Income Redistribution and Trade Policy Effects on Macroeconomic Aggregates:

A Simulation Study of The Singapore Economy Based on An Extended Input-Ouput Model

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I. Introduction

In this paper, our attention is focused on the effects of income redistribution and trade policies on macroeconomic aggregates such as employment, savings, Gross Domestic Product in an open developing economy.

The relationship between economic growth and income distribution is one of the favourite topics in development economics. Much efforts have been spent in considering how income distribution would be affected in the process of economic growth. Kuznets, in particular, hypothesized a non-linear relation[1] between economic growth and income distribution: during the early decades of a nation's entry into modern growth, the distribution of income tends to become unequal and only after some time will tendencies towards equality begin to dominate over forces tending to widen the distribution. The economic history of

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[1] It is popularly known as the invested U hypothesis. There have been numerous cross sectional studies attempting to prove or disprove the hypothesis. Some recent examples include Ahluwalia and Chenery, et al. Earlier literature is surveyed by Paukert and Cline (1975). A critical evaluation of the methodology used by Ahluwalia is found in Anand and Kanbur.

The records of past experience of many countries have indicated that industrial growth of the import-substituting type has been highly capital intensive in nature and has generated relatively little employment opportunities. It has been emphasized by a number of economists that countries adopting import-substitution industrialization policies have experienced a worsening of factor-price distortions and a reduction in labour absorption.[4] These countries indirectly redistribute income in favour of the manufacturing sector and against the generally poorer agricultural sector.

On the other hand, it is often suggested that for developing countries, the promotion of labour intensive manufactured exports is a powerful remedy to mass unemployment. Taiwan and South Korea have often been cited as countries having successfully combined rapid and equitable growth. These two countries have pursued an export-led growth strategy and have achieved remarkable rates of expansion in export industries which provide employment to many unskilled and semi-skilled workers. The results of a variety of empirical studies of the employment creating potentials of alternative industrial policies have clearly suggested that an export-oriented strategy is to be preferred by this criterion.[5]

In order to help us to study the effect of income distribution and trade policies on the economic aggregates during the growth process in Singapore, we make use of an extended input-output model. The methodology and the assumptions involved in using the model for simulation exercises are detailed in the following two sections. In section IV, the results of the empirical study pertaining to the Singapore economy are presented. A brief summary of the results is included in the final section.

II. Input-Output Based Model for Simulation Experiments

The model used in this study is a standard closed input-output model. In the open, static I-O model and its numerous applications, final demand is exogenously given, current and primary inputs and, therefore, income and income distribution depend on final demand. Several authors have pointed out that final demand at least partly depends on production and income

[4] For example, Lewis, Krueger and Little, et al.

[5] Morawetz, 309-10, summarizes the findings of some of these countries.

where A = a square matrix of order n x n of input coefficients for domestically produced intermediate inputs.
The elements of A are defined as,
$a_{ij} = x_{ij}/X_j \quad ; i,j = 1,2\ldots,n$
n is the number of sectors (or industries)

x_{ij} = intermediate deliveries of domestic output of industry i to industry j

X_j = gross output of industry j

C = a matrix of order n x k of private consumption expenditure pattern by expenditure groups. The elements of this matrix are estimated as follows:

$$c_{ij} = \frac{e_{i,k}}{Y_k} \quad ; \quad \begin{matrix} i = 1,2,\ldots,n \\ k = 1,2,\ldots,k \end{matrix}$$

e_{ik} = the expenditure on private consumption of commodity i by expenditure group k

Y_k = total personal income in the k^{th} expenditure group

c_m = a row vector of k elements representing direct import coefficients for private consumption

c_t, s and π are row vector each of order k, representing, respectively, indirect tax, saving and personal income tax coefficients associated with the expenditure groups.

By definition, it is obvious that for a particular expenditure group, k

$$(2) \quad \sum_i c_{ik} + c_{m\,k} + s_k + c_{t\,k} + \pi_k = 1$$

Similarly for the industries:

a_m = a row vector of import coefficients

a_t = a row vector of indirect taxes coefficients

ℓ = a row vector of labour input coefficients

Furthermore,

Λ = a column vector of k elements of stipulated income distribution pattern. Elements for this vector, corresponding to the actual income distribution in the base year are defined as,

$$(3) \quad \lambda_k = Y_k / \sum_j Y_j$$

V = a row vector of value-added coefficients.

contains the following elements:

(i) n values of gross output of industries
(ii) Total personal income[9]
(iii) k values of total personal income by expenditure groups
(iv) The sum of imports for intermediate use and for consumption
(v) Total indirect tax
(vi) Total saving of households
(vii) Total income tax of households
(viii) Total employment

III. Main Assumptions of the Model

Some of these assumptions are standard assumptions, generally applied in a static Leontief-model; others are specific to the present version of it.

(i) Each sector (identified with a production function) produces a single product thus ruling out joint products.
(ii) The technological coefficients are fixed and there is no possibility of substitution among factors of production. This simply means that a product can be produced in only one way.
(iii) There are no interactions between sectors, thereby implying negligible economies or diseconomies of scale.
(iv) No upper bounds on productive capacity or any other resoruces are imposed. The figures provided by the simulation experiments are, therefore, "unconstrained" solutions and comparison with the actual situation of impending constraints, such as labour shortage, will shed light on the feasibility of the equilibrium state of the economy corresponding to each income distribution alternative.[10]

[9] In the model, we have added an extra row in order to obtain in the solution the total value added corresponding to each stipulated income distribution pattern. The size of the B matrix is therefore increased by one column and one row.

[10] Quantitatively, we can increase the amount of workers by encouraging higher participation rates, especially among female population; by relaxing immigration rule to allow foreign inflow of required manpower. Plant capacity can be increased, at least temporarily, by increasing the intensity of utilization, at least temporarily, by increasing the intensity of utilization, such as adding extra shift. In any case, our simulation results show that not too great a strain on the resources are engendered by income redistribution.

tion pattern of each income group is unaffected by income redistribution. They rightly noted that this is a simplifying assumption. A shift in income distribution will change the average household income in each income group leading to a change in the pattern of total private consumption and the level of total private savings. To take into account the impact of changes in the average household income in each income group, Paukert, et al. in their 1979 paper presented an iterative version of the Model. In the first step, the consumption pattern corresponding to the average income after the stipulated redistribution of income is used. The model is solved and the average incomes by income group adjusted to the new level of total personal income. Calculations continue until a full correspondence between the average incomes by income group and the consumption patterns is established.[12]

In our present exercise, we will consider an alternative procedure which would not require iteration. In order to take the interdependence between the average income and consumption pattern into consideration, we assume the saving function takes a form that is justifiable by the relative income hypothesis[13] formulated by Duesenberry (1949).

Consider the particular expenditure group, k. We let

$$(6)\quad y_k = \frac{Y_k/Y}{H_k/H} = \frac{Y_k/H_k}{Y/H} = \frac{\text{average household income of expenditure group } k}{\text{average income per household in the economy}}$$

We postulate a linear function for the saving ratio, s_k

$$(7)\quad s_k = a + by_k \quad ; \quad 1 > b > 0$$

So, as the income distribution changes, y_k will change, it follows from (7) that the saving (hence consumption) of the household

[12] This iterative procedure is designated Version II in Paukert et al. Version I refers to the case where the pattern of consumption of the household in each group remains constant and unaffected by income redistribution.

[13] The relative income hypothesis argues that the fraction of a family's income devoted to consumption depends on the level of its income relative to the income of other families with which it identifies rather than on the absolute level of its income. This hypothesis emphasizes the imitative or emulative nature of consumption.

combination provide us with a number of solutions of the model which may be interpreted accordingly.

IV. Application of the Model to the Singapore Economy

A. Data Sources

The following main data sources have been used:
(1) Input-Output Table: The 1973 input-output table compiled by the Government Statistics Department was used. The table was aggregated into 19 industries in order to make it compatible with other data sources. The set of tables does include an import matrix, which allows us to consider import-substitution policies.

(2) Family Income and Expenditure Statistics: Data on private consumption patterns by expenditure groups were available from the Report on Household Expenditure Survey 1972/73. Complementary information on private consumption expenditure disaggregated by major commodities group are obtained from the Statistical Yearbook of Singapore.

(3) Employment Statistics: From the Report of the Annual Labour Force Survey 1973, we can obtain the estimates of employment in different economic sectors. To break down the labour force data to the industry level, the information from the Census of Industrial Production 1973 was used.

B. Results of Calculation

The 15 stipulated income distributions for which the calculations have been carried out are presented in Table 1. These are ranked by the values of the Gini coefficients, proceeding from the most unequal income distribution to the most egalitarian one. The income distribution corresponding to alternative 5 is the one observed for the Singapore economy referring to the year 1972/73, while the Gini coefficient given in alternative 1 is of the same magnitude as that of Singapore in 1966.[15] The other distributions in the table are hypothetical and are designed to provide information about different degrees of inequaltiy between the position in alternative 1 and the most radical redistribution in alternative 15.

[15] Information is based on the 1966 Sample Household Survey conducted by the Ministry of National Development and Economic Research Centre.

Calculations were performed for both versions: the first version assumed consumption patterns to be independent of income redistribution and the second version relaxed this assumption. As the qualitative conclusions do not differ when adopting either version, only results pertaining to the second version will be discussed in the following.

1. Effects on Employment

The results in Tables 2 and 3 show that redistribution of income in favour of the lower income groups results in an increase in total employment, GDP and personal income. A comparison of alternative 1 and alternative 15 (see Table 3) shows a relatively higher increase in GDP (7.8 per cent)[16] than in employment (5.3 per cent). This is in contrast to the finding of Paukert, et al., for the Philippine economy, where employment growth is greater than GDP growth. Basically, we can say the elasticity of employment with respect to GDP is elastic for the Philippines but inelastic for Singapore. This is not an unfavourable feature in the context of Singapore. Since the country is in a stage of economic transition in which labour has become scarce, the pursuit of the double objectives of increasing growth together with equity will be less constrained by the problem of insufficient labour resources.

Since employment shows a lower increase, these results also suggest that the GDP per employed person and personal income per employed person would increase as a result of redistribution. This increase in productivity (defined as GDP per worker) as a result of a shift of income distribution in favour of lower income recipients may be explained by the fact that such a change in income distribution causes a change in the structure of production. The structure of production is shifted in favour of those industries which are employing more productive labour and also more highly paid workers. Such a change in the structure of production is induced through a change in the pattern of consumer demand caused by the shift in income distribution in favour of lower income groups.[17]

16 Unless otherwise stated, all growth rates are computed with the figures corresponding to alternative 1 as base.

17 The "capital intensity" of the basket of goods preferred by the household increases as a result of redistribution. This is in contrast to the finding by Paukert, et al. for the Philip-

Table 2

IMPLICATIONS OF STIPULATED ALTERNATIVES OF INCOME DISTRIBUTION
(SAVING RATIOS VARY WITH INCOME DISTRIBUTION)

(S$Million)

Income Distribution Alternatives	Employ-ment (1,000)	GDP (Factor Cost)	Personal Income	Personal Saving	Total Imports	Indirect Tax	Personal Income Tax
1	785.755	9265.525	7327.119	1072.943	9371.475	701.420	218.878
2	790.080	9333.892	7379.940	1022.529	9407.200	707.351	212.830
3	792.432	9367.210	7405.680	997.541	9423.670	710.378	209.272
4	804.384	9522.256	7525.468	884.367	9504.503	721.367	196.806
5	799.549	9466.137	7482.111	925.236	9474.926	717.342	201.586
6	805.086	9538.808	7538.255	874.449	9510.777	723.083	194.235
7	811.550	9622.185	7602.672	821.671	9550.110	726.948	184.826
8	809.383	9607.427	7591.270	828.903	9544.131	727.896	185.999
9	814.633	9681.083	7648.176	785.777	9576.851	731.300	176.226
10	816.184	9708.500	7669.358	769.344	9588.584	733.288	171.931
11	819.207	9754.283	7704.730	747.828	9606.768	735.199	163.708
12	818.700	9751.109	7702.278	746.958	9605.901	736.810	164.556
13	821.228	9790.965	7733.070	730.189	9620.125	737.944	156.892
14	814.094	9716.242	7675.340	765.761	9591.067	738.019	167.371
15	827.394	9992.279	7888.603	654.596	9687.840	750.931	105.999

Table 4

SOURCES OF SAVINGS AND INVESTMENT, 1973

(S$ Million)

Savings		Investment	
Private Saving	925.3	Gross domestic fixed capital formation	3561.0
Corporate Saving	922.1		
Government Saving	877.6	Increase in Stocks	439.0
Foreign Saving	1275.0		
Total Saving	4000.0	Gross Domestic Capital Formation	4000.0

Sources: Estimated from data provided in the Yearbook of Statistics, 1974, and I-O Table 1973.

deficit on the balance of payments. It is equal to the excess of imports of goods and services over exports of goods and services plus net transfer payments abroad. In our model, the volume of exports is assumed constant, while imports vary with different income distribution. Thus, assuming the volume of transfer payments remains unchanged, we can compute the extra foreign capital inflow/outflow relative to the 1973 level. We note that as income is redistributed in favour of the poor, additional foreign capital inflows are required. In the last column of the table, we note that the total resources available for investment financing declines with more equitable income distribution. However, the decrease is not very substantial. Camparing alternative 15 (the most egalitarian distribution) with alternative 5 (the actual distribution in 1973), total resoces decreased by 23 million dollars or about 0.6 per cent. Even if the additional foreign capital inflow is not forthcoming, the total decline in resources available is less than 236 million dollars or about 6 per cent.[19]

19 We might wonder whether the economy could cover this deficit in resources. One suggestion is that the government could draw from its foreign reserves to cover the deficit. In the case of Singapore, foreign reserves in 1973 were 5,800 million dollars, more than sufficient to cover the deficit.

3. Effects on Growth

If there are data on the ICOR for each industry, then we could estimate the capital stock of the economy corresponding to each income distribution alternative. Unfortunately, information on the capital stock for separate industries is incomplete in the case of Singapore. However, the effect of income distribution on economic growth could still be studied by making some assumptions. Using the actual growth rate and saving ratio in 1973, we could estimate the capital-output ratio by the well known growth equation:

$$(10) \qquad g = \frac{s}{(K/Y)}$$

where g is the growth rate, s the saving ratio and K/Y is the capital output ratio. We note the capital output ratio can be written as the quotient of capital labour ratio and average productivity of labour

$$(11) \qquad \frac{K}{Y} = \frac{K/L}{Y/L}$$

Again using the actual values of (Y/L) in 1973, together with the value of (K/Y) estimated earleir, we can estimate the capital labour ratio, (K/L). Call this $\bar{k}$. Assuming that the capital labour ratio remains the same for all income distribution alternatives, the implied growh rate is given by,

$$(12) \qquad g = \frac{s \cdot (Y/L)}{\bar{k}}$$

Obviously from equation (12), we note that the growth rate of the economy depends not only on the savings ratio, but on the productivity of labour as well, given that the capital-labour ratio remain unchanged. A higher saving ratio and labour productivity will increase the implied growth rate. Using the information on the saving ratio and the productivity of labour, the implicit growth corresponding to each income distribution is computed and shown in Table 6. The decrease in the implied growth rate caused by the decrease in the volume of savings is quite small. The decline in growth would have been larger if labour productivity had not risen and if the capital-labour ratio had increased as the economy moved towards greater equality in income distribu-

sumption rising with increased income equality, it is not unexpected that total revenue from indirect tax shows a concomitant increase.

Table 5 also shows a significant decrease in total revenue from personal income tax. This is consistent with the progressive tax structure of the economy. The rich are taxed at a higher rate than the poor. Income redistribution reduces the concentration of income in the higher income group. Consequently the total personal tax revenue decreases with increasing income equality.

Our present model also allows us to compute and compare the pre-tax and post-tax income distribution for each stipulated income distribution.[20] This is presented in Table 7. The pre-tax

Table 7

PRE- AND POST-TAX INCOME DISTRIBUTION FOR ALTERNATIVE INCOME DISTRIBUTIONS

	Pre-Tax		Post-Tax	
Alternatives	Gini Coeff.	Entropy Measure	Gini Coeff.	Entropy Measure
1	.4965	.4663	.4848	.4413
2	.4609	.4050	.4484	.3802
3	.4471	.3817	.4343	.3578
4	.4226	.3100	.4112	.2912
5	.4210	.3244	.4084	.3030
6	.4023	.2883	.3903	.2694
7	.3893	.2602	.3786	.2457
8	.3659	.2339	.3536	.2167
9	.3431	.1996	.3317	.1860
10	.3232	.1768	.3116	.1642
11	.3002	.1555	.2894	.1452
12	.2922	.1483	.2807	.1370
13	.2716	.1308	.2607	.1219
14	.2489	.1337	.2344	.1185

20 As noted earlier, information on indirect tax and personal income tax paid by each expenditure group is obtained from a tax incidence study by Anne Booth in 1978.

greater emphasis on export promotion is supported by the argument that the domestic market is small and also the need to earn more foreign exchange to meet the increasing demand for imports. Any sutstantial changes in the exports of the country are likely to affect production and employment and thus income distribution. The two important aspects of the effects of changes in exports on the rest of the economy are:

(1) Effects of changes in the volume of exports, and
(2) Effects of changes in the composition of exports.

For analysing the former type of effects we have assumed four alternative rates of growth of exports, viz, 5.0, 10.0, 15.0 and 20.0 per cent per annum. For the latter type of effects, we have divided the exports into two groups — exports from the manufacturing sector and exports from non-manufacturing sectors (see Table 8).

It is found that a 20.0 per cent increase in the volume of exports brings about increases in employment (11.5 per cent), in GDP (12.6 per cent) and in personal income (12.3 per cent). Again we have a productivity (i.e. GDP per worker) increase as exports increase proportionately in all sectors. As increasing exports require the use of more raw materials, imports increase by 12.2 per cent as a result of a 20 per cent increase in export volume.

When we confine the export expansion exercise only to the manufacturing industries, the growth of GDP (6.3 per cent) remains higher than the growth in employment (5.8 per cent), as a result of a 20.0 per cent expansion in exports (see Table 9). However, we now observe that the import growth (8.3 per cent) is greater than the growth in GDP. This together with the results obtained above allows us to infer that the manufacturing sector is relatively more import-dependent than the other non-manufacturing sectors.

2. Effects of Changes in Imports

Similar to the exercise on export expansion, we analyse the effects of a changing degree of import-substitution. We find that a 20.0 per cent substitution of imports for all sectors, results in a 12.7 per cent increase in employment and 13.2 per cent increase

Table 9

IMPLICATIONS OF EXPORT EXPANSION (MANUFACTURING SECTOR) GROWTH:
(WITH INCOME DISTRIBUTION AS IN 1972/73)

(S$ Million)

Export Expansion (In Percent)	Employ-ment (1,000)	GDP (Factor Cost)	Personal Income	Personal Saving	Total Imports	Indirect Tax	Personal Income Tax
0	799.621	9467.007	7482.782	925.315	9475.346	717.410	201.604
5	811.267	9614.948	7597.081	939.449	9671.731	726.958	204.684
10	822.914	9762.889	7711.379	953.583	9868.115	736.507	207.763
15	834.560	9910.831	7825.677	967.717	10064.499	746.055	210.843
20	846.206	10058.772	7939.975	981.851	10260.883	755.603	213.922
Comparison with Basic Solution							
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0146	1.0156	1.0153	1.0153	1.0207	1.0133	1.0153
10	1.0291	1.0313	1.0305	1.0305	1.0415	1.0266	1.0305
15	1.0437	1.0469	1.0458	1.0458	1.0622	1.0399	1.0458
20	1.0583	1.0625	1.0611	1.0611	1.0829	1.0532	1.0611

Table 10

IMPLICATIONS OF IMPORT SUBSTITUTION GROWTH:
(WITH INCOME DISTRIBUTION AS IN 1972/73)

(S$ Million)

Import Substitution (In Percent)	Employ-ment (1,000)	GDP (Factor Cost)	Personal Income	Personal Saving	Total Imports	Indirect Tax	Personal Income Tax
0	799.621	9467.007	7482.782	925.315	9475.346	717.410	201.604
5	822.275	9744.702	7697.327	951.845	9361.941	735.381	207.385
10	846.600	10042.987	7927.780	980.343	9240.132	754.680	213.594
15	872.804	10364.404	8176.103	1011.051	9108.882	775.469	220.284
20	901.128	10711.934	8444.602	1044.253	8966.974	797.943	227.518
Comparision with Basic Solution							
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0283	1.0293	1.0287	1.0287	.9880	1.0251	1.0287
10	1.0588	1.0608	1.0595	1.0595	.9752	1.0519	1.0595
15	1.0915	1.0948	1.0927	1.0927	.9613	1.0809	1.0927
20	1.1269	1.1315	1.1285	1.1285	.9463	1.1123	1.1285

terns growing out of an aggressive policy of income redistribution. An egalitarian society was therefore imposed on the Singapore model, with all individual households given the mean income. Surely any tampering with the existing structure of income classes would at once alter the consumption pattern of every household. In our experiment, the consumption pattern of group 2 (poor) group 6 (average) and group 11 (rich) were imposed on the egalitarian population. The results corresponding to the export expansion strategy and the import substitution strategy were shown respectively in Table 12 and 13.

In both cases, employment and income per capita rose to a higher level when the consumption pattern of the "poor" was adopted than in the case when the pattern of the "average" was adopted. However, when the consumption pattern of the rich class was imposed, both employment and income per capita fell. This illustrates that in an egalitarian society, if foreign trade policies (either import substitution or export expansion) are pursued without due attention paid to the consumer preference structure, lower living standards and unemployment may result instead of growth in output and employment.

If the goal of policy-makers is to maximize GDP, after selecting a desired income distribution, the results so far indicate that an import substitution policy does have a slight edge over the export expansion policy. However, in the context of Singapore, the feasibility of an extensive import substitution policy is much constrained by the small size of the domestic market, the limited range of goods suitable for import substitution and the small resource base. In so far as export expansion is adopted as the only alternative policy to import substitution, the extra growth achievable by the latter policy indicates the cost of the inability to circumvent those constraints. For instance, adopting an export expansion strategy by increasing exports of the manufacturing industries by 20 per cent, will increase GDP by 6.2 per cent and employment by 5.8 per cent, which are 4.3 per cent less in term of GDP and 4.0 per cent less in term of employment should an import substitution strategy of 20 per cent be adopted for the manufacturing industries, instead.

Table 13

RESULTS OF IMPORT SUBSTITUTION AND INCOME REDISTRIBUTION SCHEMES, 1973

Development Strategy	Total		Absolute Increases		Percentage Increases	
	Employment ('000) (1)	Income Per Capita (S$) (2)	Employment ('000) (3)	Income Per Capita (S$) (4)	Employment (5)	Income Per Capita (6)
1. Actual economy, 1973	799.621	4304	–	–	–	–
2. "Selected" import substitution 20 per cent (manuf'g sector only)	878.382	4753	78.761	449	9.85	10.42
3. import substitution 20 per cent for all sectors	901.128	4870	101.507	566	12.69	13.15
import substitution of 20 per cent overall and redistribution to mean income with						
4. Consumption pattern for class 2	951.132	5375	151.511	1071	18.95	24.88
5. Consumption pattern for class 6	935.351	5048	135.730	744	16.97	17.29
6. Consumption pattern for class 11	799.351	4166	-.270	-138	-.03	-3.21

range of goods for import substitution and a scarcity of resoruces (especially skilled manpower). An export expansion strategy is deemed to be the best option when such constraints are taken into consideration.

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