{ex}
s1	Agriculture	0.7800	0.5000	0.8000	1.1387	0.9200	0.8400
s2	Mining	1.3200	0.5000	0.8000	1.6195	0.4600	0.8600
s3	Manufacturing 1	0.7420	0.5000	0.8000	2.2470	1.7000	1.2300
s4	Manufacturing 2	0.9682	0.5000	0.8000	2.7368	1.3855	1.1739
s5	Construction	1.1000	0.5000	0.8000	0.0000	0.0000	0.0000
s6	Elec. Gas & W.S.	2.2600	0.5000	0.8000	0.0000	0.0000	0.0000
s7	Trans. & Stor.	1.4500	0.5000	0.8000	2.1450	0.9200	1.3200
s8	Whole & Ret.Trade	1.4500	0.5000	0.8000	2.1450	0.9200	1.2800
s9	Fin., Ins. & Real Es.	1.6500	0.5000	0.8000	2.1450	0.9200	1.3600
10	Comm.,Soc.& Per. Servs.	1.0800	0.5000	0.8000	0.7150	0.3067	0.6667

Note : ρ_1 : elasticity of substitution between composite labour and capital.
ρ_2 : elasticity of substitution between skilled labour composite labour and uneducted labour.
ρ_3 : elasticity of substitution between secondary-educated labour and higher-educated labour.
ρ_a : elasticity of substitution between domestic demand and imports.
ρ_a : elasticity of substitution between domestic sales and exports.
ε_{ex} : export demand elasticity
Source : Jung and Thorbecke (2003) and Chadha et al (1999) .

Table 4 : Resource endowment shares in percentages

	Non-educated labour	*Secondary-educated labour*	*Higher-educated labour*		*Physical Capital*
RC	20.34	13.98	2.65		27.34
RATN	19.54	4.33	0.63		10.06
RAL	31.02	11.59	0.32		0.33
RO	14.69	21.68	9.45		2.61
UF	1.37	0.50	0.00		1.00
UNASE	2.59	8.86	8.79		14.16
US	6.64	33.30	75.73		6.18
UCL	3.25	5.02	0.90		1.53
UO	0.55	0.75	1.54		3.64
	100.00	100.00	100.00		66.86

Note : RC : Rural Cultivator ; RATN : Rural Artisan ; RAL : Rural Agricultural Labourer ;
RO : Rural Others ; UF : Urban farmer ; UNASE : Urban Non-agricultural Self-employed ;
US : Urban Salaried ; UCL : Urban Casual Labouer ; UO : Urban Others.
Physical capital endowment includes that of land. Capital column sums upto only 66.86% because the remaining 33.14% accrues to private enterprise, public enterprise, government and the rest of world.

Source : Calculations from MIMAP India Survey, 1996, NCAER.

3.2 Labour supply and wage levels

In the base-line scenario, labour supply grows annually at the rate of 1.84 percent (table 5). Among the three types of labour, the supply of higher educated workers grows fastest at the rate of 4.94 percent, followed by secondary-educated workers' supply which increase at the rate 3.66 percent. The supply of non-educated labour, which is determined residually, grows by only 1.04 percent annually. It would seem that the 8.31 percent and 9.34 percent annual growth in real public expenditure on secondary and higher education respectively is making a positive impact on the supply of educated workers.

Regarding wage levels, there is maximum improvement in the non-educated workers' wage rate which increases by 3.86 percent annually. Education expenditure benfits the non-educated labour indirectly, by inducing a relative decrease in its supply. Secondary-educated workers' wage rate also grows fast at 3.57 percent . The wage rate of higher-educated workers increases at only 3.07 percent per annum. The wage rates of secondary and higher educated workers rise despite the increase in their supplies because the techniques of production become more skill intensive as the economy grows over time (table 5).

Table 5 : Baseline : Labour supply, wage rates and public education expenditure

	Average annual growth rates for 1994-95 to 2001–02 in percent
Labour Supply	**1.84**
Non-educated labour	1.04
Secondary-educated labour	3.66
Higher-educated labour	4.94
Wage rate (real)	**4.55**
Non-educated labour	3.86
Secondary-educated labour	3.57
Higher-educated labour	3.07
Public education expenditure (real)	**8.47**
Secondary education	8.31
Higher education	9.34

Table 6 : Baseline : Wage rate indexes

	Wage rate as a multiple of non-educated worker's wage rate	
	1994-95	2001-02
Wage rate (real)		
Non-educated labour	1.00	1.00
Secondary-educated labour	1.98	1.95
Higher-educated labour	7.55	7.16

The higher rate of growth of the non-educated worker's wage notwithstanding, the wage inequality across the three types of labour – particularly between non-educated and higher-educated labour - remains acute at the end of the seven-year period (see table 6). This is mainly due to the extreme inequality of wages of the three types of labour prevailing at the beginning of the period.

3.3 GDP and household income

Real GDP in the base-run grows at 5.99 percent per annum, with investment in physical capital being on an average 28.35 percent of GDP. The rate of growth of wage income is 2.45 percent higher than that of the capital income (table 7).

Household income as a whole grows at 5.64 percent per annum. But the rates of growth of incomes vary widely across the various household groups. The rate of growth of incomes of the urban salaried class is, expectedly, the highest – i.e., 7.35 percent. Urban salaried households are

the greatest beneficiaries from the spread of education. These households account for 75.75 percent of the higher-educated and 33.30 percent of the secondary-educated labour (see table 4). Urban non-agricultural self-employed improve their incomes at the rate of 5.17 percent per annum. This class also depends largely for its income on secondary and higher educated labour. Another group, not so expected, which benefits from the spread of education is rural others. This group is endowed with 21.68 percent of the secondary–educated workforce and 9.45 percent of higher-educated workforce. However, the non-beneficiaries of education – i.e., those having mainly non-educated labour as a source of their income – are also significantly better-off, thanks to the rise in the wage rate of non-educated labour. For example, household incomes of the rural agricultural labourers grow at 5.28 percent per annum. Urban casual labourers, who are to a large extent though not mainly dependent on non-educated labour, also increase their incomes by 5.49 percent per annum[11].

Table 7 : Baseline : GDP and household income

	Average annual growth rates for 1994-95 to 2001 –02 (in percent)
GDP (real)	**5.99**
Investment (% of GDP)	28.35
Wage Income (real)	6.57
Capital Income (real)	4.12
Household Income (real)	**5.64**
Rural Cultivator	4.70
Rural Artisan	4.71
Rural Agricultural Labour	5.28
Rural Others	6.07
Urban Farmers	4.66
Urban Non-ag. Self-Employed	5.17
Urban Salaried	7.35
Urban Casual Labourer	5.49
Urban Others	4.85

[11] Note that wage income is allocated to each household group on the basis of the base-year endowment shares for all the years. That is, the flow of new labour types is distributed across household groups in the same way as the whole labour stock.

4. The Policy Simulations

We develop three alternative policy scenarios for an expansion in the public education expenditure. In all the the three simulations, the increase in public education expenditure is financed by an increase in the direct taxes – i.e., income and corporate tax. In fact, the increase in public education expenditure is implemented in a manner suggested by Mehrotra (2004). That is, we increase the income and corporate taxes by a specified percentage and dedicate the resulting additional revenue to public spending on education. The mode of financing remains the same in all the three simulations, but the mode of expenditure varies across them. In the first simulation, the additional expenditure on education is distributed between secondary and higher education in the same proportions as in the total expenditure of the base-line scenario. In the second scenario, the extra expenditure is directed exclusively towards secondary education. In the third policy scenario, the additional revenue from the specified increase in tax rates is shared equally between investment in physical capital and education expenditure concentrated in the secondary education sector.

4.1 Policy simulation 1

In this simulation, we increase the rates of income tax and corporate tax by 10 percent and use the additional revenue for increased public spending on secondary and higher education in the same proportions as in total public education expenditure of the base-run. By this mechanism, the 10 percent increase in the two direct tax rates, results in a 14.40 percent increase in real public education expenditure over the base-run. And public education expenditure as a percentage of GDP, increases by 0.43 percentage point compared to the base-run.

Table 8 : Simulation 1 : Labour supply and wage rates

	Average annual growth rates for 1994-95 to 2001 –02 (in percent)		Diff.from base-line in %age points
	Simulation 1	Baseline	Simulation 1
Labour Supply	**1.84**	**1.84**	**0.00**
Non-educated labour	0.61	1.04	-0.43
Secondary-educated labour	4.01	3.66	0.35
Higher-educated labour	5.26	4.94	0.32
Wage rate (real)	**4.57**	**4.55**	**0.02**
Non-educated labour	5.13	3.86	1.27
Secondary-educated labour	3.02	3.57	-0.55
Higher-educated labour	2.57	3.07	-0.50

In policy scenario 1, the growth rate of secondary and higher educated labour supply goes up by 0.35 and 0.32 percentage points respectively, but that of the non-educated labour supply goes down by 0.43 percentage point, since it is determined residually. As a result non-educated workers become relatively more scarce and improve the growth rate of their wage rate by 1.27 percentage points. The secondary and higher educated workers are supplied more abundantly and, therefore, suffer a decline in the growth rates of their wage rates by 0.55 and 0.50 percentage points respectively (table 8). The inequality in the wages also narrows down a little, with the higher and secondary educated workers receiving wages which are respectively 6.35 times and 1.73 times the wage of the non-educated workers (table 9).

Table 9 : Simulation 1 : Wage rate indexes

	Wage rate as a multiple of non-educated worker's wage rate in 2001-02	
	Simulation 1	Baseline
Wage rate (real)		
Non-educated labour	1.00	1.00
Secondary-educated labour	1.73	1.95
Higher-educated labour	6.35	7.16

With a 14.40 percent increase in public education expenditure, GDP growth rate improves by 0.17 percentage point. Investment as a percentage of GDP declines marginally, since its level is fixed exogeously and remains the same as in the base-run. As a result, capital, in comparison to educated labour whose supply increases, becomes more scarce. Hence, capital income growth rate increases by twice as many percentage points as the increase in the wage income growth rate (table

10). Household income also grows faster by 0.13 percentage points. An inter-group comparison of the household income growth rates reveals that all groups experience a faster growth in their incomes except, the urban salaried and the rural others, who suffer a decline in their income growth rates as a consequence of the fall in the growth rates of the wages of secondary-educated and higher-educated workers. It may be noted that these two groups are the ones experiencing the highest growth rates in their incomes in the business-as-usual scenario. Hence, a decline in their income growth rates in the face of a rise in the income growth rates of the remaining groups represents a distinct change towards greater equalisation of incomes.

Table 10 : Simulation 1 : GDP and household income

	Average annual growth rates for 1994-95 to 2001 –02 (in percent)		Diff.from base-line in %age points
	Simulation 1	Baseline	Simulation 1
GDP (real)	**6.16**	**5.99**	**0.17**
Investment (% of GDP)	27.65	28.35	-0.70
Wage Income (real)	6.63	6.57	0.06
Capital Income (real)	4.24	4.12	0.12
Household Income (real)	**5.77**	**5.64**	**0.13**
Rural Cultivator	4.88	4.70	0.18
Rural Artisan	4.85	4.71	0.14
Rural Agricultural Labour	5.46	5.28	0.18
Rural Others	*5.98*	*6.07*	*-0.09*
Urban Farmers	4.59	4.66	-0.07
Urban Non-ag. Self-Employed	5.24	5.17	0.07
Urban Salaried	*7.24*	*7.35*	*-0.11*
Urban Casual Labourer	5.58	5.49	0.09
Urban Others	5.08	4.85	0.23

Note : The fast movers – i.e., those household groups having income growth rates higher than 6% in the base-line - are shown in italics.

4.2 Policy simulation 2

In this simulation, we increase the rates of income tax and corporate tax by 10 percent and use the additional revenue for increased public spending exclusively on secondary education. By this mechanism, the 10 percent increase in the two direct tax rates, results in a 17.53 percent increase in real public expenditure on secondary education over the base-run. For public expenditure on education as whole the increase is of 14.47 percent. As a percentage of GDP, the increase in expenditure on elementary education is by 0.41 percentage point.

In policy scenario 2, supply of secondary-educated labour goes up while that of non-educated labour goes down like in simulation 1. But the order of magnitudes involved are higher in case of this simulation. In comparison to the base-run, the rate of growth of supply of secondary-educated labour increases by 0.52 percentage point, while that of non-educated labour declines by 0.48 percentage point. The growth rate of higher-educated workers also declines marginally. The improvement in the wages of the non-educated labour is, as compared to the base-run, much faster. That is, the rate of growth in their wages is 5.18 percent, whereas it was only 3.86 percent in the base-run. For secondary-educated labour, which is now more abundantly supplied, there is a fall in the growth rate of wages. It may be noted that in this scenario, there is a significant substitution in production in favour of secondary-educated labour *vis-à-vis* higher-educated labour. And this explains why there is a marginal *decline* in the growth rate of the higher-educated worker's wage even as higher-educated labour becomes relatively more scarce. The wage rate inequality shows some improvement as the rate of growth of non-educated labour rises and that of the secondary-educated labour falls, but the higher-educated labour still earns a wage which is more than 6.5 times that of non-educated labour (table 12).

Table 11 : Simulation 2 : Labour supply and wage rates

	Average annual growth rates for 1994-95 to 2001 –02 (in percent)		Diff.from base-line in %age points
	Simulation 2	Baseline	Simulation 2
Labour Supply	**1.84**	**1.84**	**0.00**
Non-educated labour	0.56	1.04	-0.48
Secondary-educated labour	4.19	3.66	0.52
Higher-educated labour	4.89	4.94	-0.05
Wage rate (real)	**4.62**	**4.55**	**0.07**
Non-educated labour	5.18	3.86	1.32
Secondary-educated labour	3.08	3.57	-0.49
Higher-educated labour	3.03	3.07	-0.04

Table 12 : Simulation 2 : Wage rate indexes

	Wage rate as a multiple of non-educated worker's wage rate in 2001-02	
	Simulation 2	Baseline
Wage rate (real)		
Non-educated labour	1.00	1.00
Secondary-educated labour	1.70	1.95
Higher-educated labour	6.52	7.16

Table 13 : Simulation 2 : GDP and household income

	Average annual growth rates for 1994-95 to 2001 –02 (in percent)		Diff.from base-line in %age points
	Simulation 2	Baseline	Simulation 2
GDP (real)	**6.22**	**5.99**	**0.23**
Investment (% of GDP)	27.54	28.35	-0.81
Wage Income (real)	6.66	6.57	0.09
Capital Income (real)	4.29	4.12	0.17
Household Income (real)	**5.83**	**5.64**	**0.19**
Rural Cultivator	4.93	4.70	0.23
Rural Artisan	4.89	4.71	0.18
Rural Agricultural Labour	5.58	5.28	0.30
Rural Others	*6.09*	*6.07*	*0.02*
Urban Farmers	4.65	4.66	-0.01
Urban Non-ag. Self-Employed	5.31	5.17	0.14
Urban Salaried	*7.31*	*7.35*	*-0.04*
Urban Casual Labourer	5.64	5.49	0.15
Urban Others	5.12	4.85	0.27

Note : The fast movers – i.e., those household groups having income growth rates higher than 6% in the base-line - are shown in italics.

With a 17.50 percent increase in public expenditure on secondary education, GDP growth rate improves by 0.23 percentage point. An increase in the supply of secondary-educated labour (notwithstanding the marginal decline in the supply of higher educated labour), in our labour aggregation scheme, leads to a higher value for composite labour, resulting in higher value-added and, thus, higher GDP. Note that in this simulation, as compared to simulation 1, the GDP growth rate is higher, which suggests that the negative impact on productivity due to the decline in the growth rate of higher-educated workers is more than compensated by the positive impact on productivity on account of the rise in the growth of secondary-educated workers. However, this by

no means indicates the relative unimportance of higher education. On the contrary, a large-scale substitution of secondary-educated workers for higher-educated workers will, in all likelihood, result in a net loss of productivity for the economy. Hence, promoting secondary-education at the cost of higher education beyond a point may well be detrimental to GDP. In fact, the result of this simulation can easily reverse in a longer time frame or for a larger diversion of resources from higher to secondary education within the same time frame.

Household income as a whole grows at 5.83 percent per annum – which is faster than its rate of growth in the base-run by 0.19 percentage point. Except for the urban salaried households, all households benefit from the faster spread of education under scenario 2. For the urban salaried and urban farmers groups, the income growth rates marginally decline ; for all other groups the growth rates of income are higher (table 13). Urban salaried group is hugely dependent upon higher and secondary labour for its incomes (see table 4). For higher-educated workers the growth rates of the wage rate as well as the labour supply decline in this simulation, while, for, secondary-educated workers the faster growth in labour supply is more than compensated by the slower growth in their wage rate. Hence, a decline in the income growth rate of the urban salaried households. But the decline in the income growth rate of this group is only marginal – by 0.04 percentage point, and even after the decline its income growth rate is 7.31 percent. All other household groups improve their positions. Especially those groups which had income growth rates of less than 5 percent , such as, rural cultivator and rural artisan, have moved up to income growth rates near 5 percent. In short, the fast movers are slowing down and the slow movers are catching up. Income distribution thus changes for the better when the growth of secondary education is speeded up.

4.3 Policy simulation 3

In this simulation, we increase the rates of income tax and corporate tax by 10 percent, and the additional revenue is shared equally between investment in physical capital and education expenditure concentrated in the secondary education sector. This results in a 8.55 percent increase in real public expenditure on secondary education over the base-run. For public expenditure on education as whole the increase is of 7.25 percent. As a percentage of GDP, the increase in expenditure on secondary education is by 0.22 percentage point. On the other hand, the additional investment in physical capital raises the investment-GDP ratio from 28.35 percent to 28.65 percent.

Under this scenario, the increase in expenditure on secondary education is smaller in comparison with that in the previous simulation. Hence, the growth in the supply of secondary-

educated workers increases by only 0.20 percentage point (table 14). The decrease in the growth of residually determined non-educated labour supply is also of a lower order. The growth rate of higher-educated labour supply, however, picks up in this simulation, even though the expenditure on higher education does not increase. The growth in higher-educated labour supply is stimulated by the rise in the wages of this type of labour[12]. The growth in wage rates, in this simulation, increases not only for non-educated labour but for secondary and higher-educated workers as well. The reason for this is that the production techniques under this scenario become more skill intensive intensive, thus increasing the demand for skilled labour – i.e., secondary and higher educated labour. It may be noted that the wage rates for secondary and higher educated labour grow faster in this simulation *vis-à-vis* the previous siumlation. Finally, the wage-rate inequality in this simulation is the same as that in the base run. And in comparison to the previous simulation the wage inequality has worsened.

Table 14 : Simulation 3 : Labour supply and wage rates

	Average annual growth rates for 1994-95 to 2001 –02 (in percent)		Diff.from base-line in %age points	
	Simulation 3	Baseline	Simulation 3	Simulation 2
Labour Supply	**1.84**	**1.84**	**0.00**	**0.00**
Non-educated labour	0.81	1.04	-0.23	-0.48
Secondary-educated labour	3.86	3.66	0.20	0.52
Higher-educated labour	4.98	4.94	0.04	-0.05
Wage rate (real)	**4.71**	**4.55**	**0.16**	**0.07**
Non-educated labour	4.17	3.86	0.31	1.32
Secondary-educated labour	3.75	3.57	0.18	-0.49
Higher-educated labour	3.29	3.07	0.22	-0.04

[12] Note that the new labour supply at any level is influenced not only by the government expenditure on that level of education but also by the wage differential between the given level and the preceding level.

Table 15 : Simulation 3 : Wage rate indexes

	Wage rate as a multiple of non-educated worker's wage rate in 2001-02		
	Simulation 3	Baseline	Simulation 2
Wage rate (real)			
Non-educated labour	1.00	1.00	1.00
Secondary-educated labour	1.92	1.95	1.70
Higher-educated labour	7.11	7.16	6.52

Table 16 : Simulation 3 : GDP and household income

	Average annual growth rates for 1994-95 to 2001 –02 (in percent)		Diff.from base-line in %age points	
	Simulation 3	Baseline	Simulation 3	Simulation 2
GDP (real)	**6.36**	**5.99**	**0.37**	**0.23**
Investment (% of GDP)	28.65	28.35	0.30	-0.81
Wage Income (real)	6.72	6.57	0.15	0.09
Capital Income (real)	4.37	4.12	0.25	0.17
Household Income (real)	**5.94**	**5.64**	**0.30**	**0.19**
Rural Cultivator	4.85	4.70	0.15	0.23
Rural Artisan	4.82	4.71	0.11	0.18
Rural Agricultural Labour	5.48	5.28	0.20	0.30
Rural Others	*6.25*	*6.07*	*0.18*	*0.02*
Urban Farmers	4.64	4.66	-0.02	-0.01
Urban Non-ag. Self-Employed	5.42	5.17	0.25	0.14
Urban Salaried	*7.43*	*7.35*	*0.08*	*-0.04*
Urban Casual Labourer	5.58	5.49	0.09	0.15
Urban Others	5.23	4.85	0.38	0.27

Note : The fast movers – i.e., those household groups having income growth rates higher than 6% in the base-line - are shown in italics.

Under scenario 3, in which there is a simultaneous increase in investment in physical capital and expenditure on secondary education, the GDP growth rate goes up by 0.37 percentage points - which is 0.14 percentage point more than the increment in GDP growth rate under scenario 2. (Recall that in scenario 2, the additional resources raised from the increase in the income and corporate tax rates is spent completely and exclusively on secondary education). It follows that when an increase in expenditure on secondary education is matched with an increase in investment in physical capital, the growth in labour productivity and thus GDP is enhanced. Household income as a whole is also growing faster in this simulation as compared to simulation 2. However, an inter-group comparison of the houshold income growth rates of this simulation *vis-à-vis* the previous

simulation shows that the income distribution is tending to become more unequal. That is, the fast movers among the household groups, such as, urban salaried and rural others are moving up the income ladder faster, while, the slow movers – rural cultivator, rural artisan, rural agricultural labour and urban casual labourer - are inching up even more slowly.

4.4 Policy simulations – caveats

In the interpretation of the simulation results, the assumptions on which our model is based must be borne in mind. First, we assume that increased public education expenditure will translate into improved educational outcomes. We have already discussed in section 1.1 how the efficiency of public education expenditure varies across states. The low efficiency of public education expenditure in many states will bring down the "average" efficiency of such expenditure, which we have tried to capture in the model by assigning "low" values for the elasticities of the output flow of educated labour with respect to public education expenditure. Second, we assume that the technology and the resource endowment shares of different household groups are fixed during the time span of our model. This is justifiable for the relatively moderate policy changes considered in our simulations.Third, we assume that the labour markets for the three types of labour are segmented. In the real world, it may be possible that higher-educated workers enter the market for secondary-educated workers and secondary-educated workers enter the market for non-educated workers, if they are unsuccessful in finding a job of their respective skill (educational) level. However, the magnitudes of these reverse flows of educated labour are not likely to be large especially because the initial wage rates of the three types of labour are far apart from each other and do not converge very much in the time frame of our model. In other words, this assumption is not as restrictive as it seems

5. Conclusions and Policy Implications

We conclude by highlighting the main policy lessons from our simulation exercises. The policy lessons that emanate from our policy scenarios are mainly three.

In policy scenario 1 we saw that a 14 percent increase in real public expenditure on secondary and higher education, financed through a 10 percent increase in the income and corporate tax rates, helps in achieving higher economic growth as well as an improved income distribution. However, it may be noted that the improvement in both GDP growth and income distribution is a moderate one. An interesting aspect of the result is that the non-educated workers also benefit from the spread of education. There is a marked rise in the wage rate of these workers, which is instrumental in reducing the wage inequality. The policy conclusion which emerges from this scenario is that it is possible to augment investment in human capital in the resource constrained fiscal environment of the Indian economy and reap the benefits in terms of a faster economic growth and a better income distribution.

In policy scenario 2, there is 17.5 percent increase in real public expenditure on secondary education (financed in the same way as in scenario 1) and the base run level maintained for public expenditure on higher education. As a result, both the GDP growth and the improvement in income distribution is enhanced. This scenario does indicate that, from a policy point of view, secondary education needs to be accorded higher priority. However, it does not follow that secondary education should be promoted at the cost of higher education. Limiting the growth of higher educated labour would amount to limiting the growth of labour productivity and thus of GDP. On balance the conclusion seems to be that efforts need to be directed and intensified towards finding alternative means of financing higher education so that more resources are available for expanding secondary education.

In policy scenario 3, there is a judicious mix of investment in physical capital and investment human capital. The mobilisation of resources is done similarly, but the spending of the additional resources is spread equally over investment in physical capital and expenditure on secondary education. The productivity gains are larger in this scenario, and GDP growth is further enhanced. But the wage inequality and the household income distribution clearly worsen (in comparison to scenario 2). This result in combination with the result of the previous simulation indicates, on one hand, that investment in physical capital is essential for easing the constraints on productivity growth, and, on the other hand, that investment in human capital plays a crucial role in spreading the benefits of economic growth more evenly across the various sections of the

population. The policy lesson that we would like to draw from this is that government should preoccupy itself with the task of expanding the human capital base, and, at the same time, encourage the private sector to accelerate investment in physical capital. This is now a widely accepted view. It is also endorsed by our simulation results.

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Appendix I : SAM -1994-95

	agriculture	mining	manuf. 1	manuf. 2	construction	elec.gas & water supply	transport & storage	wholesale & retail trade	fin.,ins. & real estate
agriculture	5285356.94	10.02	5265520.72	572030.19	448484.83	4813.25	173982.37	770818.42	0.00
mining	3782.21	22909.40	93214.58	2702251.73	461349.66	971848.52	5621.84	33258.75	0.00
manufacturing 1	307298.68	14104.17	3934489.15	764400.09	292759.34	10862.91	81667.97	587704.54	51188.26
manufacturing 2	2038420.92	353276.83	1583612.96	13427760.77	3484476.62	216973.30	2567012.13	285326.02	32178.81
construction	394024.72	8783.89	18367.86	63311.05	39303.31	133568.83	209430.31	114152.16	611942.59
elec., gas and w.s.	234188.55	117265.53	690261.01	1908134.69	56870.19	1423011.71	230622.20	350466.07	102663.38
trans.& stor.	287180.70	40372.04	699786.98	1974192.92	599712.59	398938.20	633460.47	1871799.27	207623.29
whol.& ret. trade	863050.74	57000.74	1653878.87	2627899.15	784325.72	279609.29	458022.39	299552.67	110023.95
fin., ins. & real est.	298998.00	59428.64	517324.37	1651278.89	334302.60	244534.82	472256.38	520766.21	501414.47
comm., soc. & per. servs.	69577.74	55624.00	574069.40	1085108.66	33504.15	36400.65	403235.48	790374.11	115516.31
Unskilled labour income	10309396.89	290526.22	1222065.37	1010569.71	2388836.00	131412.15	1052626.02	1347901.43	3092.68
Semi-skilled labour income	2235617.73	110277.69	781588.87	1354501.40	941898.17	235046.81	1152475.66	1511550.30	58081.95
Skilled labour income	382880.40	107257.54	449021.96	2034459.69	648189.99	296464.28	788057.22	1335180.23	1421865.37
Capital income	12948414.50	1309885.00	2344528.97	5957788.03	849078.84	1600101.58	3505514.85	7547870.41	5797849.00
RC									
RATN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RAL									
RO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UNASE									
US									
UCL									
UO									
Private enterprise									
Public enterprise									
Government									
net. Ind. tax	-608177.73	92341.29	772292.93	3928407.02	514207.99	304100.69	670510.73	287286.41	38402.95
Capital Account	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rest of World Account	317659.00	1926026.00	755573.00	5399637.00	0.00	0.00	578867.00	0.00	61200.00
Total	35367670.00	4565089.00	21355597.00	46461731.00	11877300.00	6287687.00	12983363.00	17654007.00	9113043.00

	comm.,soc.& per. services	Unskilled labour income	Semi-skilled labour income	Skilled labour income	Capital income	RC	RATN	RAL	RO
agriculture	356154.03					5799221.27	2762612.42	3414693.43	2490367.15
mining	79726.56					2518.51	1472.77	1887.00	2140.59
manufacturing 1	401781.48					2508190.27	1332561.34	1449934.00	1284992.89
manufacturing 2	1744642.86					1093242.69	507057.39	354651.23	365047.34
construction	59387.10					0.00	0.00	0.00	0.00
elec., gas and w.s.	175352.79					114831.27	67150.60	86037.75	97599.88
trans.& stor.	267928.24					1072144.88	463971.51	411744.99	293579.03
whol.& ret. trade	449897.40					1972772.89	853718.97	757620.89	540192.62
fin., ins. & real est.	514260.55					575348.08	317623.27	312039.83	402168.58
comm., soc. & per. servs.	320732.52					955720.28	406383.03	453746.83	425685.90
Unskilled labour income	982814.90								
Semi-skilled labour income	1887741.88								
Skilled labour income	5338691.15					0.00	0.00	0.00	0.00
Capital income	2046534.08					0.00	0.00	0.00	0.00
RC		3811734.14	1435394.41	339808.72	11593751.25	0.00	0.00	0.00	0.00
RATN	0.00	3662271.09	444270.66	80433.42	4267287.08	0.00	0.00	0.00	0.00
RAL		5813431.50	1190452.96	40369.70	140361.15	0.00	0.00	0.00	0.00
RO	0.00	2753373.88	2226277.32	1209552.09	1106807.98	0.00	0.00	0.00	0.00
UF	0.00	257658.19	51194.26	0.00	424561.79	0.00	0.00	0.00	0.00
UNASE		485649.55	909819.03	1125009.62	6003120.56	0.00	0.00	0.00	0.00
US		1244324.31	3419103.74	9695360.51	2619123.32	0.00	0.00	0.00	0.00
UCL		608148.11	515046.50	114756.49	650808.10	0.00	0.00	0.00	0.00
UO		102650.51	77221.59	196777.37	1542855.11	0.00	0.00	0.00	0.00
Private enterprise					2705200.00	0.00	0.00	0.00	0.00
Public enterprise					1018100.00	0.00	0.00	0.00	0.00
Government					818800.00	94975.00	334581.00	0.00	409619.00
net. Ind. tax	366843.48				0.00	398224.14	189632.89	183762.52	163778.47
Capital Account	0.00				9512187.00	5118145.96	2216637.22	538401.55	1659399.57
Rest of World Account	183274.00				0.00	0.00	0.00	0.00	0.00
Total	15175763.00	18739241.27	10268780.46	12802067.93	42402963.34	19705335.24	9453402.42	7964520.02	8134571.00

	UF	UNASE	US	UCL	UO
agriculture	295712.66	2453468.53	3042785.81	810736.64	376505.07
mining	164.43	2219.35	6338.14	639.68	634.53
manufacturing 1	121243.13	1208269.62	2587884.96	346934.40	383579.39
manufacturing 2	34314.46	464499.41	1100385.41	96626.70	139872.36
construction	0.00	0.00	0.00	0.00	0.00
elec., gas and w.s.	7497.00	101190.92	288986.93	29166.32	28931.33
trans.& stor.	43859.58	594184.33	1029129.73	110380.15	162859.81
whol.& ret. trade	80702.71	1093313.74	1893623.96	203102.18	299666.04
fin., ins. & real est.	41706.18	545436.14	1246811.90	113311.52	349040.50
comm., soc. & per. servs.	50771.64	539594.45	1181970.98	117935.93	235529.96
Unskilled labour income					
Semi-skilled labour income					
Skilled labour income	0.00	0.00	0.00	0.00	0.00
Capital income	0.00	0.00	0.00	0.00	0.00
RC	0.00	0.00	0.00	0.00	0.00
RATN	0.00	0.00	0.00	0.00	0.00
RAL	0.00	0.00	0.00	0.00	0.00
RO	0.00	0.00	0.00	0.00	0.00
UF	0.00	0.00	0.00	0.00	0.00
UNASE	0.00	0.00	0.00	0.00	0.00
US	0.00	0.00	0.00	0.00	0.00
UCL	0.00	0.00	0.00	0.00	0.00
UO	0.00	0.00	0.00	0.00	0.00
Private enterprise	0.00	0.00	0.00	0.00	0.00
Public enterprise	0.00	0.00	0.00	0.00	0.00
Government	30045.00	508450.00	920511.00	0.00	133519.00
net. Ind. tax	18255.89	218379.24	448171.00	48877.88	76819.98
Capital Account	146562.88	2368212.16	4533664.63	213281.25	464568.79
Rest of World Account	0.00	0.00	0.00	0.00	0.00
Total	870835.56	10097217.89	18280264.45	2090992.64	2651526.77

	Private enterprise	Public enterprise	Government	net. ind. tax	Capital account	Rest Of World Account	Total	
agriculture	0.00	0.00	130246.00	0.00	441888.00	472261.00	35367668.76	***35367668.76***
mining	0.00	0.00	964.00	0.00	50752.00	121395.00	4565089.24	***4565089.24***
manufacturing 1	0.00	0.00	156148.00	0.00	495021.00	3034578.00	21355593.59	***21355593.59***
manufacturing 2	0.00	0.00	1106873.34	0.00	12474084.35	2991394.00	46461729.89	***46461729.89***
construction	0.00	0.00	698378.00	0.00	9526650.00	0.00	11877299.82	***11877299.82***
elec., gas and w.s.	0.00	0.00	177459.00	0.00	0.00	0.00	6287687.11	***6287687.11***
trans.& stor.	0.00	0.00	653130.00	0.00	392103.00	775282.00	12983363.69	***12983363.69***
whol.& ret. trade	0.00	0.00	215420.66	0.00	948721.22	1211891.00	17654007.81	***17654007.81***
fin., ins. & real est.	0.00	0.00	56192.00	0.00	0.00	38800.00	9113042.94	***9113042.94***
comm., soc. & per. servs.	0.00	0.00	7057925.00	0.00	0.00	266356.00	15175763.03	***15175763.03***
Unskilled labour income							18739241.38	***18739241.38***
Semi-skilled labour income							10268780.45	***10268780.45***
Skilled labour income	0.00	0.00	0.00	0.00	0.00	0.00	12802067.84	***12802067.84***
Capital income	0.00	0.00	0.00	0.00	0.00	-1504600.00	42402965.27	***42402965.27***
RC	0.00	0.00	2472462.88	0.00	0.00	52183.84	19705335.24	***19705335.24***
RATN	0.00	0.00	931127.25	0.00	0.00	68012.92	9453402.42	***9453402.42***
RAL	0.00	0.00	693376.65	0.00	0.00	86528.07	7964520.02	***7964520.02***
RO	0.00	0.00	606335.08	0.00	0.00	232224.66	8134571.00	***8134571.00***
UF	0.00	0.00	84820.73	0.00	0.00	52600.59	870835.56	***870835.56***
UNASE	0.00	0.00	1028014.77	0.00	0.00	545604.36	10097217.89	***10097217.89***
US	0.00	0.00	848418.19	0.00	0.00	453934.38	18280264.45	***18280264.45***
UCL	0.00	0.00	181747.02	0.00	0.00	20486.42	2090992.64	***2090992.64***
UO	0.00	0.00	296897.44	0.00	0.00	435124.75	2651526.77	***2651526.77***
Private enterprise	0.00	0.00	327400.00	0.00	0.00	0.00	3032600.00	***3032600.00***
Public enterprise	0.00	0.00	0.00	0.00	0.00	0.00	1018100.00	***1018100.00***
Government	1382200.00	0.00	0.00	9533999.70	0.00	-218900.00	13947799.70	***13947799.70***
net. Ind. Tax	0.00	0.00	209586.74	0.00	1212295.21	0.00	9533999.70	***9533999.70***
Capital Account	1650400.00	1018100.00	-3985123.04	0.00	0.00	87079.00	25541516.96	***25541516.96***
Rest of World Account	0.00	0.00	0.00	0.00	0.00	0.00	9222236.00	***9222236.00***
Total	3032600.00	1018100.00	13947799.70	9533999.70	25541514.78	9222236.00	406599219.18	

Source : Pradhan, B K, Amarendra Sahoo & M R Saluja, Economic and Political Weekly , November 27, 1999 , Pages 3378-3394

Appendix 2

Equations of the Model

Production structure

$$X_i = as_i \left[\lambda_i CL_i^{\rho 1_i} + (1 - \lambda_i) \overline{K}_i^{\rho 1_i} \right]^{1/\rho 1_i} \quad (1)$$

$$CL_i = \overline{K}_i \left[\left(\frac{WK_i}{WCL_i} \right) \left(\frac{\lambda_i}{1 - \lambda_i} \right) \right]^{1/(1-\rho 1_i)} \quad (2)$$

$$PX_i * X_i * (1\text{-}exct_i) = WLL1 * LL1_i + WLL2 * LL2_i + WLL3 * LL3_i + WK_i * \overline{K}_i + \sum_j PC_j * a_{ji} * X_i \quad (3)$$

$$CL_i = as_{2i} \left[\lambda_{2_i} LL1_i^{\rho 2i} + (1 - \lambda_{2_i}) SLC_i^{\rho 2i} \right]^{1/\rho 2_i} \quad (4)$$

$$LL1_i = SLC_i \left[\left(\frac{WSLC_i}{WLL1} \right) \left(\frac{\lambda_{2i}}{1 - \lambda_{2i}} \right) \right]^{1/(1-\rho 2_i)} \quad (5)$$

$$WCL_i * CL_i = WLL1 * LL1_i + WSLC_i * SLC_i \quad (6)$$

$$SLC_i = as_{3i} \left[\lambda_{3_i} LL2_i^{\rho 3i} + (1 - \lambda_{3_i}) LL3_i^{\rho 3i} \right]^{1/\rho 3_i} \quad (7)$$

$$LL2_i = LL3_i \left[\left(\frac{WLL3}{WLL2} \right) \left(\frac{\lambda_{3i}}{1 - \lambda_{3i}} \right) \right]^{1/(1-\rho 3_i)} \quad (8)$$

$$WSLC_i * SLC_i = WLL2 * LL2_i + WLL3 * LL3_I \quad (9)$$

$$XD_i = cet_i \left[\lambda c_i EXP_i^{\rho c_i} + (1 - \lambda c_i) ADD_i^{\rho c_i} \right]^{1/\rho c_i} \quad (10)$$

$$EXP_i = ADD_i \left[\left(\frac{PEX_i}{PD_i} \right) \left(\frac{\lambda_{c_i}}{1-\lambda_{c_i}} \right) \right]^{1/(1-\rho_{c_i})} \quad (11)$$

$$PX_i * XD_i = PEX_i * EXP_i + PD_i * ADD_I \quad (12)$$

$$PEX_i = PWE_i * ER \quad (13)$$

$$EXP_i = exs_i * (pwes_i / PWE_i)^{\varepsilon_I} \quad (14)$$

$$AD_i = arm_i \left[\lambda_{a_i} IMP_i^{\rho a_i} + (1-\lambda_{a_i}) ADD_i^{\rho a_i} \right]^{1/\rho a_i} \quad (15)$$

$$IMP_i = ADD_i \left[\left(\frac{PM_i}{PD_i (1+salt_i)} \right) \left(\frac{\lambda_{a_i}}{1-\lambda_{a_i}} \right) \right]^{1/(1-\rho_{a_i})} \quad (16)$$

$$PC_i * AD_i = PM_i * IMP_i + PD_i * (1+ salt_i) * ADD_I \quad (17)$$

$$PM_i = pwm_i * (1 + tarf_i) * ER \quad (18)$$

Labour Markets

$$\sum_i LL1 = LS_1 \quad (19)$$

$$\sum_i LL2 = LS_2 \quad (20)$$

$$\sum_i LL3 = LS_3 \quad (21)$$

Commodity Markets

$$XD_i = X_I \quad (22)$$

Incomes

$$Y_h = WLL3 * end_{h,LL3} + WLL2 * end_{h,LL2} + WLL2 * end_{h,LL2} + WLND * end_{h,LND} \\ fk_h * \sum_i (WK_i * \overline{K}_i) \quad (23)$$

$$YD_h = Y_h - inct_h * (Y_h - WLND * end_{h,LND}) + fg_h * trnfg * PINDEX + trnfw_h * ER \quad (24)$$

$$HS_h = sav_h * YD_h \quad (25)$$

$$CORPDI = (1- corpt) * [WLND * end_{corp,LND} + fk_{corp} * \sum_i (WK_i * \overline{K} i)] + fg_{corp} * trnfg * PINDEX \quad (26)$$

$$CORPSAV = CORPDI \quad (27)$$

$$PUBDI = fk_{pub} * \sum_i (WK_i * \overline{K} i) \quad (28)$$

$$TAXREV = inct_h * (Y_h - WLND * end_{h,LND}) + corpt * [WLND * end_{corp,LND} + fk_{corp} * \sum_i (WK_i * \overline{K} i)] + \sum_i PX_i * X_i * exct_i + \sum_i PD_i * ADD_i * salt_i + \sum_i IMP_i * pwm_i * ER * tarf_i \quad (29)$$

$$GREV = TAXREV + WLND * end_{gov, LND} + fk_{gov} * \sum_i (WK_i * \overline{K} i) + trnfw_{gov} * ER \quad (30)$$

Expenditures

$$C_{h,i} = minc_{h,i} + (\gamma_{h,i} / PC_i) * [(YD_h - HS_h) – (\sum_i PC_i * minc_{h,i})] \quad (31)$$

$$INVDT_i = pukv_i * pubinv + prkv_i * prinv \quad (32)$$

$$ID_i = ad_i * (pubinv + prinv) ; \quad (33)$$

$$AD_i = \sum_h C_{h,i} + ID_i + cg_i + \sum_j a_{ij} * X_j \quad (34)$$

$$GEXP = trnfg * PINDEX + \sum_i PC_i * cg_I \quad (35)$$

Savings and Investment

$$GS = GREV + PUBDI – GEXP \quad (36)$$

$$FSD = \sum_i (pwm_i * IMP_i) + [fk_{row} * \sum_i (WK_i * \overline{K} i)] / ER - \sum_i (pwe_i * EXP_i)$$

$$- \sum_{h} trnfw_h + trnfw_{gov} \quad (37)$$

$$TS = \sum_{h} HS_h + CORPSAV + GS + FSD * ER \quad (38)$$

$$TS = \sum_{i} PC_i * ID_I \quad (39)$$

$$PVA_i = PX_i * (1\text{-}exct_i) - \sum_{j} PC_j * a_{ji} \quad (40)$$

$$PINDEX = \sum_{i} \alpha_i * PC_i \quad (41)$$

$$RGDP = [\sum_{i} PVA_i * X_i] / PINDEX \quad (42)$$

Intertemporal Adjustments

$$\overline{K}_{i,(t+1)} = \overline{K}_{i,t} * (1\text{-}dp_i) + INVDT_I \quad (43)$$

$$MS_{mt} = \beta_1 \text{ x } GED_{lt}^{\rho ed_l} + \beta_2 \text{ x } \left(\frac{W_{m\,(t-1)}}{W_{l\,(t-1)}} \right) \left(\frac{1+g_{t-1}}{1+r_{t-1}} \right) \quad (44)$$

$$ML_{3\,t} = MS_{3\,t} \; ; \quad ML_{2\,t} = MS_{2\,t} - MS_{3\,t} \quad (45)$$

$$ML_{1\,t} = n \text{ x } P_t + (\sum_{l=1}^{3} dh_l \, LS_{l\,t}) - (ML_{2\,t} + ML_{3\,t}) \quad (46)$$

$$LS_{l\,(t+1)} = LS_{l\,t} (1\text{-} dh_l) + ML_{l\,t} \quad ; \quad \text{for } l = 1,2,3 . \quad (47)$$

Notations:

Endogenous variables

AD_i	aggregate demand
ADD_i	aggregate domestic demand
$C_{h,i}$	consumption demand of commodity ‘i’ by household group ‘h’
CORPDI	private corporate sector disposable income
CORPSAV	private corporate sector savings

CL_i	composite labour
EXP_i	exports
ER	exchange rate
FSD	foreign savings in dollars
GED_l	government education expenditure at education level 'l'
GREV	government (total) revenue
GEXP	*government (total) expenditure*
GS	government savings
G	growth rate of the economy (GDP)
HS_h	household savings by household group h
ID_i	real investment demand by sector of origin
$INVDT_i$	real investment by sector of destination
IMP_i	imports
LL1	demand for lablour level 1 (non-educated labour)
LL2	demand for lablour level 1 (secondary-educated labour)
LL1	demand for lablour level 1 (higher-educated labour)
LS_l	labour supply of educational level 'l' , l = 1,2,3.
MS_m	output flow of labour of educational level 'm' , m= 1,2,3.
ML_m	new labour supply of educational level 'm' , m= 1,2,3.
PC_i	price of composite good for domestic demand
PD_i	price of domestic sales
PEX_i	export price in rupees
PWE_i	export price in dollars
PM_i	import price in rupees (inclusive of tariffs)
PX_i	producer's price
PINDEX	overall price index
PVA_i	value-added price
PUBDI	public sector disposable income
RGDP	real GDP
SLC_i	skilled labour composite
TAXREV	tax revenue of the government
WLL1	wage for labour of educational level 1 (non-educated labour)
WLL2	wage for labour of educational level 2 (secondary-educated labour)
WLL3	wage for labour of educational level 3 (higher-educated labour)
$WSLC_i$	wage for skilled labour composite
WCL_i	*wage for composite labour*
WLND	*price of land*
WK_i	price of capital
X_i	domestic output
XD_i	demand for domestic output
Y_h	income of household group h
YD_h	disposable income of household group h

Exogenous variables and parameters

as_i	shift parameter in production function for domestic output
as_{2i}	shift parameter in aggregation function for composite labour
as_{3i}	shift parameter in aggregation function for skilled labour composite

arm_i	shift parameter in Armington function for imports and domestic demand
a_{ij}	input-output coefficient
α_i	weight in the price index (share of value added of product i)
cet_i	shift parameter in CET function for export demand and domestic demand
cg_i	real government consumption
corpt	corporate tax rate
ad_i	share of investment by sector of origin
dh_i	depreciation rate of human capital
dp_i	depreciation rate of physical capital
$end_{h,LL\mathit{l}}$	household 'h'endowment of labour level *l* , l = 1,2,3
$end_{h,LND}$	household 'h'endowment of land
$end_{gov,LND}$	government's endowment of land
$end_{corp,LND}$	corporate sector's endowment of land
$exct_i$	excise tax rate
exs_i	scale factor in the export demand function
ε_i	export demand elasticity
fg_h	share of government transfer to household group 'h'
fg_{corp}	share of government transfer to the corporate sector
fk_h	share of capital income to household group h
fk_{corp}	share of capital income to corporate sector
fk_{pub}	share of capital income to public sector
fk_{gov}	share of capital income to government
fk_{row}	share of capital income to rest of world (row)
$\gamma_{h,i}$	marginal budget share of good 'i' for household group 'h'
$inct_h$	income tax rate for household group 'h'
λ_i	factor share parameter in production function for domestic output
$\lambda 2_i$	factor share parameter in in aggregation function for composite labour
$\lambda 3_i$	factor share parameter in in aggregation function for skilled labour composite
λa_i	share parameter in Armington function for imports and domestic demand
λc_i	share parameter in CET function for export demand and domestic demand
$minc_{h,i}$	minimum real consumption parameter for household group 'h'
n	labour participation rate
P	population
pwm_i	world price of imports in dollars
$pwes_i$	world price of export substitutes (in dollars)
prinv	total private real investment
pubinv	total public real investment
$prkv_i$	share of private investment by sector of destination
$pukv_i$	share of public investment by sector of destination
r	discount rate
ρ_{1i}	substitutability parameter in production function for domestic output
ρ_{2i}	substitutability parameter in aggregation function for composite labour
ρ_{3i}	substitutability parameter in aggregation function for skilled labour composite
ρ_{ai}	substitutability parameter in Armington function for imports and domestic demand
ρ_{ci}	substitutability parameter in CET function for export demand and domestic demand
$salt_i$	sales tax rate
sav_h	savings-income ratio of household group 'h'
$tarf_i$	import tariff rate

trnfg	real transfer from government
$trnfw_h$	transfer from rest of the world to household group ‘h’ in dollars
$trnfw_{gov}$	transfer from rest of the world to government in dollars