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MACROECONOMIC ADJUSTMENT AND INCOME DISTRIBUTION: ALTERNATIVE MODELS APPLIED TO TWO ECONOMIES

by

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Abstract:

To analyze the impact of alternative macroeconomic adjustment mechanisms on the distribution of income in developing countries, we construct a CGE model that is general enough to incorporate neoclassical, neo-Keynesian, and a variety of structuralist macro closure rules. The model is applied to two economies, Brazil and Korea, with alternative macro closures both for savings-investment and for the balance of trade. We find that (1) the size distribution of income is largely insensitive to macro closure rules, (2) the functional distribution is very sensitive to macro closure rules, and (3) the balance-of-trade closure is at least as important in determining distributional outcomes as the savings-investment closure.

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1. Introduction

In the early 1970s, various attempts were made to use multisectoral models of developing countries to explore the feasibility of using various policy instruments to change the distribution of income. This work led to a continuing controversy about the impact of macroeconomic adjustment on the distribution of income. The early debate centered on two computable general equilibrium (CGE) models: the Adelman-Robinson (AR) (1978) model of Korea and the Lysy-Taylor (LT) (1980) model of Brazil. It has been asserted [for example, Duloy preface to Taylor et al. (1980, pp. x-xi) and Srinivasan (1982)] that there is a significant difference between the distributional results obtained with the two models. The alleged difference has been attributed both to the choice of country and to differences in model specification.

In part, the controversy is due to lack of a careful identification of what is meant by the term, "distribution of income": the size distribution, the functional distribution between profit earners and wage earners only, or the extended functional distribution that distinguishes classes of income recipients by sector of activity as well as by asset ownership. As indicated in our book [Adelman and Robinson (1978, pp. 183 and 184)], we found sensitivity of the extended functional distribution to policies and programs coupled with insensitivity of the size distribution. Examination of the LT results reported in Taylor et al. (1980) indicates that their findings are quite similar: stable size distributions and variable extended functional distributions. Nevertheless, the impression of qualitative difference in distributional results with closure rules has persisted, and the issue is worth considering further.

To analyze how macroeconomic specification affects distributional outcomes, we have constructed a CGE model that is general enough to incorporate a variety of macro specifications. Specifically, we examine neoclassical, Keynesian, and varieties of structuralist macro closure rules. The model focuses on the distribution of income, generating both the functional and size distributions and incorporating seven socioeconomic groups. The model is applied to two countries, Brazil and Korea, and starts from the original LT and AR models. While capturing the essential features of both models in a common framework, it is not an exact replication of either.

The plan of the paper is as follows. In the next section, we review earlier work using CGE models to analyze distributional questions and discuss the controversy on the role of a model's macro specification in determining its distributional results. We then present the core CGE model, including a detailed discussion of the different macro closure rules, followed by a discussion of two sets of empirical experiments. The first set explores the macro properties of different closures and the sensitivity of the distributional results to the macro specification. The second set explores the distributional impact of a change in development strategy in the two models toward export-led growth. Finally, we present some conclusions.

2. Controversies

In the development literature, CGE models trace their lineage back to the input-output based multisector models widely applied to problems of planning in developing countries in the 1960s. While firmly based on the foundation of

Walrasian general equilibrium theory, a CGE model can also be seen as a logical culmination of a trend in the planning model literature to add more and more substitutability and nonlinearity to the basic input-output model. A CGE model works by: (1) specifying the various actors in the economy (for example, firms, households, government, and the rest of the world); (2) describing their motivation and behavior (utility maximization for consumers and profit maximization for firms); (3) specifying the institutional structure, including the nature of market interactions (competitive markets for goods and labor); and (4) solving for the equilibrium values of all endogenous variables. The model simulates the working of a market economy and solves for a set of prices (including wages, product prices, and, perhaps, the exchange rate) that clears all markets (including markets for labor, commodities, and foreign exchange). The model is highly nonlinear, with neoclassical production expenditure functions, and incorporates a variety of substitution possibilities in production and demand.

The first CGE model was developed by Leif Johansen (Johansen, 1960). He used a solution technique based on log-linearization of the model which achieves only an approximate solution.[1] In the early 1970s, a new generation of models was developed based on solution algorithms that solved the nonlinear model directly with no linearization. These CGE models were developed more or less simultaneously for both developed and less-developed countries, but the two strands of work differed in specification.

The first CGE models applied to developed countries were very small, stayed very close to the Walrasian paradigm, and focused on issues of tax policy.[2] The first CGE model applied to a less-developed country was the AR model of Korea which was developed to explore questions of income distribution. A later model was developed by Lysy and Taylor for Brazil which also focused on income distribution. These models were much larger than the models built for developed countries and, in structure, reflected many of the country characteristics and concerns in the literature on economic development and development planning models. Since then, CGE models have been constructed for some 30 developing countries to analyze a variety of issues.[3]

In applications of CGE models to developing countries, most researchers have introduced a number of micro and macro "structuralist" features which aim to capture the stylized facts characterizing these countries. [For a survey, see Robinson (1986).] Both the AR and LT models incorporate numerous non-neoclassical features (including elements traditionally found in macro models such as endogenous determination of the aggregate price level, some fixed nominal magnitudes, and special treatment of the labor market) which were felt to be important in capturing significant forces affecting the distribution of income in the medium run.

Lysy and Taylor argued that the way in which savings and investment are equilibrated is the major factor determining the distributional results arising from the CGE models. Taylor, for example, states [Taylor et al. (1980, p. 14)]:

> "It seems clear from the results here and in Adelman and Robinson (1978) that some sort of forced savings mechanism holds the key to macro adjustment in general equilibrium models in which saving must equal investment and in which output responds to aggregate demand. Income gainers and losers under any policy change can be traced by asking how the payments flows they receive will adjust to an assumed savings-investment disequilibrium."

How the equilibrating mechanism for achieving savings-investment balance affects the distribution of income was the subject of a symposium issue of the

Journal of Development Economics in 1979. [See, especially, the articles by Taylor and Lysy (1979) and the introductory article by Bruno (1979). See also Taylor (1983).] More recently, there have been numerous articles exploring the theoretical and practical problems of incorporating macroeconomic features in multisector models whose roots are essentially Walrasian.[4]

In the next section, we describe the core CGE model and its Korea and Brazil variations. The two original models were both quite large and complex. The versions here are greatly simplified but still capture the essential features of the larger models. We have also taken account of recent advances in the art of CGE modeling, particularly in the specification of foreign trade, that were absent from both of the original models. These differences enable us to explore some "closure" issues concerning the role of foreign capital inflows that could not easily be addressed with the original models.

3. A computable general equilibrium model with alternative macro closures

The model we use in this paper starts from a family of models developed by Dervis, de Melo, and Robinson (1982) to explore questions of foreign trade policy in semi-industrial countries characterized by many structural rigidities. To this core model we have added a number of the features from the Korea and Brazil models needed to provide a focus on income distribution. In particular, we expand the number of income-recipient groups, provide much more detail on the mapping from value added to income, generate both the overall size distribution of income and an expanded factor distribution, and incorporate a number of macro adjustment mechanisms. The differences between the Korea and Brazil models thus can be specified as variants of the same overall model, and the effect of these differences can be isolated for analysis.

3.1. The core computable general equilibrium model

The core model is very neoclassical in spirit. Sectoral production is given by mixed, two-level production functions. Intermediate inputs are required according to fixed input-output coefficients; aggregate labor and capital are combined to create value added according to a CES function; aggregate labor is a CES aggregation of labor of different types; and aggregate capital used in each sector is a linear aggregation of capital goods from different sectors. Sectors are assumed to maximize profits, and labor demand functions come from the first-order conditions equating the wage rate to the marginal revenue product of labor of each category.

The labor market is segmented with five distinct categories of labor: agricultural, unskilled, skilled (in the industrial sectors), service sector, and government workers. Agricultural labor is largely fixed, with only limited endogenous migration through sectoral shifts of unskilled labor. The model incorporates two alternative specifications of the labor markets. In the first variant, there is full employment of aggregate labor in each category with average wages adjusting to equate aggregate supply and demand achieving an equilibrium sectoral allocation of labor by different categories. In the second variant, wages are fixed, firms are assumed to be on their demand curves for labor, and both aggregate and sectoral employment are determined endogenously, with labor supply assumed to be perfectly elastic.

Household demand for goods is determined by linear expenditure systems (LES) with different LES functions for each household group. The model generates the flow of funds to all economic agents including wage earners, proprietors, recipients of capital income, and government (whose income consists of tax revenue).

The size distribution of income is calculated by assuming that the distribution of income within each of the socioeconomic categories is given by a two-parameter lognormal distribution with fixed (exogenous) log variance. This approach was used in the AR model of Korea and is also used here for Brazil.[5] In the original Brazil model, Lysy and Taylor generate the size distribution directly from endogenous solutions for employment and wages differentiated by labor category and sector, assuming that all workers in each sector-skill-category receive the same wage. However, their model yields only an average wage for each skill category, with sectoral variations given by fixed ratios to the skill-specific average. The result is that, in their model, the variance of wages across sectors for a given skill category varies only due to employment composition effects which are relatively small. The two approaches, therefore, have the same net effect--a significant fraction of the overall variance in the size distribution is largely exogenous.

In the core model, the supply of exports in each sector is a function of the ratio of the domestic-currency price of exports (determined by the world price, the exchange rate, and any subsidies) to the price in the domestic market. This treatment partially segments the domestic and export markets. Prices in the two markets are linked but need not be identical. Imports and domestic products are assumed to be imperfect substitutes--an assumption that is now widely used in CGE models of trade but was not used in either the original Korea or Brazil models. Imports and domestic goods are combined according to a CES trade-aggregation function, with consumers demanding the resulting composite good.[6] The trade substitution elasticity determines the ease with which import shares adjust in response to changes in relative prices. For both exports and imports, the world price in dollars is assumed to be constant--the "small country" assumption.

There are two alternative mechanisms by which the CGE model can achieve equilibrium in the balance of trade. In the first, a fixed foreign capital inflow is assumed and is reflected in an exogenous value for the dollar balance of trade; and endogenous variation in the real exchange rate provides the equilibrating mechanism. The real exchange rate is defined as the relative price of tradables and nontradables. Since we use an index of domestic prices as numeraire, variations in the "nominal" exchange rate in the model directly affect the ratio of the domestic-currency price of imports and exports to that for domestic sales. For example, a devaluation raises the domestic price of imports and exports relative to domestic sales and so encourages both exports and import substitution. The model determines the equilibrium real exchange by manipulating the nominal rate relative to the numeraire index of domestic prices.[7]

In the second mechanism, the exchange rate is assumed fixed and the foreign capital inflow adjusted, with the balance of trade being determined endogenously. If an aggregate price index is chosen as numeraire and this index is set exogenously, this specification effectively fixes the real exchange rate. If the aggregate price index is determined endogenously to satisfy some macro equilibrium condition, the real exchange rate will change but will still not adjust to clear the balance of trade. With a fixed nominal exchange rate, the model achieves equilibrium through a quantity adjustment mechanism--in this case, through changes in the balance of trade.

3.2 Alternative macro closures

To the core CGE model, AR and LT add quite different models of how savings-investment equilibrium is achieved--different macro closures. In the AR closure, investment is set exogenously in nominal terms, which introduces an element of nonhomogeneity into the model--total nominal investment in the AR model was determined by an elaborate, but separate, model of the loanable funds market. In this paper, we just set it exogenously. Next, there is a transactions demand for money (with fixed velocity) that enters the household budget equation as part of savings. In the aggregate, any change in the demand for money balances appears as savings or dissavings because the model satisfies Walras' Law. Given an exogenously specified money supply, the aggregate price level adjusts so as to equate the demand for money (real balances) with the specified supply. In effect, the aggregate price level is the equilibrating variable to achieve savings-investment equilibrium. Given the fixed level of nominal investment, changes in the aggregate price level affect both real savings and investment. An increase in prices, for example, reduces real investment and increases real savings rates (without necessarily changing real incomes). Finally, nominal wage rates are flexible. The AR macro closure thus has no effect on aggregate employment since the model has a neoclassical labor market with fixed aggregate labor supply.

By contrast, in the LT model, aggregate investment is set exogenously in real terms. The nominal wage rate is fixed, and firms are assumed to be always on their demand curves for labor. Money does not appear. Two alternative macro closures are used to achieve savings-investment balance. Since aggregate real investment is exogenous, the two variants differ only in how they generate the necessary real savings. In one version, which LT call

Keynesian closure, the nominal wage is fixed. As they state [Lysy and Taylor (1980, p. 161)] ". . . fixed nominal wages make the model behave in traditional short-run Keynesian fashion--employment levels can increase in response to increases in aggregate demand via reduction in the real wage." Changes in the aggregate price level cause the real wage to adjust so as to yield the employment (and output) needed to generate the income required to generate the real savings needed to finance the exogenous level of real investment. The model has a Keynesian demand multiplier but with an increase in real output always associated with a decline in the real wage.[8] There are also potential Kaldorian effects in this model since changes in real wages can shift income between low and high savers. While the price level is the equilibrating variable in the model, one could also have fixed the price level and let the nominal wage adjust--the essential mechanism is through changes in the real wage and labor demand.

In a second savings-investment closure, Lysy and Taylor specify a different savings adjustment mechanism in which the incomes of certain nonwage-earning groups--proprietors and recipients of transfer income--are fixed in nominal terms. An increase in the aggregate price level lowers the real income of these groups and shifts the distribution of income in favor of other groups with higher savings rates. The aggregate price level drives a Kaldorian mechanism such that the functional distribution changes to achieve the equilibrium level of savings, given the exogenous level of real investment. In this variant, the nominal wage in the labor market is flexible adjusting so as to maintain full employment. However, the employment of proprietors in the model is determined by demand. This particular closure seems to cause problems in making the model yield sensible behavior. This is understandable given the fact that it puts the entire burden of macroeconomic adjustment on changes in the real income of a single group.[9]

In our simplified version of the LT and AR models, we did not use the second LT closure. We specified the income of proprietors as deriving from a share of sectoral profits, treating proprietors as essentially self-employed. In the agricultural sector, proprietors are similar to the small farmers in the AR model; in the nonagricultural sectors, they are similar to the selfemployed category in the AR model.

While both the LT and AR macro closure specifications use the aggregate price level as the equilibrating variable to achieve savings-investment equilibrium, the mechanisms at work are quite different. The LT closure is Keynesian in that aggregate output adjusts through a multiplier process to generate the income and, hence, savings needed to validate the exogenous level of real investment. It is also Kaldorian in that, by shifting real income from low to high savers, the change in the real wage of workers is also a potential equilibrating mechanism for equating savings to investment. In the AR closure, both real savings and real investment adjust, and there is little real output effect. The LT closure could potentially generate a stronger link between macro adjustment and distribution, since it involves changes in real wages and total income. The AR closure is potentially more distributionally "neutral" across classes of income earners differentiated by functional income sources since it involves proportional changes in savings rates across classes of income recipients and spreads the real adjustment to both savings and investment.

The two closure specifications focus on private savings. However, other sources of aggregate savings may be significant. In the two models, the government deficit is not allowed to adjust endogenously in response to macro disequilibrium; so it is not an important equilibrating variable. However, the balance of trade can have an important impact on total savings since changes in the aggregate price level change the real exchange rate if the nominal exchange rate is fixed. To explore this issue, we specify two variants of the LT and AR. models. In the first, LTV and ARV, a variable exchange rate adjusts to maintain a specified balance of trade. In the second variant, LTF and ARF, there is a fixed nominal exchange rate. In this case, fluctuations in the aggregate price level change the real exchange rate causing changes in the balance of trade and, hence, in aggregate savings.[10] In both models, an increase in the price level implies a real revaluation, higher imports, lower exports, and hence an increase in foreign savings (foreign capital inflow). Thus, the fixed exchange rate reinforces the positive impact of price-level changes on savings in both models by spreading the burden of adjustment across the household and foreign sectors.

The original AR and LT models did not have very sophisticated treatments of foreign trade. The LT model specified a fixed exchange rate, with foreign capital inflow determined edogenously--the LTF variant. However, in dynamic runs, it appears that ad hoc adjustments were made over time to keep the exchange rate "more or less in line with some overall price index" [Taylor et al. (1980, p. 149)]. The LTF variant is therefore probably closest in spirit to the original model. On the other hand, the ARV variant is closer to the original AR model. In the original AR model, exports and imports were computed using fixed coefficients in the spirit of earlier multisector planning models. Thus, the balance of trade was not related to the real exchange rate and varied little across experiments.

With the two foreign trade specifications, there are four closures for the two models: LTF, LTV, ARF, and ARV. As a point of comparison, we also provide another closure rule that starts from the core model and simply adjusts all savings rates proportionately to achieve macro equilibrium, keeping the aggregate price level fixed and assuming all relative prices and wages are free to adjust. This closure rule is the most distributionally neutral and was used by Johansen in his 1960 model of Norway. In our tables, we label the two variants of this closure as JOF and JOV, for the fixed and variable exchange rate versions.

To check how different macro closure rules affect the nature of the structural adjustment of the economy and various aspects of the distribution of income, we performed one experiment with six different closure rules in two model economies--one based on Korea in 1968 and the other on Brazil in 1959. The data for each country were taken from the two books describing the different CGE models [Adelman and Robinson (1978) and Taylor et al. (1980)]. However, in the present paper, the same core CGE model is applied to both economies Thus, in the experiments performed, the two economies differ only in their basic data. Across runs within each country, the only difference is in the macro closure rules.

4. Investment macro closure experiment

Tables 1, 2, and 3 present the results of an experiment in which nominal investment was increased by 10 percent. The first column of the tables presents the base solution without the increase in investment. The second to sixth columns summarize the results of raising investment by 10 percent under alternative model specifications. In order, we have the Johansen variable

Table 1

Macroeconomic Results--Investment Experiment

	Brazil						
	Base	JOV	JOF	LTV	LTF	ARV	ARF
Indices, base = 100							
Real GDP	100	100	100	117	107	100	100
Real investment	100	110	110	110	110	101	104
Employment	100	100	100	146	116	100	100
Capital stock	100	100	100	100	100	100	100
Exports	100	101	100	117	100	100	96
Trade deficit	100	100	111	99	201	100	157
Real wage	100	100	100	82	92	100	100
Real profit rate	100	100	100	117	108	100	100
Price index	100	100	100	124	109	109	106
Agricultural terms of trade	100	99	99	99	99	99	99
Private saving/investment (%)	71.0	73.6	72.9	67.7	65.6	70.0	67.9
Foreign saving/investment (%)	4.2	3.8	4.4	3.3	8.8	4.1	7.1
Consumption/GDP (%)	84.8	83.0	83.1	85.6	85.2	84.6	84.7
Keynesian multiplier	--	0.0	0.0	9.6	4.3	0.0	0.1
Nominal devaluation (%)	0.0	1.3	0.0	25.0	0.0	8.9	0.0
Real devaluation (%)	0.0	1.3	0.0	1.0	-8.4	0.1	-5.5
	Korea						
Indices, base = 100							
Real GDP	100	100	100	116	108	100	100
Real investment	100	110	110	110	110	102	105
Employment	100	100	100	126	112	100	100
Capital stock	100	100	100	100	100	100	100
Exports	100	101	100	119	104	100	97
Trade deficit	100	100	102	100	117	100	110
Real wage	100	100	100	92	97	100	101
Real profit rate	100	100	100	109	108	100	101
Price index	100	100	100	110	104	106	104
Agricultural terms of trade	100	98	98	95	98	99	98
Private saving/investment (%)	20.0	27.0	27.4	23.0	18.1	22.0	20.0
Foreign saving/investment (%)	45.0	41.0	42.0	42.0	47.0	44.0	46.0
Consumption/GDP (%)	85.3	82.7	82.5	84.7	85.6	84.6	84.9
Keynesian multiplier	--	0.0	0.0	5.6	2.8	0.0	0.2
Nominal devaluation (%)	0.0	1.1	0.0	15.8	0.0	6.8	0.0
Real devaluation (5)	0.0	1.1	0.0	5.2	-4.1	0.2	-4.1

Table 2

Size Distribution Results--Investment Experiment

	Brazil						
	Base	JOV	JOF	LTV	LTF	ARV	ARF
Size distribution							
Top 10 percent	45.4	44.2	44.3	47.6	45.9	45.5	45.7
Next 10 percent	11.8	12.1	12.0	11.7	11.7	11.8	11.8
Next 20 percent	17.2	17.5	17.5	16.7	17.0	17.1	17.1
Next 20 percent	12.6	12.9	12.9	12.3	12.5	12.6	12.5
Next 20 percent	8.9	9.1	9.0	8.6	8.8	8.9	8.8
Poorest 20 percent	4.1	4.2	4.3	3.6	4.1	4.1	4.1
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Gini coefficient	.509	.500	.501	.528	.516	.511	.512
Theil coefficient	.587	.557	.561	.630	.605	.592	.594
Atkinson measure	.570	.561	.562	.607	.584	.571	.574
Coefficient of variation	1.51	1.46	1.46	1.58	1.54	1.52	1.53
	Korea						
Size distribution							
Top 10 percent	33.8	31.8	32.0	32.8	33.4	33.8	33.9
Next 10 percent	15.0	15.5	15.5	15.1	15.0	15.1	15.1
Next 20 percent	20.5	21.2	21.1	20.7	20.5	20.6	20.5
Next 20 percent	14.3	14.6	14.6	14.5	14.4	14.2	14.2
Next 20 percent	10.2	10.5	10.4	10.5	10.3	10.1	10.1
Poorest 20 percent	6.2	6.4	6.4	6.4	6.4	6.2	6.2
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Gini coefficient	.413	.399	.400	.403	.409	.414	.416
Theil coefficient	.313	.282	.285	.297	.307	.315	.319
Atkinson measure	.394	.378	.380	.383	.390	.396	.399
Coefficient of variation	.95	.88	.88	.92	.94	.95	.96

Table 3

Functional Distribution Results--Investment Experiment

	Base	JOV	JOF	LTV	LTF	ARV	ARF
	Brazil						
	percent						
Wages/GDP	42.4	42.4	42.7	42.5	42.5	42.4	42.4
Poor/employment	30.0	30.0	30.0	38.0	32.5	30.3	30.3
Socioeconomic composition of the poor							
Farm workers	59.4	59.4	59.4	57.8	59.3	58.9	59.0
Marginal labor	8.4	8.3	8.3	19.9	12.3	8.6	8.4
Organized labor	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Service labor	5.7	5.7	5.6	9.7	7.5	5.9	5.7
Government workers	1.7	1.6	1.6	2.8	2.2	1.7	1.6
Small farmers	23.2	23.3	23.4	10.2	17.6	23.3	23.7
Industrial proprietor	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Service proprietor	1.4	1.4	1.4	0.5	1.0	1.4	1.4
Agricultural capitalists	0.2	0.3	0.3	0.1	0.1	0.2	0.2
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Rural share[a]	87.0	87.1	87.2	78.1	83.1	86.7	91.3
Proprietor share[b]	24.6	24.7	24.8	10.7	18.6	24.7	25.1
Labor share[c]	15.8	15.6	15.5	32.4	22.0	16.2	15.7
	Korea						
Wages/GDP	66.0	65.0	65.0	66.0	66.0	65.0	65.0
Poor/population	30.0	30.4	30.3	34.0	30.8	29.9	29.6
Socioeconomic composition of the poor							
Farm workers	42.8	43.4	43.5	34.2	38.4	43.6	44.0
Marginal labor	24.4	24.1	24.1	23.4	24.4	21.2	21.3
Organized labor	6.2	5.9	5.9	6.2	6.2	6.9	6.8
Service labor	4.5	4.3	4.3	2.7	3.4	4.6	4.4
Government workers	2.8	2.6	2.6	2.9	2.9	3.0	2.8
Small farmers	11.6	11.8	11.9	18.4	14.7	12.4	12.5
Industrial proprietor	1.0	1.0	1.0	1.5	1.3	1.0	1.0
Service proprietor	5.5	5.3	5.2	7.8	7.0	5.6	5.5
Agricultural capitalists	1.2	1.6	1.5	2.9	1.7	1.7	1.7
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Rural share[a]	67.9	68.9	68.9	66.2	67.0	68.3	68.9
Proprietor share[b]	18.1	18.1	18.1	27.7	23.0	19.0	19.0
Labor share[c]	37.9	31.9	31.9	29.1	36.9	35.7	35.3

[a]Includes: farm workers, small farmers, agricultural capitalists, and half of the marginal workers.

[b]Includes: small farmers, service, and industrial proprietors.

[c]Includes: marginal labor, organized labor, service labor, and government workers.

(JOV) and fixed (JOF) exchange rate closure in columns two and three, the Lysy-Taylor variable (LTV) and fixed (LTF) exchange rate closures in columns four and five, and the Adelman-Robinson variable (ARV) and fixed (ARF) exchange rate closures in columns six and seven.

In discussing their work, Lysy and Taylor state that, in their model with fixed wage rates, the major mechanism at work in their experiments is Kaldorian--the adjustment to exogenous shocks occurs through changes in the functional distribution of income. In particular, a decline in real wages leads to distributional shifts "to favor national profit recipients and foreigners over workers [see Taylor et al. (1980, pp. 7 and 8 and Taylor and Lysy (1979)]. While such processes are built into their model, an examination of the experiment results indicates that they are evidently small, since the Keynesian multiplier is very large and the change in the aggregate savings rate is quite small. The major adjustment mechanism to the 10 percent increase in real investment in their model is thus Keynesian not Kaldorian.

As part of the Keynesian adjustment, there is a large increase in employment (46 percent in the variable exchange rate model and 16 percent in the fixed exchange rate model in Brazil) which allows for a substantial increase in GNP (17 percent in LTV and 7 percent in LTF). The Keynesian multipliers in the Brazil model seem unrealistically large (9.6 for LTV and 4.3 for LTF). The consequent increase in GNP raises household incomes and so generates more savings to match the increase in investment. The share of investment that is privately financed actually drops. The real wage rate decreases, but that is necessary to generate the increase in employment, given the LT specification of the labor market. The increase in employment counterbalances the decrease in the real wage, and the share of wages in national income remains almost unchanged. (This is not a necessary result of the model's specification since nested CES production functions were used.)

The trade specification matters; it greatly affects the magnitude of the multiplier in the LT closures. The fixed exchange rate generates larger leakages through endogenous changes in foreign savings (the balance of trade) and, hence, a smaller change in employment and GNP. The foreign capital inflow increases substantially (it doubles in Brazil and increases by 16 percent in Korea) and finances a larger share of investment than in the flexible exchange rate model. But it displaces mostly government savings; the ratio of investment financed by private savings remains virtually unchanged. The difference in changes in the price level between the two experiments is dramatic (in both Korea and Brazil, the changes are approximately halved). The consequences of this for the real exchange rate are to convert a small devaluation under a flexible exchange rate into a small appreciation, with obvious consequences for exports, the balance of trade, and the share of foreign finance in total savings.

Structural adjustment under the AR closure works differently. Since the size of the labor force remains constant in this model, the Keynesian multiplier achieved in response to an increase in nominal investment is very small. Aggregate output effects can arise only from sectoral reallocations of labor, and allocative efficiency gains are typically small empirically. The final real adjustment depends on the relative response of real savings and investment to changes in the aggregate price level and on changes in the relative price of capital and consumer goods. In fact, the real savings response is very low, and there is some increase in the relative price of capital goods.

The net effect is that, in final equilibrium, real investment increases by much less than the increase in nominal investment.

Again, the trade specification matters. The supply response in the fixed exchange rate specification is larger than in the flexible exchange rate case since it occurs partially through an increase in imports financed by a large increase in foreign capital inflow (note, however, that this adjustment is smaller than in the LT closures).

The economy behaves in a much more stable manner under the AR closure than under the LT closure. There are smaller changes in the price level, smaller swings in the balance of trade and in the real exchange rate, a smaller output multiplier, and a smaller change in real investment. The major difference appears to be whether it is reasonable to assume, with Lysy and Taylor, that achieving a 20 to 40 percent increase in the employed labor force is realistic--the assumption responsible for the major difference in adjustment mechanism between the two closure specifications.

The comparison between Brazil and Korea indicates that qualitatively there is no difference in the way the different closure rules behave in the two economies. Since Korea is a much more open economy than Brazil and foreign capital inflow is a much larger share of the total finance of investment, the domestic multipliers are much larger in Brazil than in Korea; the leakages into the rest of the world are proportionately smaller under the fixed exchange rate specifications. As a result, Korea behaves in a more stable manner under either closure than does Brazil.

The sensitivity of the size distribution of income to the investment shock is quite similar--it is very small in both. From Table 2, the ranking in terms of increasing inequality is uniform across indices but differs in the two countries: JO, AR, LT for Brazil; JO, LT, AR for Korea. Part of the explanation is that Korea is a much more open economy. But there is also a conceptual problem in the computation of the inequality measures in the LT experiments. Following Lysy and Taylor, the coefficients are computed for the employed labor force only. When comparing full-employment experiments, this is not a problem; but in the LT specification, aggregate employment varies greatly across experiments. We discuss ways to adjust for this problem in the next section. There, we show that the greater apparent variability of inequality in the LT experiments is partly due to the nonconstancy of the labor force.

The extended functional or class distribution of income varies more than does the size distribution of income between the two types of closure. But the primary effect is not a change in the functional distribution between workers and capitalists--as the Kaldorian story would entail. It is, rather, between rural and urban groups. The primary mechanism at work, as we argued in our book [Adelman and Robinson (1978, pp. 184 and 191)], is changes in the agricultural terms of trade. The extended functional distribution of income appears to vary more in the LT closures than in the AR closures.[11]

5. An export-led growth strategy experiment

The investment experiment was performed primarily in order to isolate the mechanisms at work under the different closure rules. It does not correspond to a policy experiment. We now perform a composite policy experiment analogous to one that was performed by both Lysy and Taylor and Adelman and Robinson--an export-led growth strategy experiment. The experiment consists of several elements. First, export levels were set exogenously and increased over the base values. (For this experiment, the model was changed to make exports exogenous so that their magnitude could be controlled.) Second, in order to reflect the benefits of export expansion on import liberalization, import propensities were increased in both countries. Next, the capital stocks in the export sectors were increased to permit output expansion in those sectors. Finally, aggregate investment was increased so as to keep the investment rate constant in the neo-classical version (JO).

The magnitudes in each country were chosen so as to generate an approximate 10 percent increase in real GNP under the full employment versions of the model. Since Brazil and Korea have very different capital intensities and degrees of openness to trade, the calibration on the same change in GNP meant that the magnitudes chosen for the changes in exports and the capital stock differed between the two countries. The specific percentage increases chosen for each of these variables in each country are indicated in Table 4. Tables 4-6 summarize the results of this experiment for the six different closure rules in the two countries.

We again find that the macroeconomic results and the extended functional distributions are strongly affected by closure rule while the size distributions are relatively stable. The changes in GNP in all but the LT closures are approximately the same. In all the variable exchange rate experiments, the increase in investment is financed by an increase in private domestic savings. In all of the fixed exchange rate experiments, there are significant changes in foreign capital inflows. In the LT closures, there is also a Keynesian adjustment mechanism working through the multiplier and employment changes. Indeed, the multiplier again appears to be the primary adjustment mechanism in the LT closures. The changes in real gross domestic product,

Table 4

Macroeconomic Results--Export Drive Experiment

	Brazil						
	Base	JOV	JOF	LTV	LTF	ARV	ARF
Indices, base = 100							
Real GDP	100	111	111	91	114	111	111
Real investment	100	110	111	111	108	119	113
Employment	100	100	100	64	111	100	100
Capital stock	100	112	112	112	112	112	112
Exports	100	200	200	200	200	200	200
Trade deficit	100	100	-124	100	-143	100	1
Real wage	100	110	110	140	102	110	110
Real profit rate	100	104	102	88	105	103	104
Price index	100	100	100	72	96	99	103
Agricultural terms of trade	100	106	107	103	106	104	106
Private saving/investment (%)	71.0	70.4	68.2	79.7	65.9	72.7	69.7
Foreign saving/investment (%)	4.2	2.1	5.0	1.5	6.6	2.1	3.4
Consumption/GDP (%)	84.8	85.6	84.3	82.7	84.9	84.3	84.3
Nominal devaluation (%)	0.0	0.0	0.0	-51.4	0.0	-13.6	0.0
Real devaluation (%)	0.0	0.0	0.0	-32.3	4.6	-12.7	-3.2
	Korea						
Indices, base = 100							
Real GDP	100	111	111	108	116	111	111
Real investment	100	110	111	110	111	117	117
Employment	100	100	100	97	110	100	100
Capital stock	100	119	119	119	119	119	119
Exports	100	172	172	172	172	172	172
Trade deficit	100	100	100	100	85	100	95
Real wage	100	110	110	95	90	110	110
Real profit rate	100	96	96	96	97	96	96
Price index	100	100	100	87	91	97	97
Agricultural terms of trade	100	120	118	111	108	118	118
Private saving/investment (%)	20.0	26.1	26.8	28.5	31.9	30.5	32.5
Foreign saving/investment (%)	45.0	37.0	36.5	35.0	31.5	34.8	33.2
Consumption/GDP (%)	85.3	84.1	83.9	83.2	82.8	82.5	82.0
Nominal devaluation (%)	0.0	0.5	0.0	-16.8	0.0	-1.8	0.0
Real devaluation (%)	0.0	0.5	0.0	-4.5	10.4	0.9	3.5

Table 5

Size Distribution Results--Export Drive Experiment

	Brazil						
	Base	JOV	JOF	LTV	LTF	ARV	ARF
Size distribution							
Top 10 percent	45.4	45.6	44.4	44.0	45.4	45.1	44.9
Next 10 percent	11.8	11.8	12.0	12.4	11.8	11.9	11.9
Next 20 percent	17.2	17.1	17.4	18.0	17.2	17.3	17.3
Next 20 percent	12.6	12.5	12.8	12.6	12.6	12.6	12.7
Next 20 percent	8.9	8.9	9.1	8.6	9.0	9.0	9.0
Poorest 20 percent	4.1	4.1	4.3	4.4	4.0	4.1	4.2
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Gini coefficient	.509	.511	.500	.506	.510	.508	.508
Theil coefficient	.587	.592	.561	.557	.587	.580	.575
Atkinson measure	.570	.571	.557	.539	.577	.569	.563
Coefficient of variation	1.51	1.53	1.47	1.45	1.51	1.50	1.49
	Korea						
Size distribution							
Top 10 percent	33.8	32.9	32.9	33.3	32.6	32.7	32.6
Next 10 percent	15.0	15.1	15.2	15.1	15.1	15.2	15.2
Next 20 percent	20.5	20.8	20.9	20.7	20.7	20.9	20.9
Next 20 percent	14.3	14.6	14.5	14.4	14.6	14.6	14.6
Next 20 percent	10.2	10.3	10.3	10.2	10.5	10.3	10.3
Poorest 20 percent	6.2	6.3	6.2	6.2	6.5	6.3	6.4
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Gini coefficient	.413	.407	.408	.411	.402	.406	.405
Theil coefficient	.313	.302	.302	.309	.294	.298	.297
Atkinson measure	.394	.390	.391	.392	.379	.389	.387
Coefficient of variation	.95	.92	.92	.94	.91	.91	.91

Table 6

Extended Functional Distribution Results--Export Drive Experiment

	Base	JOV	JOF	LTV	LTF	ARV	ARF
	Brazil						
	percent						
Wages/GDP	42.4	42.8	42.9	42.5	43.0	42.9	42.9
Poor/employment	30.0	25.6	25.1	24.9	27.2	25.6	25.3
Socioeconomic composition of the poor							
Farm workers	59.4	64.2	64.8	45.7	66.0	64.0	64.3
Marginal labor	8.4	6.7	6.6	1.3	8.3	6.5	6.7
Organized labor	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Service labor	5.7	4.2	4.4	1.6	5.9	4.1	4.4
Government workers	1.7	1.3	1.4	0.5	1.7	1.3	1.4
Small farmers	23.2	22.4	21.4	47.7	16.9	22.8	21.8
Industrial proprietor	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Service proprietor	1.4	1.1	1.2	2.6	0.9	1.1	1.2
Agricultural capitalists	0.2	0.1	0.2	0.6	0.3	0.2	0.2
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Rural share[a]	87.0	90.5	89.7	94.1	87.3	90.3	89.7
Proprietor share[c]	24.6	23.6	22.6	50.3	17.8	23.9	23.0
Labor share[d]	15.8	21.2	12.4	3.4	15.9	11.9	12.5
	Korea						
Wages/GDP	66.0	66.6	66.6	66.1	66.2	66.6	66.6
Poor/population	30.0	25.8	26.0	26.4	28.5	26.0	26.1
Socioeconomic composition of the poor							
Farm workers	42.8	37.5	38.4	44.1	38.6	38.4	38.2
Marginal labor	24.4	29.7	29.4	25.6	25.6	29.4	29.4
Organized labor	6.3	10.8	10.3	6.3	6.3	10.3	10.4
Service labor	4.5	4.6	4.4	4.8	3.7	4.4	4.5
Government workers	2.8	2.6	2.5	2.6	2.7	2.5	2.5
Small farmers	11.5	8.0	8.3	10.3	14.7	8.3	8.3
Industrial proprietor	1.0	1.6	1.6	0.7	0.9	1.6	1.6
Service proprietor	5.5	4.6	4.4	4.7	5.6	4.4	4.4
Agricultural capitalists	1.2	0.6	0.7	1.0	1.9	0.7	0.7
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Rural share[a]	67.9	60.3	62.1	68.2	68.0	62.1	59.9
Proprietor share[c]	18.1	14.2	14.3	15.9	21.2	14.3	14.3
Labor share[d]	37.9	47.8	46.6	33.3	8.3	46.6	46.8

[a]Includes: farm workers, small farmers, agricultural capitalists, and half of the marginal workers.

[b]Includes: small farmers, service, and industrial proprietors.

[c]Includes: marginal labor, organized labor, service labor, and government workers.

therefore, are sensitive to the trade specification and differ from the other closures.

The fixed exchange rate (LTF) specification has a 40 percent higher change in GDP in Brazil than do the full employment closures. The variable exchange rate (LTV) specification, by contrast, yields a 9 percent fall in GDP--given the successful export drive. This counterintuitive result arises because, despite a large revaluation (51 percent in Brazil and 17 percent in Korea), which lowers the value in domestic currency of foreign saving, the export drive generates more savings than can be absorbed by the increase stipulated for nominal investment.[12] The only way to adjust savings to investment is to reduce income. In Brazil the variable exchange rate LTV closure is accomplished by a 36 percent drop in employment (!) and a 9 percent drop in real GDP. In Korea, the adjustment is not quite so drastic. There is a 3 percentage point drop in employment and a 3 percentage point smaller increase in GDP than in the full employment versions of the model.

The difference between the fixed and the variable exchange rate versions of the LT closure is quite large. It is, indeed, larger than the difference between the LT closures, on the one hand, and the AR closures on the other. The two LT closures bracket the two AR closures. This is true not only of the macroeconomic results of the two models but also of the size distribution results although the variation is much smaller. However, it is interesting that the distributions are more sensitive to the trade specification than to the choice of macro closure.

Again, we find that the extended functional distributions are more sensitive to the closure rules and more variable than are the size distributions. Indeed, in this experiment the extended functional distribution varies substantially across closure rules largely because there is more variability in the impact of the closure rules on the agricultural terms of trade. The incidence of poverty within the rural sector, between farm workers and small farm proprietors, varies more than does the incidence of poverty between labor and profit earners in the urban sector. This result highlights the need to examine the extended functional distribution rather than focus only on labor and capital. The proprietor share of poverty varies substantially because of variations in the impact of the adjustment upon small farm proprietors who constitute the bulk of the proprietor group.

There is a problem, however, in comparing the distributional results reported among experiments (Tables 1-6) because the distributions are calculated, as Lysy and Taylor did, using only the economically active population. As noted in the previous section, this does not matter when one compares full employment experiments since the overall labor force is fixed. But in the LT experiments, the labor force changes, sometimes dramatically. The distributions reported thus involve different numbers of people across experiments.

It is hard to know how to adjust for this phenomenon. In the Adelman and Robinson book, the adjustment was carried out by composing the total population into households, generating household-based income distributions, using labor force participation elasticities to generate changes in the supply of labor, and absorbing the unemployed, if any, into households. This was not done here in order to keep as close as possible to the LT specification.[13]

To get a feeling for the effect that differences in population size might have on the distributional results, we repeated the distribution calculations for the Brazil export experiment based on a constant labor force (Table 7). We took the highest labor force (that in the LTV experiment) and assumed that the difference between the maximal employment and the actual employment in any

Table 7

Distribution Results, Constant Labor Force
Export Driven Experiment, Brazil

	Size Distribution Results						
	Base	JOV	JOF	LTV	LTF	ARV	ARF
Size distribution							
Top 10 percent	45.1	45.3	44.1	44.0	44.3	44.9	44.6
Next 10 percent	11.9	11.9	12.1	12.4	12.2	12.0	12.0
Next 20 percent	17.3	17.4	17.5	18.0	17.5	17.4	17.4
Next 20 percent	12.6	12.4	12.8	12.6	12.3	12.5	12.6
Next 20 percent	8.9	8.7	9.0	8.6	8.8	8.9	8.9
Poorest 20 percent	4.3	4.3	4.5	4.4	4.9	4.3	4.5
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Gini coefficient	.509	.511	.501	.506	.499	.508	.505
Theil coefficient	.531	.584	.554	.557	.553	.572	.567
Atkinson measure	.555	.556	.543	.539	.524	.554	.549
Coefficient of variation	1.50	1.51	1.45	1.45	1.46	1.49	1.48
	Extended Functional Distribution Results percent						
Poor/population	33.3	28.6	28.1	24.9	37.9	28.6	28.4
Socioeconomic composition of the poor							
Farm workers	50.6	55.1	55.6	45.7	39.1	55.1	55.7
Marginal labor	7.1	5.7	5.7	1.3	4.9	5.6	5.7
Organized labor	0	0	0	0	0	0	0
Service labor	4.9	3.6	3.8	1.6	3.5	3.5	3.8
Government workers	1.4	1.1	1.2	.5	1.0	1.1	1.2
Small farmers	19.8	19.2	18.4	47.7	10.0	19.6	18.7
Industrial proprietor	0	0	0	0	0	0	0
Service proprietor	1.2	.9	1.0	2.6	.5	.9	1.0
Agricultural capitalists	.2	.1	.1	.6	.1	.2	.1
Unemployed	14.8	14.2	14.2	0	40.9	14.0	14.2
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Rural share[a]	74.1	77.3	76.3	94.1	49.2	77.7	77.2
Proprietor share[b]	21.0	20.1	19.4	50.3	10.5	20.7	19.8
Labor share[c]	28.2	24.6	24.9	3.4	50.3	24.2	24.9

[a](as in Table 6).

[b](as in Table 6).

[c]Includes: marginal, organized, service, and government workers plus unemployed.

given experiment was accounted for by unemployment. The unemployed were given an income and a log variance equal to half that of the marginal workers. The results indicate that, despite a swing of 46 percentage points between the maximal employment and the minimal employment (both in LT experiments), the size distributions so standardized are even closer to each other than those that are unstandardized. The corrected extended functional distributions, on the other hand, display greater variability than those that are unstandardized, since the labor categories now include the unemployed.

6. Conclusion

We find that: (1) the effects of macro adjustment on the size distribution are relatively small and insensitive to the choice of closure rule; (2) the functional and socioeconomic distributions are more strongly affected by macro adjustment, although the variations in impact under alternative closure rules are not nearly as great as the results from highly simplified theoretical models would predict; and (3) the balance-of-payments effects and adjustments in the structure of output, which are assumed away in some of the theoretical macro models, are empirically important and tend to damp the distributional impact of adjustment to macro shocks. We also find that macro closure rules matter, but their primary impact is upon macroeconomic rather than distributional variables. Of the two macro closure rules considered, the foreign trade or balance-of-payments closure rule is at least as important as the savings-investment closure. In turn, Keynesian effects rather than Kaldorian effects are the primary mechanism by which the model economies adjust to external shocks under the LT closures.

Traditionally, multisector models have been used to analyze alternative growth paths in the medium term, say, 5 to 10 years. Our results in this paper indicate that it is inappropriate to impose a short-run macro model on top of a medium-term multisector model without paying a great deal more attention to the transition from short-run to medium-run adjustment mechanisms than is usual in the literature. Grafting Keynesian multipliers onto a neoclassical core is not really adequate.

Finally, the feeling which appears to exist in the profession that the LT and AR closures generate totally different distributional results seems wholly unfounded. The size distributions are quite close, the share of wage income in GDP varies very little, and the major differences appear in the extended functional distributions. These results are consistent with the results we obtained in our 1978 book.

Footnotes

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[1]The approximation can be made as accurate as desired. This approach has been extended considerably by Dixon et al. (1981).

[2]For a survey of CGE models focusing on issues of tax policy and international trade in developed countries, see Shoven and Whalley (1984).

[3]Dervis, de Melo, and Robinson (1982) provide a detailed description of the theoretical structure of CGE models in general and, in particular, of models focusing on issues of international trade and income distribution. Devarajan, Lewis, and Robinson (1986) provide an extensive bibliography of published work on CGE models applied to developing countries.

[4]See Robinson (1986), Dewatripont and Robinson (1985), Lewis (1985), Robinson and Tyson (1984), Dewatripont and Michel (1984), Lysy (1982), and Rattso (1982). The more recent literature has a broader focus than just distributional issues and has widened the scope of macro closure to include the balance of trade and the government deficit in addition to the savings-investment balance.

[5]In the Korea model, we generated a number of size distributions (e.g., before and after taxes and transfers, by households, and by the economically active population). For a detailed description of the technique, see Adelman and Robinson (1978), p. 215 or Dervis, de Melo, and Robinson (1982), pp. 417-420.

[6]See Dervis, de Melo, and Robinson (1982) for a discussion of the implications of this treatment. Armington (1969) used this specification in estimating import demand functions, and the trade aggregation function is sometimes called an Armington function.

[7]Alternative mechanisms have been specified in CGE models for achieving equilibrium with a fixed balance of trade that involve various forms of import rationing. For a discussion of modeling alternative rationing schemes, see Dervis, de Melo, and Robinson (1982).

[8]Whether this is the "true" Keynesian model is a matter of some debate. See Dewatripont and Robinson (1985), who specify an alternative Keynesian closure in a CGE model characterized by price rigidities and rationing in which an increase in employment arising from the multiplier process need not be associated with a decline in the real wage.

[9]Lysy and Taylor discuss these problems and the essentially ad hoc way they dealt with the issue in a long footnote [Taylor et al. (1980, p. 162, footnote 3)].

[10]In the original AR model, imports and exports were largely tied to output through fixed coefficient relationships in the tradition of earlier planning models. In the model here, however, they are sensitive to changes in relative prices through the sectoral import-demand and export-supply equations.

[11]The impact of terms of trade changes on the extended functional distribution has been explored extensively in later CGE models; see, for example, M. de Melo (1979) and Chichilnisky and Taylor (1980).

[12]The impact of exchange rate changes on the value of foreign savings in domestic currency is called the "Hirschman Effect"; see Hirschman (1948).

[13]Another approach was used by de Melo and Robinson (1982): The labor force was kept fixed, and variations in employment were accounted for by generating a class of unemployed whose ranks swelled or diminished appropriately.

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