

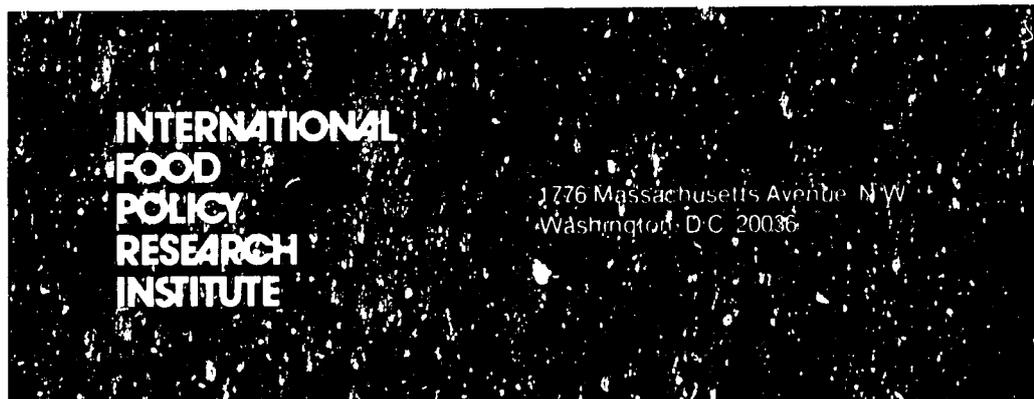
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Measuring the Indirect Effects of an Agricultural Investment Project on Its Surrounding Region

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Agricultural investment projects may generate important downstream benefits for the regions in which they are located. Using a semi-input-output model of the regional economy, an attempt is made to quantify the downstream benefits generated by an irrigation project in Malaysia. In aggregate the project's downstream effects on regional income were of an order similar to its direct effects, but the main beneficiaries of the downstream benefits were the nonfarm households. Each dollar of downstream income probably was supported by just over a dollar of additional investment in the local economy.

Key words: growth linkages, input-output analysis, Malaysia, project appraisal, regional development.

Investment projects may generate substantial indirect effects, or pecuniary external economies, as Scitovsky would call them. These effects stem partly from production linkages. First, the project will generate demands for investment and intermediate goods. Second, the rise in output due to the project may cheapen supplies to other sectors, and so increase the profitability of new investment in those sectors, a case which has been analyzed extensively by Chenery. But consumption linkages also come into play if the extra income flowing from the project boosts the level of final demand in the economy. Hirschman, in arguing for the relative neglect of agriculture in development strategies, discounted the value of these linkages for agricultural investments. Recently, however, both Mellor and Johnston and Kilby have renewed debate on the importance of these linkages for economic growth in developing countries, with Mellor laying particular stress on the importance of final linkages arising from increases in agricultural incomes.

It is also of interest to ascertain how the indirect (or "downstream") effects of a project affect the distribution of incomes. For example, while an agricultural project may generate a strong rise in the incomes of all farm households, the resulting downstream benefits may be reaped by richer nonfarm households. There is also a regional dimension to this issue. Suppose an agricultural project produces powerful downstream effects upon its surrounding region, which was previously poor. Then, as Mellor has emphasized, income disparities among agricultural regions will be increased all the more, even though the income gap between industrial regions and that receiving the project will narrow.

Another consideration is that knowledge about the structural sources of downstream effects could be useful in improving the design of integrated regional development strategies. In particular, if the structure and relative strength of linkages are known, then public policy can attempt to see that such linkages function without friction.

In this paper we propose and apply an approach to measuring the magnitude and incidence of regional downstream effects, based on a social accounts matrix (Pyatt et al.) and a variant of Tinbergen's semi-input-output method. We begin by sketching the main features of the Muda River project and surrounding region in northwestern Malaysia, the sub-

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ject of our empirical application. Next, we discuss the considerations influencing our choice of methodology and then present the semi-input-output model on which the quantitative analysis is based. Subsequently, we use this model to estimate the direct and indirect effects of the project at maturity (in 1974) on output and incomes in the regional economy. In so doing, we also estimate both the pace and pattern of the region's growth over the period 1967-74 and those which would have occurred in the hypothetical event that the project had not been undertaken. Finally, we provide some sketchy estimates of all the balancing investments needed to support the downstream incomes generated by the project.

The Project and Its Region

The project involved a total investment over the period 1967-73 of about \$270 million in the form of dams, a canal system, feeder roads, and drainage infrastructure for the irrigation of 240,000 acres of paddy land.¹ Before irrigation, a single paddy crop was grown each year in harmony with the rainfall pattern. Double cropping followed irrigation, and the accompanying introduction of quicker maturing, fertilizer-responsive varieties also has increased yields. The incomes of the 51,000 farm households in the project's command area almost doubled over the period 1967-74, and the region claimed new prominence as the supplier of some 40% of Malaysia's annual rice requirements. Nevertheless, the region is still relatively poor, with a per capita gross domestic product in 1972 of \$600 compared to \$1100 for Malaysia as a whole.

The basis for the spatial definition of the regional economy is discussed in a United Nations FAO IBRD Report (pp. 22-24). In brief, the region encompasses the whole of the state of Perlis and about half of Kedah. It comprises the irrigation command area, a further 70,000 acres of low-lying, rain-fed paddy land, and a fringe area made up mostly of rubber smallholdings. The region's population was 687,100 in 1972, 16% of whom were resident in towns with 5,000 people or more, and 81% lived within the boundaries of the irrigation command area.

We have distinguished between five household classes to reflect the income distribution aspects of regional activities. Our definitions rest on socioeconomic criteria: in particular, endowments of labor and land, access to irrigation, and sector of employment. The three agricultural household classes within the project area are: (a) "landless" households, which derive most of their income from employment on other paddy farms; (b) "labor abundant" farm households, which possess a high ratio of family labor to area operated; and (c) "land abundant" households, which hire in substantial amounts of nonfamily labor. Clearly, the household's endowments of land and labor are connected intimately with its labor market transactions, which underlie the definitions adopted here.

Farm households outside the project area are engaged heavily in "other agriculture" as well as the production of rubber and/or unirrigated main season paddy. They also supply labor to households in the project area at the times of peak activity in paddy cultivation. As their economic activities are different from those of farm households within the project area, and there is an intrinsic interest in what happens to households outside, but on the periphery of, large development projects, they merit the status of a separate household category.

Nonfarm households account for 35% of the region's population, and they display wide variations in income and wealth. Ideally, therefore, they should be subdivided into further categories. However, data to place them in more refined classes were lacking. A majority of nonagricultural households are ethnic Chinese, who generally enjoy higher per capita incomes than the predominantly rural Malays. A summary picture of population and incomes for these classes in 1972 is set out in table 1.

The region's production structure was disaggregated into the thirty-five sectors listed in table 3. These definitions are generally straightforward. Cases arose where two or more sectors produced the same commodity. This happened because either the commodity was produced under different institutional arrangements with important differences in technology and/or in the distribution of sectoral value added among households, e.g., small and commercial rice mills, or because the commodity took different forms according to its end use or type of demand it could sat-

¹ All monetary values are in 1972 Malaysian dollars unless otherwise indicated.

Table 1. Socioeconomic Characteristics of Household Classes in 1972

	Landless Paddy Workers	Labor- Abundant Paddy Farms	Land- Abundant Paddy Farms	Other Agricultural Households	Nonfarm Households	All Households
Number of households	4,367	18,045	33,426	25,333	44,047	125,239
Number of persons (thou.)	21.3	103.3	184.7	131.8	246.0	687.1
Average family size	4.88	5.72	5.53	5.20	5.58	5.49
Income per family (\$)	1,029	1,568	2,528	1,825	4,984	3,059
Income per capita (\$)	211	274	457	351	893	557

Source: Bell et al.

isfy, e.g., road and rail transport, residential and nonresidential construction.

Methodological Considerations

Two considerations bore heavily on our choice of methodology. First, to capture adequately the effects flowing from interindustry and final demand linkages between agriculture and the rest of the economy, some degree of sectoral disaggregation may be necessary. Also, the evidence on household expenditure and savings behavior suggests the need to disaggregate households by income levels. These considerations can be accounted for at any point in time through the construction of a social accounting matrix (SAM). In the present case, sufficient data were at hand to construct a detailed regional SAM for 1972 (Bell et al.)

Second, because a project's implementation is almost invariably accompanied by changes in the levels of regional activities which owe nothing to the advent of the project, e.g., technical change, autonomous private investment, and government spending, a correct analysis of its impact at maturity requires construction of a "picture" of how the economy would have looked in the absence of the project. Pictures of the economy may also have to be constructed for the pre- and/or post-project situations if sufficient primary data are not available for the estimation of SAMs for the years in question. In constructing these pictures, the most important assumptions concern the choice of exogenous variables. For each sector one must decide whether output or final demand is to be fixed exogenously. This led us to a variant of the semi-input-output method, which can accommodate a choice between inelastically fixed supply and inelastically fixed demand in each sector—unlike the standard formulation of the

closed Leontief system, in which the complete bill of gross outputs follows solely from the set of final demands.

A Semi-Input-Output Model

Beginning with the set of material balances, we have

$$(1) \quad X_i = \sum_{j=1}^n a_{ij}X_j + \sum_{k=1}^h C_{ik} + J_i + E_i,$$

there being n commodities (sectors) and h types of household; X_i denotes the gross output of sector i , a_{ij} the input of commodity i needed to produce a unit of commodity j , C_{ik} the expenditure of household class k on commodity i , J_i the deliveries of good i to investment activities, and E_i the net exports of good i .

The gross income of each household class is made up of direct earnings in commodity production and distributed profits from incorporated enterprises plus net transfers (R^*_k) from other household classes and abroad. The first two are taken to be proportional to gross output, whereas the latter are assumed to be exogenous. Choosing physical units of measure such that all commodity prices are unity, we have

$$(2) \quad Y_k = \sum_j \omega_{kj}X_j + R^*_k.$$

The claims on such incomes are taxes, savings, and consumption expenditures. The tax schedule is assumed to be linear in income

$$(3) \quad T_k = t_k Y_k + T^*_k.$$

Savings are assumed to be proportional to disposable incomes,

$$(4) \quad S_k = s_k(Y_k - T_k),$$

as there were no data to warrant a more com-

plicated form. Finally, household class k 's expenditure on good i is assumed to be a linear function of its total outlays on consumption,

$$(5) \quad C_{ik} = \gamma_{ik} + \beta_{ik}C_k.$$

Here we must enter a qualification concerning household's purchases of the outputs produced by government sectors. Households may make small cash outlays on some services, such as education and health, but their overall consumption of government services depends on the size of (exogenous) government expenditures and administrative "access" rather than disposable income. Hence, the relevant C_{ik} are fixed in relation to the corresponding gross output levels quite independently of the household's income-outlay identity: $Y_k \equiv T_k + S_k + C_k$. However, to preserve the latter, the actual cash outlays on government education and health must then be treated as taxes, the relevant γ_{ik} and β_{ik} being absorbed into T^*_k and t_k , respectively.

Substituting (3), (4), and (5) into (1), and combining the result with (2), we obtain the following more compact system:

$$(6) \quad \begin{bmatrix} I - A - Bc \\ -\Omega \end{bmatrix} \begin{bmatrix} X \\ Y \end{bmatrix} = \begin{bmatrix} -\Gamma u \\ 0 \end{bmatrix} - \begin{bmatrix} B(I - s)\Gamma^* \\ -R^* \end{bmatrix} + \begin{bmatrix} J \\ 0 \end{bmatrix} + \begin{bmatrix} E \\ 0 \end{bmatrix},$$

where A denotes the $n \times n$ matrix (a_{ij}); B , the $n \times h$ matrix (β_{ik}); c , the $h \times h$ diagonal matrix whose elements are $c_k = (1 - s_k)(1 - t_k)$; Γ , the $n \times h$ matrix (γ_{ik}); E , the $n \times 1$ vector (E_i); u , an $h \times 1$ vector of ones; J , the $n \times 1$ vector (J_i); R^* , the $h \times 1$ vector (R^*_k); s , the $h \times h$ diagonal matrix (s_k); T^* , the $h \times 1$ vector (T^*_k); X , the $n \times 1$ vector (X_i); Y , the $h \times 1$ vector (Y_k); Ω , the $h \times n$ matrix (ω_{kj}).

Equation (6) is written in the standard closed Leontief form, which solves for all gross outputs and household incomes given the levels of exogenous demands—in this case, deliveries to investment activities and net exports. For some purposes, however, this may not be an appropriate statement of the problem. As we are concerned with the indirect effects of a project, we want household incomes to be endogenous. But in each of the n material balances, we are still free to fix any two of gross output, deliveries to investment and net exports, leaving the third to be determined endogenously; for the system remains linear in $(n + h)$ equations and $(n + h)$ unknowns.

In what follows, investment deliveries are assumed to be exogenously determined by entrepreneurs' "animal spirits" and/or the government's development expenditure programs. This is a departure from previous applications of semi-input-output, which focus on the "complementary bunch" of investments which must take place in the nontradable sectors to support a given increase in the output of a particular traded good—see, for example, Kuyvenhoven. Although our choice is dictated by the absence of data from which a full investment matrix could be estimated, it is still necessary to check, if only in a sketchy way, that the stream of exogenously specified investment deliveries is consistent with the changes in output levels that occur over the relevant period.

This treatment of investment implies that the final choice for "closing" the economic system is between fixing domestic supply (gross output), and fixing net foreign demand (exports). In making this choice, there are two general considerations. First, we may wish to create a fairly comprehensive set of social accounts for some year in the past for which we have only fragmentary information, on the assumption that the parameters of equation (6) estimated from the social accounts of some "base year" are stable. Estimates of exogenous taxes (T^*), transfers (R^*) and investment deliveries (J) for the earlier year are needed. But when it comes to choosing between gross output and net exports, the search for data is eased by recognizing that sectors producing nontraded goods and services must have zero net exports. As for the remaining sectors, piecing together a set of estimates of gross output levels commonly will be a less speculative exercise than doing so for net exports—in the context of a regional economy, at least.

Second, we may be interested in forecasting or in simulating some hypothetical circumstances, such as the absence of the project. Here, whether gross output levels or net exports are made exogenous is not a matter of convenience or reliability in estimation, but rather of one's view as to how the economy works. In the present context, the output trajectories of some tradables are exogenous, having been fixed by decisions made in the past. In these circumstances, net exports must do the adjusting. However, sectors producing nontradables are faced with additional demand from firms and households, and so their outputs will expand also, either by fuller capacity

utilization or, if enough time is allowed, by additions to existing capacity. But excess capacity or not, the key assumption is that the production of nontradables takes place at constant costs, which implies that short-period supply bottlenecks, and hence the rises in prices which accompany them, are ignored. In this respect, the analysis set out is in keeping with the general recommendations concerning the treatment of nontradables offered, e.g., Little and Mirrlees.

The foregoing discussion can be translated into a simple, comparative static account of the development of a regional economy in which the source of growth is the expansion of the primary sector. In each "period," the supply of output from this sector is fixed, and the region faces a perfectly elastic "foreign" demand curve for its products. By contrast, the supply of nontradables is perfectly elastic, and foreign demand for these goods is perfectly inelastic (at zero).

Let the subscripts *T*, *D*, and *N* denote, respectively, the following sets of sectors: tradables, distributive and transport services, and other nontradables. Noting that the set of endogenous variables is the vector (E_T ; X_D ; X_N ; Y), equation (6) can be rearranged as

$$(7) \begin{bmatrix} -I & -A_{TD} & -A_{TN} & -B_{TC} \\ -\mu_{DT} & I - A_{DD} & -A_{DN} & -B_{DC} \\ 0 & -A_{ND} & I - A_{NN} & -B_{NC} \\ 0 & -\Omega_D & -\Omega_N & I \end{bmatrix} \begin{bmatrix} E_T \\ X_D \\ X_N \\ Y \end{bmatrix} = \begin{bmatrix} \Gamma_{T\mu} \\ \Gamma_{D\mu} \\ \Gamma_{N\mu} \\ 0 \end{bmatrix} + \begin{bmatrix} J_T \\ J_D \\ J_N \\ 0 \end{bmatrix} - \begin{bmatrix} B_T(I-s)T^* \\ B_D(I-s)T^* \\ B_N(I-s)T^* \\ 0 \end{bmatrix} + \begin{bmatrix} -I + A_{TT} & 0 & 0 & 0 \\ -A_{DT} & 0 & \mu_{DN} & 0 \\ -A_{NT} & 0 & I & 0 \\ \Omega_T & 0 & 0 & I \end{bmatrix} \begin{bmatrix} X_T \\ 0 \\ E_N \\ R^* \end{bmatrix}$$

where μ_{DT} and μ_{DN} are the matrices of distributive and transport margins on the net exports of tradables and nontradables, respectively.²

Equation (7) is the semi-input-output model from which our empirical results were derived.

The Growth of the Regional Economy: 1967-74

Before embarking on a discussion of how the exogenous variables and their values were chosen, two important implicit assumptions in our use of equation (7) should be noted. First, the effects of changes in the structure of relative prices were ignored, although in fact the region's barter terms of trade worsened slightly between 1967 and 1972, before improving strongly over the next two years. But if relative prices are changing, equation (7) will be free of error in generating real value added (measured in units of own output) if, and only if, intermediate inputs form a Cobb-Douglas aggregate in each sector. And even then, there are likely to be substitution effects in household expenditure patterns. It should be noted also that while the exogenous quantity flows that drive (7) are those which occurred at the prices which actually ruled (at one time or another), all inputs and outputs are valued at base year prices. Hence, changes in the barter terms of trade are not allowed to alter the levels of real incomes through the usual effects of changes in prices on nominal value added; they do so only through their effects on the output of tradables. The only alternative to making a foray into the difficult terrain of price endogenous systems is to take the position that these blemishes are the price to be paid in using a tractable system such as (7).

Second, with the two following exceptions, it was assumed that the structural parameters of equation (7) also remained stable in the face of all other influences. First, there were the changes in paddy production technology and the distribution of the sector's value added following the introduction of irrigation and new paddy varieties. Second, there have been changes in the region's population and in the pattern of seasonal migration associated with paddy cultivation.

Where the paddy sector is concerned, the estimates of the technology (A_5) and distribution (Ω_5) vectors are derived largely from a programming model which predicts inputs, output, land rents, and wages, given certain resource endowments and the prices of tradables. The important changes in technology between 1967 and 1974 were the substitution of

² It may happen that some sectors face completely inelastic, albeit positive, "foreign" demand. In that case, they are producing nontradables at the margin and are treated as such in the analysis, the vector of these foreign demands being E_N . It should be noted also that distributive and transport margins are earned on gross rather than net flows, so that the formulation in equation (7) is strictly correct only when there are no competitive imports for those sectors which export. In the empirical application pursued below, that is a defensible approximation to the observed trade patterns.

mechanical for animal draught power and the more intensive use of fertilizer on new, high-yielding varieties. There was also a marked increase in the proportion of value added paid as wages to migrant laborers from the non-project area and other regions, although the real wage rate rose only slightly. The distribution of value added among households underwent more radical changes, the most noteworthy being the fall in the share of nonproject farm households, which continued to cultivate a single crop, although they did benefit from additional wage earnings within the project area. The shares of output paid as wages to workers from landless and nonfarm households both increased somewhat, while that paid as rents (some of which accrued to renters among nonfarm households) stayed virtually constant. These shifts are presented in summary form in table 2.

As for population growth, this affects the demand system by altering the intercept terms, i.e., the $\{\gamma_{ik}\}$, though leaving the marginal expenditure proportions $\{\beta_{ik}\}$ unchanged.³ The only population data available are contained in the two censuses of 1957 and 1970. The quinquennial growth rates for these two subpopulations were 4.6% and 3.7%, respectively. These rates are assumed to hold for the period 1967-72, because only after 1971 did farm incomes begin to rise strongly in response to the arrival of irrigation; and expectations about alternative income levels, which

³ In period t , the expenditure of the k th class of household on the i th commodity is

$$C_{ik}(t) = \gamma_{ik} + \beta_{ik}C_k(t)$$

If the population grows by g_k percent and expenditure per family stays constant, then $C_{ik}(t)$ grows by g_k percent also. If, however, the population is stationary and expenditure per family grows by ϵ_k percent, then

$$C_{ik}(t+1)_{p.u.} = \gamma_{ik} + \beta_{ik}(1 + \epsilon_k)C_k(t)$$

Combining the two, we get

$$C_{ik}(t+1) = (1 + g_k)\gamma_{ik} + \beta_{ik}[(1 + g_k)(1 + \epsilon_k)]C_k(t) \\ = (1 + g_k)\gamma_{ik} + \beta_{ik}C_k(t+1)$$

figure heavily in the decision to migrate, are unlikely to have been revised sharply in the immediate aftermath. It seems plausible that the surge in real incomes between 1971 and 1974 should have done something to stem the outflow of permanent migrants from the region. But in the absence of any evidence, we were reduced to guessing that the farm and nonfarm populations were rising at 1% and 2% per annum, respectively, between 1972 and 1974.

Exogenous Variables for 1967

Recall that an attempt to construct a detailed picture of the economy as it was in the past need take account only of data availability when it comes to choosing between fixing export or output levels for each sector. The sectors comprising the agricultural complex (1-11) all produce tradable goods. With the exception of sector 10, it was possible to derive estimates of gross output. Fortunately, in the case of sector 10, there were relevant data for estimating exports in 1967. The only other sector producing tradables is (14), and once again data were available on its export components. In the remaining sectors, of course, net exports were set at zero, although it should be noted that the output levels of the four government sectors are known and given independently of demand.⁴ Deliveries to investment activities are made only by sectors 10, 14, 26, and 27. Again, the sources for the 1972 estimates provided the data for their 1967 counterparts. Of the remaining exogenous variables, net private transfers to households were set at their 1972 levels, these being very small and there being no other basis for a set of

⁴ To be exact, they are completely independent of household incomes, but slightly dependent on activity levels in other sectors through weak interindustry linkages. The allocations to households are given exogenously and the (small) supplies to satisfy interindustry demands are endogenously determined.

Table 2. Household Shares in Gross Output from the Paddy Sector (Ω_3)

Household Class	1967	1972	1974	1974 ^a
1 Landless	0.0179	0.0190	0.0207	0.0168
2 Labor abundant	0.1436	0.1442	0.1499	0.1451
3 Land abundant	0.4658	0.4675	0.4859	0.4705
4 Nonproject farm	0.1846	0.1188	0.1138	0.1710
5 Nonfarm	0.0475	0.0540	0.0590	0.0460
Total	0.8594	0.8035	0.8293	0.8494

^a In the absence of the project.

1967 estimates. Finally, "exogenous" taxes (T^*_k) on households were estimated in the same way as for the 1972 SAM. These taxes take the form of licenses, fees, and duties, and are levied independently of income levels.

fect, then, the output of this sector in 1974 was demand-driven. Net private transfers were kept at their 1972 levels, and exogenous taxes on households were estimated on the same basis as before.

Exogenous Variables for 1974

The relevant sectoral outputs, exports, and investment deliveries were estimated in similar fashion to those for 1967. It also should be noted, however, that the treatment of sawmilling for 1974 differed from that for 1967 in that net exports were set at their 1972 level. This choice reflects the fall in the volume of Malaysia's timber exports during the 1974 world recession and accords well with the views expressed by local businessmen. In ef-

The Results

These values of the exogenous variables generate the salient flows in the economy during 1967 and 1974 which are set out in tables 3 and 4, along with their counterparts from the 1972 SAM. Gross output rose by 55% over the seven-year period, the largest absolute contribution being made by the paddy sector, which accounted for about 21% of the total in 1974. Regional value added grew slightly faster than gross output, as output increased at

Table 3. Regional Gross Output and Value Added in 1967, 1972, and 1974 (\$10,000 in 1972 Prices)

Sector	1967 (1)	1972 (2)	1974 (3)	1974 ^a (4)	$\frac{(3)}{(1)} \cdot 100$	$\frac{(3)}{(4)} \cdot 100$
1-9 ^b	24,819 ^c	35,553 ^c	42,691 ^c	28,652 ^c	172.0	149.0
10 Other agriculture	1,375	1,782	2,295	1,972	166.9	116.4
11 Sawmilling	736	990	954	838	129.7	113.8
12 Agr. machinery services	124	257	311	135	250.8	230.4
13 Machinery repairs	472	595	662	460	140.4	143.9
14 Manufacturing not elsewhere classified	1,867	2,141	2,244	1,983	120.2	113.2
15 Road transport	1,196	1,634	1,993	1,513	166.7	131.7
16 Rail transport	64	104	137	89	214.8	153.9
17 Hotels & restaurants	989	1,435	1,823	1,497	184.3	121.8
18 Entertainment	300	468	599	468	199.7	128.0
19 Services not elsewhere classified	77	123	170	112	220.4	151.8
20 Private health	273	349	418	341	153.3	122.6
21 Distributive trades	2,864	4,038	4,835	3,541	168.8	136.5
22 Petty trading	245	326	408	303	166.6	134.7
23 Electricity	377	485	570	494	151.3	115.4
24 Water	186	246	299	249	160.2	120.1
25 Posts & telecommunications	125	229	377	241	253.3	131.5
26 Residential construction	1,066	1,834	1,853	1,317	173.8	140.7
27 Other construction	6,150	3,639	2,166	1,864	35.2	116.2
28-31 Government ^d	6,764 ^e	9,777 ^e	12,445 ^e	12,010 ^e	184.0	103.6
32 Trad. financial services	272	451	595	353	219.0	168.6
33 Modern financial services	171	233	289	157	169.1	184.1
34 Urban housing	1,297	1,825	2,243	1,846	176.7	121.5
35 Rural housing	2,053	2,640	3,186	2,467	155.2	129.1
Total	53,854	71,154	83,503	62,902	155.1	132.8
Total Value Added	30,507	41,889	50,575	38,827	165.8	130.3

Note: ^a Denotes output level fixed exogenously.

Source: The data source for 1972 is Bell et al.

^b In the absence of the project.

^c These are, respectively, commercial rice mills, small rice mills, food processing, fish processing, paddy production, fishing, estates rubber, smallholder rubber, rubber processing.

^d Irrigation, education, health, and other services, respectively.

Table 4. The Level and Distribution of Per Capita Household Incomes (in 1972 prices)

Household Class \ Income	1967		1967*		1974		1974*	
	Total	Paddy	Total	Paddy	Total	Paddy	Total	Paddy
1 Landless	131	75	130	75	242	166	140	73
2 Labor abundant	180	124	177	124	330	247	199	131
3 Land abundant	297	224	295	224	556	448	326	237
4 Nonproject farm	271	125	269	125	424	147	387	121
5 Nonfarm	697	17	631	17	1,034	40	904	17
All	412	111	387	111	660	204	521	115

* In the absence of the project.

a greater-than-average rate in large sectors which have a high ratio of value added to gross output, such as paddy, smallholder rubber, and government. At a more disaggregated level, gross output from the agricultural complex expanded by 70%, noteworthy details being a doubling of paddy production, big jumps in smallholder rubber output (8) and rubber processing (9), and the fact that small-scale rice mills expanded output much more rapidly than commercial ones. Elsewhere in the economy, there were broad gains in transport (15, 16), services and distributive trades (17-22), and utilities (23-25). Residential construction (26) boomed, but there was a steep decline in nonresidential construction (27) as work on the Muda irrigation project tailed off from its 1968 peak. Current outlays by government (28-31) increased substantially.

In aggregate, household incomes grew by just over 7.5% per annum between 1967 and 1974. This rapid rate also was accompanied by significant shifts in income distribution. The incomes of all households in the project area grew at about the same rate. A more rapid growth of incomes accruing to landless households from paddy production was offset by a proportionally larger gain in income from nonpaddy sources accruing to the two classes of "landed" households in the project area. Farm households outside the project boundary were less fortunate, being heavily dependent on a single crop of unirrigated paddy and wage employment in the project area. However, the sharp rise in rubber output from smallholdings kept their incomes growing at a fair rate. The incomes of nonfarm households grew at only two-thirds of the rate enjoyed by farm households in the project command area, but still accounted for 57% of aggregate household incomes in 1974.

Autonomous Growth and the Impact of the Project

Beginning with the accounting, denote the vector $[X, Y]$ by Z , and let Z^o stand for the vector of gross outputs and household incomes in the absence of the project. We have the identity

$$(8) \quad Z_{1974} - Z_{1974}^o \equiv (Z_{1974} - Z_{1967}^o) - (Z_{1974}^o - Z_{1967}^o).$$

The left-hand side is the net impact of the project in 1974. The first term on the right-hand side is the change in Z between 1967 and 1974 in the hypothetical event that there had been no project construction work in 1967; and the second term is the set of "autonomous" changes in the regional economy over the period, i.e., the changes that would have occurred had there been no project. Thus, to examine the sources of growth in a "causal" way, we must construct hypothetical pictures of the economy for both years.

1967 without the Project

It may seem that we have complicated the task unnecessarily by choosing a starting year in which project construction was already underway; but the defense is a simple one. The data set on which exogenous variables would be based is very sketchy for earlier years, and we think it better to rest our (minor) hypothetical modifications to 1967 on the relatively secure foundations of the estimated "actuals" than to estimate "actuals" for 1965 (say) on a far shakier data base. We arrived at our hypothetical picture of 1967 by making a change in one exogenous variable of the set generating Z_{1967} : investment deliveries by sector 27 were cut by \$40 million, the dif-

ference being the direct construction demands of the project in that year.

It is worth emphasizing the assumptions which implicitly accompany this change. First, the outputs of sector 1-9 in the agricultural complex are held fixed at their actual levels in 1967, which implies that they were unaffected by the demand for factors arising out of project construction work. This boils down, in essence, to assuming that labor was in perfectly elastic supply, an assumption made plausible by the heavy outmigration from the region between 1957 and 1970. Second, it is unlikely that current government outlays (28-31) would have changed from their 1967 levels. Third, in the cases of the remaining sectors, whose output is demand-driven, there is no problem of output capacity because a cut in exogenous demand will reduce output levels. Fourth, private transfers and lump sum taxes have been left alone. Estimates of the formers' 1967 "actual" values are already tenuous. License fees for vehicles and businesses might have been a little lower in the absence of project construction work, but it is difficult to gauge by how much. Last, a more subtle point: if there had been no construction work on the project, expectations about the future may well have been different, perhaps with important consequences for private investment. This, too, has been skipped over; the error, if any, would be in the direction of overstating regional activity levels and incomes in the hypothetical version of 1967 presented below.

1974 without the Project

The departures of the hypothetical exogenous variables from their actual values in that year are naturally more extensive. The most important of them is, of course, the level of paddy output. The small increase over the 1967 level is largely a reflection of improvements in yields of the main season crop, which would have occurred even if the project had not been undertaken. As for the sector's production technology, compared with 1967 there is no advance in mechanization but more intensive use of agrochemicals. The small declines in the shares in value added of households supplying labor to cultivating households are the result of a slight fall in the paddy wage measured in units of paddy, the nominal wage rate having risen more slowly than the price of

paddy but faster than that of the relevant consumption basket.

As the region supplied about 40% of Malaysia's rice needs in 1974, one might also ask whether the price of paddy would have risen even more strongly if the project had not been undertaken. However, the country's source of marginal supplies was imports, principally from Thailand and China, and it does not seem likely that the domestic price, which was close to the c.i.f. price of imports in 1974, would have risen further if there had been no Muda project.

In the agricultural complex, the gross output levels of the two rice-milling sectors have been left at their 1967 levels. As the output of paddy would have increased modestly in the absence of the project and there were small net imports of paddy into the region in 1967, this assumption seems sound. The gross output levels of sectors 3, 4, 6, 7, and 9 were set at their actual values in 1974, which amounts to assuming that, on balance, activity in these sectors was unaffected by the increased demand for domestic factors and goods generated by the project. In the case of smallholder rubber, however, some allowance was made for the fact that seasonal work in paddy production competes with rubber tapping. The level of net exports from sector 10 would have been somewhat lower in the absence of the project. For after 1970, the buffalo herd was being run down rapidly in the face of the advances in mechanization which accompanied the project, and this resulted in an increased supply of animals on the hoof for export. To reflect this, the sector's net exports were set \$0.6 million lower than their actual level in 1974. In keeping with the argument in the previous section, net export deliveries from sawmilling were left unchanged at their actual value in 1974. Both the exports of sector 14 and government outlays (29-31) were also left at their 1974 levels.

Turning to investment activities, an inspection of the time series of buffalo livestock between 1967 and 1973 led to a "guesstimate" of zero deliveries from sector 10 to investment activities in 1974 in the absence of the project. Deliveries from sector 14 and government investment in housing were taken as given, but private investment in urban housing was reduced by about 50% to reflect the likely reduction in the demand for urban housing services had the project not been undertaken. Investment in rural housing was derived from the

Table 5. The Composition of Changes in Per Capita Household Incomes Due to the Project (\$)

Source of Income Change	Household Class					Total
	1	2	3	4	5	
Paddy						
output effect	66	108	195	45	15	95
distributive effect	27	8	16	-19	8	-6
Other	9	15	17	13	107	50
Total	102	131	230	37	130	139

expenditures of single-cropping households in 1972. In the case of nonresidential construction, the tail end of Muda project work was cut out, together with a sizable chunk of the (modest) private demand for such output.

Following earlier practice, private transfers were left at their actual levels in 1974. Lump sum taxes were altered to reflect "guesstimates" of what the stock of vehicles and the number of businesses would have been in the absence of the project. These changes affected mainly nonfarm households, reducing their tax burden by almost \$4.5 million.

The only remaining issue is whether permanent outmigration from the region might have been higher if there had been no project. Although there is no direct evidence on which to base an answer, it seems plausible that the rapid rise in incomes between 1970 and 1974 has induced more people to stay in the region than otherwise would have been the case. In rough and ready fashion, it has been assumed that the farm population would have been stationary after 1972, whereas the nonfarm population would have grown at 0.5% per annum.

The Results

We begin with the net impact of the project at maturity, viz., $Z_{1974} - Z^0_{1974}$, laid out in tables 3 and 4. Regional gross output is about a third higher, fuelled largely by rises in paddy and rice-milling output. Taken as a whole, the agricultural complex accounted for about 70% of the project's net impact on aggregate gross output. For the "demand-driven" group, the heaviest absolute increases occur in sectors 15, 17, 21, 26, 27, 34, and 35. The gain in regional value added due to the project is about 30% of what total value added would have been in the absence of the project. As the absolute gain is \$117.5 million, of which \$67 million is due to the increase in paddy output, then for every dollar of value added generated directly by the project at maturity, another 75¢

was generated in the form of "downstream" or indirect effects. Within the project boundary, households enjoyed large income gains from the advent of irrigation; farm households on the region's periphery gained somewhat from additional seasonal work in paddy cultivation; and nonfarm households did rather well, especially out of the income-expenditure linkages of the system.

It is also of some interest to decompose the total change in income due to the project at maturity into that derived from paddy production and that from all other sources. And within the former, we distinguish between the pure output effect on incomes assuming that the actual 1974 distribution of value added held in the absence of the project and a distributive effect resulting from changes in the distribution vector Ω_5 , where the "distributive" effect is defined as follows: the incomes of household class k from sector j in the two situations are $\omega_{kj}X_j$ and $\omega^0_{kj}X^0_j$, respectively. The "output" effect is simply $\omega_{kj}[X_j - X^0_j]$, and the "distributive" effect, D_k , is a residual defined by: $D_k + \omega_{kj}[X_j - X^0_j] = \omega_{kj}X_j - \omega^0_{kj}X^0_j$, that is, the "output" and "distributive" effects sum exactly to the observed change in income. In aggregate, the "downstream" income increase was almost two-thirds the magnitude of the direct one, and it accrued overwhelmingly to nonfarm households. The nonzero distributive effect in aggregate arose from the fact that the actual 1974 paddy technology was more intensive in its use of intermediate inputs and migrant labor than its hypothetical counterpart, so that the sum of the income parameters $\{\omega_{k5}\}$ was smaller in the presence of the project.

To complete the picture, let us now look at the "autonomous" changes between 1967 and 1974, $(Z^0_{1974} - Z^0_{1967})$.⁵ In the absence of the

⁵ The gross output estimates for 1967 in the absence of the project are not reported in table 3. They differ only from their 1967 with project counterparts in that total gross output is 11% less at \$480.7 million, the bulk of the discrepancy being in sectors 13, 14, 15, 21, 26, and 34.

project, regional gross output would have increased by about 30%, and value added and household incomes by about 35%. The principal source of autonomous expansion was the increase in government outlays on both current and capital accounts, the former rising over 80% and the latter, which were far smaller, by about 50%. Excluding the agricultural complex, the output of the remaining sectors is demand-driven, so that a failure to undertake the project coupled with static government expenditures under other headings would have resulted in regional production and incomes growing at only half their actual pace over the period. Even so, the autonomous growth pattern would not have been an equitable one. As table 4 makes plain, the principal beneficiaries would have been non-farm households, whose incomes are well above the regional average. Similarly, the incomes of nonproject farm households would have been buoyed by rising rubber output; but the rises in the incomes of paddy farm households over their 1967 levels would have been of the order of 10%.

Balancing Investments

To complete this analysis of the project's impact on the region, it is necessary to form some estimate of the investment needed to realize the "downstream" effects. At one extreme it could be assumed that all sectors other than that producing paddy were suffering from excess capacity to such an extent that no additional investment was needed to complement the project itself. But this is hardly realistic in the light of the investments in buildings, housing, vehicles, and rice milling which accompanied the surge in incomes after 1970. Unfortunately, the available data provide only a sketchy investment series for the period in question, so the following estimates of investments related to "downstream" effects are inevitably somewhat tentative.

For present purposes, the relevant investment deliveries were made by sectors 14, 26, 27, and imports. An estimate of the investment needed to realize both "autonomous" and "downstream" increases in regional value added is obtained by omitting construction deliveries to the Muda project. Without discounting, this investment reached a cumulative total of \$240 million in 1972 prices. Leaving aside additional investments in the rice-milling sectors, which took the form mainly of

extra drying capacity to handle a second crop and did not exceed \$5 million (FAO/IBRD), it seems plausible that the composition of the investments needed to support "autonomous" growth and "downstream" effects would not be so very different. Now the "autonomous" increase in value added between 1967 and 1974 was \$110.4 million, while the "downstream" value added attributable to the project at maturity in 1974 was \$50.5 million. Apportioning the \$240 million additional investment in the same ratio as that for value added, we arrive at an estimate of \$75 million for the cumulative, undiscounted total investment associated with the steady state "downstream" increase in value added.

This estimate is, however, almost certainly on the high side; for much of residential and nonresidential construction was undertaken by the state or federal governments. Moreover, it is unlikely that extra investments were made much in advance of the appearance of the project's "downstream" effects in 1970. Fragmentary evidence suggests that annual private investment in housing and other buildings would have been about \$7 million lower in the absence of the project from 1970 onward. Cumulated over four years, this approach yields an estimate of "downstream"-related investments of \$38 million. Taking the two estimates together, it seems fairly probable that realizing each dollar of "downstream" value added associated with the project needed between \$0.75 and \$1.5 of complementary investment appropriately distributed over all other sectors.

Conclusions

It must be emphasized that the frailties of the data base, and the many assumptions thus entailed in deriving results, demand some caution in drawing conclusions from the empirical analysis. Nevertheless, the broad orders of magnitude of certain key variables should be sufficiently solid to warrant some confidence in our main findings. In aggregate, the Muda project's downstream effects were of the same order as its direct effects: for every additional dollar of value added in paddy production generated by the project at maturity, about 75¢ of value added were generated by downstream effects. Also, each dollar of downstream value added probably was supported by just over a dollar of additional investment in plant and

equipment spread appropriately over the sectors which expanded in response to the project. The direct effects of the project did not worsen the distribution of income among farm households, but its downstream added value accrued mainly to the nonfarm households engaged in paddy milling and the production of nontradables. Although the spread in nonfarm incomes was wide, the lion's share of downstream income went almost certainly to households which were better-off than those engaged in paddy farming. Thus while the project's downstream effects did much to boost the aggregate income of this relatively poor region, they worsened the intraregional distribution of income. Last, it is clear that, "new technology" notwithstanding, the project's production linkages were much weaker than its consumption linkages, for value added in paddy production accounted for more than 80% of gross output. Hence, even allowing for the expansion of paddy milling and agricultural machinery services, the doubling of paddy output injected into the system far more final demand from rising farm incomes than demand for intermediates (with final demand exogenously fixed). While there can be no claim that these findings are typical for all investment projects in LDCs, we believe that they provide a plausible first stab at the parameters for peasant agriculture, at least.

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