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This paper contains preliminary findings from research work still in progress and should not be quoted without prior approval of the authors.

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APPLIED GENERAL EQUILIBRIUM ANALYSIS
AND PERSPECTIVES ON GROWTH PERFORMANCE[1]

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I. INTRODUCTION

This paper focuses on the approach to evaluating growth performance due to Solow (1957) and Dennison (1967, 1979, 1983) commonly known as growth accounting. Despite its shortcomings (see Nelson (1981)), it has become the dominant approach for analysis of growth performance in a wide range of countries. In part, this is because it provides an implementable and relatively straightforward methodology and the alternatives are few.

In this paper we argue that the recent development of applied general equilibrium techniques (see Shoven and Whalley (1984)) has provided a tractible multisectoral framework as an alternative approach for analyzing growth performance. Perspectives on growth determinants can be quite different under the two approaches. We implicitly suggest that growth accounting as currently practised is based on a one sector approach. Therefore, this approach excludes resource misallocation effects (possibly caused by changing institutional arrangements) in its explicit analytical framework, and any attempts to incorporate these into the approach are inevitably ad hoc. Simultaneously we see these as important for understanding the behaviour of economies over time.

We have been motivated to apply general equilibrium techniques to growth analysis by recent calculations which suggest there may be large costs associated with distortions which generate idle resources or wasteful resource use. These 'non-traditional' distortions are often caused by institutional arrangements (such as import quotas or other restrictions) which themselves change over time. Incorporating the effects of changing institutional arrangements on resource allocation can lead to sharply different policy implications in an analysis of growth performance compound to a traditional growth accounting approach. To us this strongly suggests that a multisectoral framework is useful in studying growth performance.

The approach we outline is based on recent applied general equilibrium models which have been used to analyze tax and international trade distortions. In these, a multisector-multiconsumer model involving explicit production and consumer demand functions is calibrated to a benchmark equilibrium data set and then used for counterfactual policy analysis. In the analysis of growth performance similar methods can be used to calibrate a multisector general equilibrium model, in which distortions enter and change over time, to data on the performance of economies through successive periods.

We illustrate our approach by examining growth experience in three countries: India, the US, and the USSR. For each, the results we report emphasize the potentially important role changing institutional arrangements can play in determining growth performance.

II. GROWTH ACCOUNTING AND RESOURCE MISALLOCATION

Following its introduction by Solow in 1957, growth accounting has become the major analytic framework upon which empirical growth analysis is based. Solow's 1957 paper was an attempt to determine the relative importance of factor accumulation and Hicksian neutral disembodied technical progress as sources of US growth. Since then, the growth accounting approach has been extensively used both to investigate the relative importance of embodied and disembodied technical change (as in Griliches and Jorgenson (1967)) and in further refined empirical work (Dennison (1967, 1979, 1983)).

In its simplest form the growth accounting approach can be understood as follows. An aggregate constant returns to scale production function for the whole economy is assumed, which we represent here with a term representing Hicksian neutral disembodied technical progress (i.e., both factors are augmented equally by technical advance). This can be written as:

(1) $$Y_t = A_t \cdot F(K_t, L_t)$$

where

Y_t = aggregate output at time t.

$F(K_t, L_t)$ = constant returns to scale production function

K_t, L_t = are capital and labour factor inputs in period t

A_t = disembodied technical progress term (here given a time subscript)

Taking a time derivitive through equation (1) yields:

(2) $$\dot{Y} = \dot{A}F + AF_K \dot{K} + AF_L \dot{L}$$

where $\dot{Y} = \frac{\partial Y}{\partial t}$, etc.

Equation (1) can be manipulated to yield:

(3) $$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \frac{A.K.F_K}{Y} \cdot \frac{\dot{K}}{K} + \frac{A.L.F_L}{Y} \cdot \frac{\dot{L}}{L}$$

Noting that F_K and F_L are the marginal products of capital and labour respectively, and assuming that factors are paid their marginal products, the terms which premultiply $\frac{\dot{K}}{K}$ and $\frac{\dot{L}}{L}$ are simply factor shares, i.e., weights which sum to 1. Thus equation (3) can be rewritten to give the well known growth accounting equation:

(4) $$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + S_K \frac{\dot{K}}{K} + S_L \frac{\dot{L}}{L} \quad ; \text{ where } S_K+S_L=1.$$

If F is Cobb-Douglas, S_K and S_L are constant. If F is CES, S_K and S_L will change over time if the capital-labour ratio changes.[1]

Once the economy has been characterized in this manner, to implement the approach one needs to either estimate or assume a value for the elasticity of substitution between factors in the production function. Given data on growth rates of output and factor inputs, the value of $\frac{\dot{A}}{A}$ for each period can then be calculated by residual.

Applications of this approach have generated a series of null hypotheses which have been fundamental in forming policy perspectives on growth performance. In the case of the US, for instance, on the basis of Solow's work it has been widely argued that changes in growth rates are largely accounted for by changes in the rate of disembodied technical progress. Thus, in the later part of the 1970s when the US encountered a slowdown in growth rates of both real GNP and real GNP per capita, the explanation offered was that a slowing of the rate of disembodied technical progress had occured. Thus, to combat slowing growth rates the policy prescription is to improve productivity growth by such methods as promoting research and development, or innovative management techniques.

In the higher growth economies in the Pacific (such as Japan, Taiwan, Hong Kong, Singapore, and Malaysia high growth rates are often seen as a reflection of high rates of technical progress. These, in turn, are seen as achievements to be emulated by the rest of the world. Hence the current pressure for adoption of Japanese management techniques, and research and development practices outside of Japan.

For economies which have low growth rates it is widely believed that poor growth performance reflects low or negative rates of technical progress. This includes countries in sub-Sahara Africa which, since independence, have had many years of negative growth rates of GNP per capita. Thus missions from international agencies concerned with growth in these countries frequently conclude that further technical missions are necessary to facilitate the transfer of technology to encourage more rapid productivity growth.

However, in analyzing growth performance in all these countries most analyses usually do not explicitly include Resource misallocation effects. Institutional arrangements, especially the way these change over time and affect resource allocation, do not formally enter into the analysis, and as a result only have a minor role in current explanations as to why growth rates both differ across countries and change over time. To our taste this is a major weakness of existing literature on growth performance.

III. GROWTH ACCOUNTING, CALIBRATION AND APPLIED GENERAL EQUILIBRIUM ANALYSIS

In subsequent sections of our paper we extend the Solow-Dennison growth accounting approach to explicitly incorporate resource misallocation effects. To this end we develop three simple multisector general equilibrium models, each of which is applied to analyze the growth experience of various economies by including distortions of various types. In each case changes in the severity of distortions through time are used to calibrate these models to data on growth performance, rather than relying on changes in a residually determined technical change parameter to account for growth, as in existing growth accounting literature. Indeed, under this approach rates of disembodied technical change can be constant through time, even if output growth rates are falling.

Using data for the U.S., India, and the Soviet Union, we show how a particular multisectoral general equilibrium model with distortions can be calibrated in this way. The implication is that improvements in growth performance may require policy reforms such as the removal of controls, rather than simply improvements in the rates of technical progress. Equally, reforms of these types may be followed by a growth explosion as productive potential which has been increasing over previous years is subsequently more fully realized.

Each of the models we use involves a number of basic elements which will be familiar to those acquainted with the applied general equilibrium literature. In each model, CES production functions are specified for a series of industries. Each of these involves capital and labour as factor inputs. For simplicity, intermediate production is specified through fixed input-output coefficients. CES final demand functions with a single representative consumer are also assumed to further simplify the analysis. Each model also involves a specification of foreign trade; a constant elasticity offer surface formulation for foreigners' behaviour is assumed, as described in Whalley and Yeung (1984). The models also incorporate various intersectoral distortions. A series of equilibria generated by the model and consistent with observed data are examined through time. In each, demands equal supplies and zero profit conditions hold.

None of the models incorporates any explicit intertemporal decision making in which capital accumulation in the economy is endogeneously determined. This has been attempted in the dynamic sequencing equilibrium approach used by Fullerton, Shoven and Whalley (1983), and a more sophisticated implementation of the present multisectoral approach to growth accounting could employ such models. In the present analyses we instead fit each model to data on the time path of various economies through a series of one period equilibrium calculations.

The simplest way to illustrate our approach is by numerical example, and in Table 1 we present aggregate data on growth performance for a hypothetical two-industry two-commodity economy covering two sample years (or sub periods). Between years 0 and 1 both output growth and factor input growth is 2 percent. Thus, if the one sector growth accounting equation (4) is applied to this data the rate of technical progress is zero.

We also report microconsistent data for the initial year (year 0) for the outputs of each of the two industries, the factor rewards originating in each industry, and a premium value paid to labour in industry 1. The use of labour in industry 1 is assumed restricted by entry restrictions, which in turn, are assumed to be accompanied by a competitive rent seeking process with productive factors being used in seeking out rights to the rents associated with the restrictions.[2] In the present case this may be thought of as unnecessarily lengthy apprenticeship programmes being used as a method of

Table 1

Hypothetical Data Used to Illustrate How Misallocation Effects Can Influence Measured Growth Performance

	Aggregate Data
Year 0 to Year 1 Growth Rate of the Value of Output	2%
Year 0 to Year 1 Growth Rate of Capital Inputs	2%
Year 0 to Year 1 Growth Rate of Labour Inputs	2%

Year 0 (Initial) Equilibrium Data Observation

1) Aggregate Factor Shares

   K = 0.5 L = 0.5

2) Factor Rewards Originating by Industry (by Currency Units)

	K	L
1	20	30
2	30	30

3) Premium paid to labour in industry 1 due to entry restrictions - 10%

4) Value of Consumption of goods produced by the two industries

   1 - 50 2 - 50

determining union membership, which once obtained commands a premium over the wage available to labour elsewhere in the economy. The reason for using this formulation is that if entry restrictions change over time, the rate of technical progress in each sector need no longer be zero to be consistent with the aggregate data on growth performance in Table 1 between year 0 and year 1.

To show this, we construct a general equilibrium model which we calibrate to the data for the initial year (i.e., we reproduce this data as an equilibrium solution to the model). We then fit the model to the growth performance of the economy between the two years by allowing the distortion parameter which generates the premium for labour in industry 1 to change. In this way the model can be fitted to aggregate time series data for prespecified values of the rate of technical progress in each sector. Recall that traditional growth accounting which involves the application of equation (4) to the aggregate time series data to calculate the rate of technical progress by residual. However, under this alternative approach there is no reason to rule out the possibility of either accelerating or slowing technical progress since changes in distortions over time will still allow the model to track aggregate data once rates of technical progress are known.

The model we use to calibrate to the base year microconsistent data displayed in Table 1 excludes both intermediate production and foreign trade, and assumes CES production functions for each industry given by:

(5) $$Y_i^s = A_i\left[\delta_i K_i^{-\rho_i} + (1-\delta_i)L^{-\rho_i}\right]^{-\frac{1}{\rho_i}} \qquad (i=1,2)$$

where is output of good i, K_i and L_i are capital and labour inputs used by industry i; and A_i is the units term in industry i. This rises over time if there is Hicksian neutral technical progress. The δ_i are share (or distribution) parameters for each industry, and $\sigma_i = \left(\frac{1}{1+\rho_i}\right)$ is the elasticity of substitution in industry i. $\bar{K}$ and $\bar{L}$ denote the economy wide endowments of the two factors.

We also assume CES demand functions for a single consumer on the demand side of the economy, given by:

(6) $$Y_i^D = \frac{\alpha_i I}{p_i^E\ (\alpha_1 p_1^{(1-E)} + \alpha_2 p_2^{(1-E)})} \qquad (i=1,2)$$

where Y_i^D quantity demanded, p_i is the price of good i, the α_i are share parameters, E is the elasticity of substitution in preferences, and I is consumer income.

Consumer income, in turn, is given by:

(7) $$I = r_1K_1 + r_2K_2 + w_1L_1 + w_2L_1$$

where K_i is capital employed in industry i, L_i is labour employed in inndustry i, w_i is the wage rate paid to labour used in industry i, and r_i is the rental rate paid to capital used in industry i. If there are no entry restrictions applying to factors of production $r_1=r_2$ and $w_1=w_2$. If a premium is paid to labour used in industry 1 at rate λ over the wage in industry 2, $w_1=(1+\lambda)w_2$.

Ignoring, for one moment, the effects of any rent seeking activity associated with the premium paid to labour in industry 1, equilibrium for this model is given by a set of output and factor prices $(p_1^*,p_2^*,w_1^*,w_2^*,r_1^*,r_2^*)$ such that:

(a) Demand equals supply for goods and factors

$$Y_i^D = Y_i^S \qquad (i=1,2) \tag{8}$$

$$K_1 + K_2 = \overline{K} \tag{9}$$

$$L_1 + L_2 = \overline{L} \tag{10}$$

and (b) Zero profit conditions hold for each industry

$$P_i = r_i \frac{K_i}{Y_i} + w_i \frac{L_i}{Y_i} \qquad (i=1,2) \tag{11}$$

With a premium value at rate applying to labour used in industry 1, and with competitive rent seeking for rights of access to these higher wage jobs, (10) no longer holds. For simplicity, we assume that these rent seeking activities involve labour inputs equal in value to the total premium paid to labour used in this industry. In this case the equilibrium full employment condition for labour in equation (10) becomes

$$(12) \qquad (1+\lambda)L_1 + L_2 = \bar{L}$$

The other equilibrium conditions remain as stated above.

We have calibrated this model to the initial year data presented in Table 1 by separating the equilibrium data into separate price and quantity observations, and choosing values for elasticities of substitution in demand and production functions. This data separation is achieved by choosing units for both goods and factors of production as those amounts which sell for a price of 1 currency unit (net of any premium) in the initial year equilibrium (year 0). Values of substitution elasticities are exogeneously specified. Using this information, share parameters for the demand and production functions consistent with the equilibrium data are generated by applying the calibration procedures described in (Mansur and Whalley (1984).

With all the parameters of the model calculated in this way, we then proceed to calibrate the model to the data on aggregate growth performance in Table 1. We exogenously specify productivity growth rates for each industry allowing us to compute new equilibrium values for this hypothetical economy for year 1. The change in the premium paid to labour in industry 1 needed to give a new equilibrium solution consistent with aggregate data for year 1 is determined by iterating on the premium parameter. Each of the equilibrium calculations involved employs a general equilibrium solution algorithm (see Shoven and Whalley (1984)).

Table 2 reports the required changes in distortion parameters calculated by such a procedure. As can be seen, there is no requirement of zero productivity growth for the aggregate growth performance in Table 1 to be observed, as traditional growth accounting would suggest. Productivity growth in both sectors can exceed that calculated using a one sector growth accounting approach if the labour market distortion becomes more severe over time, and can be smaller if the distortion becomes less severe. Only where there are no changes in distortions over time will rates of technical progress calculated in this way be the same as those generated by a one sector growth accounting approach.

While the numerical example above is only illustrative, it nonetheless suggests how a different approach to growth accounting can change perceptions about the factors underlying aggregate growth performances. And if data on changes in distortions over time are directly available, these may be fed into a procedure similar to that outlined above and the rates of technical progress by sector endogenously determined. In the present example, traditional growth accounting calculates a constant rate of technical progress, while the multisector approach suggests that changing rates of technical progress along with changing severity of labour market restrictions are possible. In practice these and many other factors will jointly determine growth performance, but such combinations can be accomodated within a multisector approach if a more complex model is used.

Table 2

Distortion Parameters Consistent with Aggregate Growth Performance for Hypothetical Economy in Table 1 Under Different Exogenous Productivity Growth Rates

(Table Reports Percentage Premium Value for Labour in Industry 1 in Year 1)[1]

Elasticity of substitution Between Capital and Labour in Both Sectors	Assumed Productivity Growth Rate in Both Industries: -2%	-1%	0%	1%	2%
.25	1.387%	5.653%	10.0%	14.533%	19.387%
.5	1.467%	5.707%	10.0%	14.537%	19.349%
1.0	1.525%	5.669%	10.0%	14.549%	19.389%
2.0	1.589%	5.685%	10.0%	14.581%	19.493%
3.0	1.637%	5.685%	10.0%	14.613%	19.574%

1 The value assumed for the initial year is 10%; see Table 1.

This use of applied general equilibrium models also indicates how the calibration approach used in applied general equilibrium models is closely related to traditional growth accounting. Advocates of the calibration approach frequently caution that its weakness is that many alternative model specifications can be fitted to a given benchmark equilibrium data set. Because of this, the specification of exogenous parameters (typically elasticities) is required for the model to be exactly fitted to observed microconsistent data. In growth accounting there is an exact fit of a simple model to data over time through a residual calculation of the rate of technical progress. In multisector growth analyses, many alternative equilibrium models can be fitted to equilibrium data over time. Each model may provide a different perspective on both the factors underlying the growth process, and policy options which can or should be pursued to improve growth performance.

The important point for the purposes of the discussion here is that multisectoral general equilibrium models can yield different perspectives on growth policy options compared to traditional growth accounting. They can generate rival explanations of growth performance, and their results may challenge current perceptions both on the determinants of growth and appropriate policy responses.[3]

IV. THE PRODUCTIVITY DECLINE IN THE U.S.

We have used our multi-sector approach to analyze growth performance in three countries: U.S., India and the U.S.S.R. In doing so, we contrast the implications of our analyses with those generated by traditional one sector analysis. We begin with discussion of the productivity decline in the U.S.

The dimensions of the productivity decline in the US in the 1970s are by now well known, and can be illustrated by data reported by Norsworthy, Harper and Kunze (1979). During the period 1947-1965, they report a US growth rate of output of 3.71 percent per year, a growth rate of capital of 2.62 percent per year and a growth rate of labour of 0.38 percent per year. By contrast, during the period 1973-1978 output growth was 2.62 percent per year, capital growth was 2.05 percent per year, and labour growth was 1.4 percent per year. This productivity decline has been analyzed in a number of recent pieces, both explicitly thorough a growth accounting approach (such as Dennison (1983)) as well as other approaches (Norsworthy et. al.).

To illustrate how an institution-based multisectoral analysis of this growth performance can be developed in which changing severity of distortions plays a role, we have employed the Johnson-Mieskowski (J-M) data (1970) earlier used to analyze the general equilibrium implications of union non-union wage differentials in a Harberger type model. Using 1955 data, J-M implicitly construct a benchmark equilibrium data set which includes union and non-union wage differentials. We take this as a mid-year observation for an institution based growth accounting analysis of the two sub periods discussed by Norsworthy, Harper and Kunze.

Using factor share data from J-M and assuming these to be constant over the whole period,[4] a traditional growth accounting approach applied to these growth episodes would suggest that for period 1 (1947-1965) the value of $\frac{\dot{A}}{A}$ was 2.73, while the value of $\frac{\dot{A}}{A}$ for the second period (1973-1978) was 1.02 percent, i.e. a productivity decline had occurred.

If we instead take the union, non-union differential in the J-M data of 15 percent (from Lewis (1963)), and associate this with a quantity constraint on union hiring and assume rent seeking activity with union entry, this growth performance can be calibrated to a two-sector model in which $\frac{\dot{A}}{A}$ is the same in both subperiods but the union- non-union differential changes through time. In performing our calculations, combinations of elasticities of substitution and rates of growth of labour use in the premium generating sector (the quantity constraint in this sector) relative to the rate of aggregate labour force growth are calculated consistent with both the observed aggregate growth performance and constant values of $\frac{\dot{A}}{A}$ in each of the two subperiods.

The results of these calculations are reported in Table 3 and suggest that in order for this institutional explanation of the US productivity slowdown to be valid, an increase in the union to non-union wage differential would have to have occurred across the subperiods, an empirical issue on which definitive studies do not currently seem to be available. In other results not reported here (due to space limitations) we also show that capital deepening with constant severity of the union- non-union wage differential

Table 3

Parameter Values for Two Sector General Equilibrium Model of the U.S.

Consistent with Constant Values of $\dot{A}/A$ in subperiods 1947-1965 and 1973-197

Rate of Growth of Labour Use in Unionized Sector Releative to the Labour Force Growth Rate	Values of Elasticities of Substitution Assumed in Both Sectors	Union to Non-Union Wage Differential Assumed in Mid-Year Data	New Equilibriu Union to Non-Union Wage Differentials at End of Period
0.0	.274	.15	.293
0.02	.263	.15	.292
0.04	.252	.15	.292
0.06	.242	.15	.291
0.08	.231	.15	.291
0.10	.222	.15	.291

can also serve to account for slowing growth in this model in cases where $\frac{\dot{A}}{A}$ is the same across subperiods.

Our point is that such an explanation for the productivity slowdown based on increasingly severe distortions can be constructed, and this provides a rival hypothesis to account for slow U.S. growth performance in the late 1970s relative to current available thinking on this issue. This approach clearly has sharply different implications for policies to improve growth performances.

V. EXPLAINING POOR GROWTH PERFORMANCE IN INDIA 1950-1980

A second example of an institutionally based explanation for growth performance is provided by India during the period 1950-1980. Since Independence until very recently, growth performance in India has been poor, with growth of GNP per capita averaging around 1.5 to 2 percent per year.

Data from the World Development Report reports this approximately as follows. For the period 1950-1980, output growth is 3.55 percent per year, capital growth is around 5.2 percent per year,[5], and labour growth is 1.5 percent per year. If we take the period 1960-1980 output growth is 3.5 percent per year, capital growth is 5.05 percent per year[6], and labour force growth is 1.6 percent per year.

This relatively low growth of GNP per capita in India has usually been attributed to low rates of technical progress. However, if one considers an institutional approach to explaining this growth performance, it is possible instead to explore how increasing severity of distortions through time can yield low growth rates.

Productivity growth could thus be higher than conventionally thought, but increases in productive potential have not yielded comparable increases in actual output due to the effects of increasingly severe controls.

To explore these possibilities, we use data from Mohammad and Whalley (1984) to produce a benchmark equilibrium data set for India for 1980 in the presence of various price and quantity controls, whose severity seems to have increased in the years since independence. These controls operate through import quotas, controls on capital markets, labour market controls for public sector hiring, and pricing controls covering manufacturing and utilities. This data set includes 10 sectors, intermediate input use, and two factors of production in each of the 10 sectors considered.

If we use share data from this benchmark equilibrium data set and apply traditional one sector growth accounting, values for $\frac{\dot{A}}{A}$ in the region of 1 percent per year using data for the period 1960-1980 are produced, and in the region of 0.95 percent for data covering the period 1950-1980. However, if we use a multisector general equilibrium model, with elasticities of substitution in production (in all industries) and in preferences set somewhat arbitrarily as 0.6 and 1.5, and assume full rent seeking accompanies the price and quantity controls in the model, this same aggregate growth performance can occur with substantially higher values of $\frac{\dot{A}}{A}$ but under changing severity of controls.

Assuming that controls are absent in the initial year but present in the terminal year, higher values of $\frac{\dot{A}}{A}$ result when an institutionally based growth accounting approach is used. Applying our approach to the period 1960-1980 gives an estimated value of $\frac{\dot{A}}{A}$ of 3.7 percent per year, and to the period 1950-1980 an estimate of 2.8 percent per year. Thus, under this alternative institutionally based view of the growth process, the problem is not one of technical change in the physical sense, but institutional factors in the form of controls of increasing severity.

This alternative approach also emphasizes the potential which exists for a substantial increase in growth rates to occur when controls are either weakened or removed. In the Indian case, results from the ten-sector model indicate that if controls are fully removed over a two-year period[6] then for each of the two subsequent years output growth is over 30 percent per year. While fully achieving this gain in production over a two-year period is probably unrealistic, the thrust of the argument is nonetheless clear, and such an effect would not be projected from traditional growth accounting analysis. Traditional growth accounting has always found growth "explosions" such as occurred in S. Korea post 1959 or Sri Lanka post 1977 difficult to accomodate, but the present framework provides one explanation for the phenomena.

VI. GROWTH DOWNTURN IN THE SOVIET UNION

A third example of how an institutionally based approach to growth accounting alters perceptions of factors underlying growth is provided by the Soviet case. From 1929 and for over 30 years, the Soviet Union experienced high output growth of around 10 percent per year, high capital growth, also around 10 percent per year, and low labour growth of around 1 percent. However, from the mid 1960s onwards Soviet growth performance started falling, and by the early 1970s annual growth rates were much lower.

Two rival explanations are found in Western literature for this phenomenon. One is that this slowdown in growth performance simply reflects a fall in the rate of technical progress in the Soviet Union, i.e., falling $\frac{\dot{A}}{A}$ in the growth accounting equation. This, in turn, seems to be the view most widely accepted in the Soviet Union, as evidenced by the stress placed by Soviet policymakers on improving access to Western technology.

A rival explanation for this phenomenon has been offered by Weitzman (1970) who suggests that the aggregate production function in the Soviet Union has a low elasticity of substitution, which he suggests is in the region of .4. With this low elasticity, an increase in the capital to labour ratio will cause S_K to decline and S_L to rise through time. This implies that in the Soviet growth process there may have been a smaller weight over time applied to the faster growing factor in the growth accounting equation. Put another way, growth in the Soviet Union has been unbalanced since the capital labour ratio has increased substantially over time. After a certain point, continuing to accumulate large amounts of capital yields smaller benefits in terms of increased output.

We use our multisectoral approach to growth accounting to provide a third explanation of falling Soviet growth performance, namely increasing severity of resource misallocation as a result of the planning arrangements in use. The parable is that the priority ranking under the plan misallocates factors across industries and the informal reallocation system through middlemen, hoarding, tolkachi and other devices reverses some of the plan induced misallocation. The argument for a slow down in growth performance is that this informal reallocation system has become more bureaucratic over time and uses more resources.

To demonstrate this possibility, we aggregate the Weitzman value added data for 1960 used in his analysis to two sectors--heavy and light manufacturing. We also assume that factors of production are allocated through the plan such that differences in the marginal product between factors reflect changes in the priority ranking of the plan. We assume that rent seeking activities by enterprises occur corresponding to differences across industries in the marginal value product of factors. The alternative explanation of slowing Soviet growth is thus that an increase has occurred in the severity of misallocation across sectors over time, along with associated rent seeking costs as managers in non-priority sectors seek resources from priority sectors.

For the periods 1950-1960 and 1960-1969 studied by Weitzman, we employ the same data to compute values of the aggregate elasticity of substitution consistent with an unchanged value of $\frac{\dot{A}}{A}$ across the two subperiods. We make various assumptions as to the premium value associated with tighter controls on factor use in the light manufacturing industry in 1960. We adopt this procedure because the heavy manufacturing industries were and still are the priority sectors in the plan. We then calculate the changes in the severity of controls over time consistent both with unchanged values of $\frac{\dot{A}}{A}$ and aggregate data on Soviet growth performance.

In Table 4 we present results from two different subperiods. In the first, for the period 1950-1960, the severity of the controls generating resource misallocation in the plan are assumed to be 50 percent more in 1960 than 1950, and the value of $\frac{\dot{A}}{A}$ is assumed unchanged in both sectors. We then calculate the implied value of the elasticity of substitution in the production functions in the two sectors. We also perform a similar exercise for the period 1960-1969.

The results not only suggest an alternative explanation for slowing Soviet growth, but also suggest that given Soviet data on growth performance the value of the elasticity of substitution can be significantly higher than that estimated by Weitzman using aggregate data. Institutional arrangements and their changes over time can therefore be both an explanation of slowing growth performance in the Soviet case and a source of bias in estimating production side substitution elasticities.

VII. SUMMARY AND CONCLUSION

In this paper we explore the use of applied general equilibrium techniques for the analysis of growth

Table 4

Distortion Based General Equilibrium Analysis of Slowing Growth Performance in the Soviet Union

Assumed Differential Rate of Return on Capital in Light vs. Heavy Manufacturing in Benchmark Data for 1960	Elasticity of Substitution Calculated for Period 1950-1960 where Controls are Assumed 50% More Severe in 1960 than 1950, but technical progress is unchanged	Elasticity of Substitution Calculated for Period 1960-1969 where Controls are Assumed 50% More Severe in 1969 than 1960, but technical progress is unchanged
20%	0.518	0.730
40%	0.521	0.687
60%	0.523	0.652
80%	0.523	0.623
100%	0.524	0.600

performance. Our rationale is their ability to explicitly incorporate policy induced misallocation effects which allows their role in the growth process to be explored. The approach is different to that employed in conventional growth accounting literature in taking account of ways in which institutional arrangements potentially influence growth performance. It can also lead to different policy perspectives than result from using the traditional one sector growth accounting framework. We illustrate the application of these techniques both by a numerical example using hypothetical data and by illustrative calculations applied to growth experiences for the U.S., India, and the U.S.S.R.

ENDNOTES

1. In the case where the elasticity of substitution is less than 1, for instance, an increase in the capital-labour ratio will result in a reduction in the share of capital and an increase in the share of labour over time.
2. See Krueger (1974) who was one of the first to suggest that where import quotas or other controls apply and where rights to these restrictions are not auctioned by government, activities will be encouraged through which individuals will seek out rights of access to the restrictions created.
3. There are deeper issues as to the empirical basis for both growth accounting and applied general equilibrium models which we do not go into here at any length. As Shoven and Whalley emphasize in their survey of applied general equilibrium models, the parameter specifications currently in use are not statistically tested, but are instead calculated from data in a purely deterministic manner. For all the weaknesses of both approaches on empirical grounds, the fact remains that the choice of model can affect one's perception both of what factors are important in determining growth performance, and the policy options deemed appropriate to develop towards improving growth performance.
4. This corresponds to assuming the aggregate production function is Cobb-Douglas.
5. Capital stock data on India, as in most less developed countries, is poor and limited in coverage. Here we have

taken data on investment growth rates to be a proxy for capital growth rates.

6. This assumes values for $\frac{\dot{A}}{A}$ of 2.8 percent, $\frac{\dot{K}}{K}$ of 4.8 percent and $\frac{\dot{L}}{L}$ of 1.7 percent per year over the period, values which apply to the period 1950-1980.

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