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INTERRELATIONAL INCOME DISTRIBUTION IN BRAZIL

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We extend Miyazawa and Masegi's original idea of disaggregated interrelational income multipliers with regard to three aspects. First, we examine the effect of system closure on the inter-income-group matrix. Second, we formally include inter-household transactions, or the informal economy, into Miyazawa's calculus. Third, we extend the interrelational multiplier to environmental factors. These extensions are applied to the Brazilian economy of 1995. Multiplier matrices excluding and including the informal economy are presented and interpreted, and the redistributive process of transfer payments is traced through consecutive spending rounds for various scenarios. Finally, these redistributive processes are enumerated in terms of transport fuel and electricity use. Our results indicate that, because of the distribution of ownership of productive capital, the income formation process is heavily skewed toward the highest incomes. Whether the existing process and potential redistributive policies alleviate environmental pressure depends on the factors as well as the population segment appraised.

I. INTRODUCTION

THE combination of inter-industry and income-distributional analysis was introduced by Miyazawa and Masegi (1963). The basic idea is to combine Leontief's industrial interdependencies with the Keynesian multiplier process, linking consumption and income. Miyazawa's innovation is a disaggregated formulation of the Keynesian multiplier—the *interrelational income multiplier*—in the form of matrix products, detailing consumption patterns, direct requirements coefficients, and income distribution.

Interrelational income multipliers can in principle be calculated from information contained in any Social Accounting Matrix (SAM). Following pioneering work done by Stone (1961), the treatment of distributional issues using only one matrix, the SAM, was first suggested in the mid-1970s (Paukert, Skolka, and Maton 1976; Weisskopf 1976).

Social Accounting Matrices have previously been constructed for Brazil by a

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number of authors.[1] The first study where private final consumption is endogenised is probably Bonelli and da Cunha's (1982) calculation of type-II multipliers and temporal decomposition of the 1970 and 1975 input-output tables. Da Fonseca and Guilhoto (1987) extend Miyazawa's formalism to a dynamic accelerator-type formulation, but they do not present an interrelational multiplier. Guilhoto, da Conceição, and Crocomo (1996) compare the macroeconomic impacts of exogenous final demand variations for 1975 and 1980, calculated using a Leontief and a Miyazawa framework featuring three income classes. Only Cavalcanti (1997, 2001) present a 2×2 interrelational income multiplier matrix, containing only "wage earners" and "capitalists." No Brazilian interrelational matrix has been documented to date for detailed income classes. In particular, interactions between income interrelations and resource use and environmental pressure have thus far not been investigated at all. These issues can be analyzed using a recently constructed, extended SAM for Brazil, combining environmental and social accounts (Lenzen and Schaeffer 2004).

This article is organised as follows. First, Miyazawa's theory of inter-industry analysis and the structure of income distribution is explained. Second, the sources and preparation of data are outlined for the Brazilian case. Third, a range of interrelational measures suggested by Miyazawa are calculated for the Brazilian case, and extended to include energy consumption. Finally, conclusions are drawn.

II. THE INTERRELATIONAL INCOME MULTIPLIER AS A MATRIX

Consider the National Accounting Identity $\boldsymbol{x}^* = \mathbf{A}^*\boldsymbol{x}^* + \boldsymbol{f}^*$, where $\mathbf{A}^*$ is a SAM in coefficient form, including industries, the capital account, and households, $\boldsymbol{x}^*$ is the total output of all agents, and $\boldsymbol{f}^*$ is the (non-household) exogenous final demand. Consider a partitioned formulation as follows:

$$\begin{bmatrix} \boldsymbol{x} \\ \boldsymbol{y} \end{bmatrix} = \begin{bmatrix} \mathbf{A} & \mathbf{C} \\ \mathbf{V} & \mathbf{E} \end{bmatrix} \begin{bmatrix} \boldsymbol{x} \\ \boldsymbol{y} \end{bmatrix} + \begin{bmatrix} \boldsymbol{f} \\ \boldsymbol{g} \end{bmatrix}, \tag{1}$$

where the upper row represents the balance of industries, the government and the capital account, and the lower row represents that of households. Our notation follows closely that of Miyazawa (1968, 1976) and Miyazawa and Masegi (1963): the $n \times 1$ vector $\boldsymbol{x}$ contains total industry and capital output in terms of n industry groups, $\mathbf{A}$ is a Leontief-type $n \times n$ inter-industry matrix of direct requirements coefficients, $\mathbf{C}$ is a $n \times r$ matrix of consumption coefficients for r household groups, and $\boldsymbol{f}$ is a $n \times 1$ vector of exogenous final demand. $\boldsymbol{y}$ ($r \times 1$) is a vector of total income, broken down into productive income ($\mathbf{V}$, $r \times n$ coefficients), inter-household transactions

[1] Bulmer-Thomas (1982), 10 industries, 1 household sector; da Fonseca and Guilhoto (1987), 27 industries, 3 income classes; Willumsen (1990), 34 industries, 5 social classes; de Andrade and Najberg (1997), 42 industries, 1 family sector; Cavalcanti (1997, 2001), 42 industries, 2 social classes.

(**E**, $r \times r$ coefficients) and income from exogenous sources ($\boldsymbol{g}$, $r \times 1$). Solving for $(\boldsymbol{x}\,|\,\boldsymbol{y})$ yields (compare Katz [1980], Miller [1980])

$$\begin{bmatrix} \boldsymbol{x} \\ \boldsymbol{y} \end{bmatrix} = \begin{bmatrix} \mathbf{I}-\mathbf{A} & -\mathbf{C} \\ -\mathbf{V} & \mathbf{I}-\mathbf{E} \end{bmatrix}^{-1} \begin{bmatrix} \boldsymbol{f} \\ \boldsymbol{g} \end{bmatrix} = \begin{bmatrix} \mathbf{B}(\mathbf{I}+\mathbf{CKVB}) & \mathbf{BCK} \\ \mathbf{KVB} & \mathbf{K} \end{bmatrix} \begin{bmatrix} \boldsymbol{f} \\ \boldsymbol{g} \end{bmatrix}, \tag{2}$$

where

$$\mathbf{B} = (\mathbf{I}-\mathbf{A})^{-1}, \text{ and } \mathbf{K} = (\mathbf{I}-\mathbf{E}-\mathbf{VBC})^{-1}. \tag{3}$$

These results are identical to Miyazawa's, except for **E**, which is set to zero in Miyazawa's calculus. **E** can be interpreted as the *informal economy*, that is transactions that are neither formalised (contracted, billed, etc.) nor appear in any statistics, for example because of their trivial nature or illegality. First, there exist many small-scale informal activities in the Brazilian society, such as maintaining and parking cars in city streets, repairing bicycles, selling refreshments on the beach, or selling prepared meals. Second, services such as medical consultations may remain unbilled and undeclared in order to both save client expenses, and to evade taxation (in which case the client will not declare the expense either). Third, financial assistance between related or acquainted families is commonplace. Finally, crime leads to a net flow from the rich to the poor.

B is the common type-I *Leontief inverse*, and the term **B** (**I** + **CKVB**) contains type-II industry multipliers. Miyazawa called the product **VBC** the *matrix of inter-income-group coefficients*, **KVB** the *multi-sector income multiplier*, and **K** the *interrelational multiplier of income groups*. Each element of **VBC** shows a direct increase in the income of one group as a result of the consumptive spending of the income of another group. The elements of **K** show the respective total (direct, indirect, and induced) income effects.

Miyazawa illustrates the output and income formation process initiated by an exogenous consumptive stimulus $\boldsymbol{f}$ by expanding **K** into its Taylor series (ignoring **E**):

$$\begin{aligned} \boldsymbol{x} = \mathbf{B}(\mathbf{I}+\mathbf{CKVB})\boldsymbol{f} = \mathbf{B}\boldsymbol{f} + \mathbf{BC}[\mathbf{I} + \mathbf{VBC} + (\mathbf{VBC})^2 \\ + (\mathbf{VBC})^3 + \ldots]\mathbf{VB}\boldsymbol{f} \end{aligned} \tag{4a}$$

$$= [\mathbf{I} + \mathbf{BCV} + (\mathbf{BCV})^2 + (\mathbf{BCV})^3 + \ldots]\mathbf{B}\boldsymbol{f} \tag{4b}$$

$$= \mathbf{B}[\mathbf{I} + \mathbf{CVB} + (\mathbf{CVB})^2 + (\mathbf{CVB})^3 + \ldots]\boldsymbol{f} \tag{4c}$$

and

$$\boldsymbol{y} = \mathbf{KVB}\boldsymbol{f} = [\mathbf{I} + \mathbf{VBC} + (\mathbf{VBC})^2 + (\mathbf{VBC})^3 + \ldots]\mathbf{VB}\boldsymbol{f} \tag{5a}$$

$$= \mathbf{V}[\mathbf{I} + \mathbf{BCV} + (\mathbf{BCV})^2 + (\mathbf{BCV})^3 + \ldots]\mathbf{B}\boldsymbol{f} \tag{5b}$$

$$= \mathbf{VB}[\mathbf{I} + \mathbf{CVB} + (\mathbf{CVB})^2 + (\mathbf{CVB})^3 + \ldots]\boldsymbol{f}. \tag{5c}$$

In the expanded formulation, output and income formation is described as a propagation of successive step-like processes, proceeding via income-forming loops (**VBC**, equations [4a] and [5a]), production-instigating loops (**BCV**, equations [4b] and [5b]), and consumption-stimulating loops (**CVB**, equations [4c] and [5c]). These simple relations do not hold once the informal economy **E** is considered, since

$$\mathbf{K} = \mathbf{I} + \mathbf{E} + \mathbf{VBC} + \mathbf{E}^2 + 2\mathbf{EVBC} + (\mathbf{VBC})^2 + \ldots, \tag{6}$$

which reflects two parallel income formation cycles (the formal **VBC**, $(\mathbf{VBC})^2$ etc., and the informal **E**, $\mathbf{E}^2$, etc.) and their interaction (2**EVBC** etc.).

Setting $n = r = 1$, and treating the government and capital account as exogenous, **C** reduces to the Keynesian macro-propensity to consume c. Ignoring **E**, **K** becomes the Keynesian multiplier $1/(1-c)$. Therefore, in the Keynesian model of income formation, a given amount of final consumption always generates the same amount of income, independent of the share of commodities.

While Miyazawa distinguishes the r income groups by regional location (Miyazawa 1968, 1976), the traditional emphasis held before his work was on income classes: Ghosh and Sengupta (1984) provide an instructive comparison of type-II income multipliers, as initially perceived by Keynes, and then further developed by Kalecki, Kaldor, and Pasinetti in order to detail social classes. Today, class information is a key feature of SAMs, which simultaneously incorporate the role of the level and structure of production in shaping the income distribution, and the role of income distribution in shaping expenditure patterns (Gregory and Sinha 1984).

III. DATA SOURCES AND PREPARATION

The elements of the partitioned $\mathbf{A}^*$ matrix in equation (1) were taken from a SAM constructed for Brazil, which is documented in detail in a previous publication (Lenzen and Schaeffer 2004). The main sources are, therefore, only outlined in the following. All coefficients are constant, average coefficients describing linear relationship between all categories. They represent a static "snapshot" of the Brazilian economy and society in 1995.

A contains:

1. A $n \times n = 46 \times 46$ domestic direct requirements matrix, with elements describing the intermediate current input of domestic industry i into domestic industry j, per unit of total domestically produced output x_j of industry j. Transactions valued in basic prices appear separated from margins;
2. An additional row and column containing import and export shares of industries;
3. An additional row and column describing variations in stock, and the share of domestically produced and imported capital consumed and produced by industries.

These elements were derived from the Brazilian input-output tables compiled by the Instituto Brasileiro de Geografia e Estatística (1997). Items 2 and 3 are optional and can be excluded to reduce the degree of closure of the input-output system. In the context of equation (1), this means moving exports and capital production (columns) from **A** to ***f***, and removing imports and capital investment (rows) from **A**, thus reducing internal feedbacks and increasing leakage.

C contains:

4. A $n \times r = 46 \times 10$ matrix of consumption coefficients for domestically produced commodities produced by the 46 industries, and consumed by households in 10 income classes;
5. An additional row for commodities imported directly by households;
6. An additional row describing the capital investment of households.

Items 4 and 5 were obtained by prorating each entry of a column vector of private final consumption as specified in the input-output tables (Instituto Brasileiro de Geografia e Estatística 1997) across all income classes using shares derived from the Brazilian household expenditure survey (Instituto Brasileiro de Geografia e Estatística 1999). Note that the household expenditure survey covers only urban households in 11 capital cities (see income and household profile in Table I, covering 11.6 million households and 42.4 million people). In using this information we assume that rural and urban households of the same income class consume commodities in equal proportions. Item 6 was taken from a SAM compiled by de Andrade and Najberg (1997), but was prorated in the same way. Note that items 4–6 do not contain income tax, since the government is treated as exogenous. Once again, items 5 and 6 are optional.

TABLE I

AVERAGE VALUES OF TOTAL EXPENDITURE, DECLARED INCOME, SAMPLE SIZE, AND FAMILY SIZE FOR VARIOUS INCOME CLASSES IN MAJOR BRAZILIAN CITIES IN 1996

Income class[a]	< 2	2–3	3–5	5–6	6–8	8–10	10–15	15–20	20–30	> 30
Expenditure (R$/month)	232	365	485	630	788	936	1,254	1,766	2,351	4,923
Income (R$/month)	147	282	445	617	785	1,016	1,378	1,975	2,763	6,611
No. of households (million)	1.2	1.0	1.8	0.8	1.3	0.9	1.5	0.9	0.9	1.3
Family size	3.0	3.4	3.7	3.7	3.8	3.9	3.9	3.9	3.8	3.7
No. of people (million)	3.6	3.5	6.8	3.1	4.8	3.5	5.9	3.4	3.2	4.7
% of population	8.6	8.2	15.9	7.2	11.4	8.3	14.0	8.0	7.6	11.0
Gini index of the metropolitan income distribution						0.539				

Source: Instituto Brasileiro de Geografia e Estatística (1999).
Note: R$1 = U.S.$1 in 1995.
[a] Income classes are expressed in multiples of the minimum salary (R$112).

TABLE II

AVERAGE VALUES OF TOTAL INCOME AND SIZE FOR VARIOUS INCOME CLASSES IN 1996, EXTRAPOLATED FOR THE WHOLE OF BRAZIL BY TAKING INTO ACCOUNT RURAL HOUSEHOLDS AND ADDITIONAL CAPITAL INCOME

Income class[a]	< 2	2–3	3–5	5–6	6–8	8–10	10–15	15–20	20–30	> 30
Income (R$/month)	264	456	695	952	1,184	1,504	2,079	3,085	4,104	10,552
No. of households (million)	23.7	5.0	6.0	1.6	2.5	1.8	1.6	1.1	0.9	1.3
Family size	3.9	3.7	3.7	3.6	3.6	3.6	3.5	3.5	3.4	3.6
No. of people (million)	91.7	18.4	22.3	5.8	9.0	6.3	5.6	3.8	2.9	4.5
% of population	53.8	10.8	13.1	3.4	5.3	3.7	3.3	2.2	1.7	2.7
Gini index of the national income distribution					0.606					

[a] Income classes are expressed in multiples of the minimum salary (R$112).

V represents:

7. The income of households in all 10 income classes from the production of 46 industries. These include remuneration of employed and self-employed persons (salaries, autonomous income, employer's contributions), and gross operational surplus.[2] As with **C**, **V** was mostly obtained by prorating value added quantified in the input-output tables (Instituto Brasileiro de Geografia e Estatística 1997) across income classes using information collected in the household expenditure survey (Instituto Brasileiro de Geografia e Estatística 1999). Fortunately, the latter database details a range of income sources (salaries, employers' remuneration, own-account income, pensions, scholarships, rent, transfer, and capital income), which could readily be reconciled with the input-output tables. An exception was made for the "ownership of dwellings" sector, the incomes of which were prorated across income classes solely according to rent income. Since the household expenditure survey only covers urban households, salaries in the agriculture, mining, timber, and rubber industries were prorated according to the rural income distribution derived from the 2000 census of population and housing (Instituto Brasileiro de Geografia e Estatística 2000). The resulting overall national income and household profile (45.4 million households and 170.6 million people) is shown in Table II. Note that the shares of the income segments differ markedly from the urban distribution in Table I: lower income classes dominate in rural Brazil. As a consequence, the Gini index of the national distribution is considerably higher (≈ 0.606) than that of the urban distribution (≈ 0.54). This finding is in agreement with na-

[2] Income from these sources is equivalent to primary inputs into production, or to value added.

tional figures documented by Azzoni (1997; $\text{Gini}_{1991} \approx 0.64$), Székely (2001; $\text{Gini}_{1995} \approx 0.591$), and the Instituto Brasileiro de Geografia e Estatística (2000; $\text{Gini}_{2000} = 0.636$).

8. Two (optional) columns, one of zero entries representing exports by households, and one of capital income across income classes using a total figure calculated by de Andrade and Najberg (1997), prorated according to household expenditure survey information.

Due to the inclusion of rural households and additional surplus and capital income, the monthly incomes are higher than the classes' nominal incomes, and hence the national income distribution in Table II does not conform with the initial class labels used in Table I, which refer only to average salary income. Nevertheless, these labels will be kept in the following, simply for the sake of retaining a class notation. The main constituents of the national income are salaries (Gini ≈ 0.57), operational surplus (≈ 0.67), transfer payments (≈ 0.43), and capital income (≈ 0.90). Note in Table I that households in low-income classes spend more than they earn, and vice versa in higher income classes.[3] These discrepancies give rise to an adjustment in the form of a matrix **E** covering the balance of net transfers from spending households (in columns) to receiving households (in rows).[4] **E** can be regarded as a approximation of the informal economy. While the discrepancies of income and expenditure in each class provide ten figures of overall net transfers, gross transfers can in principle affect all income classes, meaning that in principle each class could give to and receive from every other class. This leaves, in principle, 100 elements to be specified in the **E** matrix. This system has no unique solution, so that additional assumptions have to be made about the nature of inter-household transfers. It is likely that flows only occur from rich to poor households, thus suggesting a form (example for five classes):

$$\mathbf{E} = \begin{bmatrix} 0 & \times & \times & \times & \times \\ 0 & 0 & \times & \times & \times \\ 0 & 0 & 0 & \times & \times \\ 0 & 0 & 0 & 0 & \times \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad \text{or} \quad \mathbf{E} = \begin{bmatrix} 0 & \times & \times & 0 & 0 \\ 0 & 0 & \times & \times & 0 \\ 0 & 0 & 0 & \times & \times \\ 0 & 0 & 0 & 0 & \times \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}, \tag{7}$$

depending on whether transfers occur all the way down to the lowest class, or only with the next two lower classes (in this example). The choice of **E** as in equation (7) strongly influences the magnitude of overall gross transfers, since a number of households both receive and spend. The approach taken in this work is to estimate a lower bound for informal transactions, and therefore assumes a minimum cash flow, which is equivalent to assuming that the overall net flow equals gross flow. In other words,

[3] The proportions change slightly when capital and surplus income and capital expenditure are added.

[4] Compare Sinha, Siddiqui, and Sangeeta (2000, Tab. III.1) who extract data on informal economic activities from household surveys and arrange them in a SAM for India.

TABLE III

INFORMAL INTER-HOUSEHOLD TRANSACTIONS

(R$ million)

Income class	< 2	2–3	3–5	5–6	6–8	8–10	10–15	15–20	20–30	> 30	% of total
< 2	0	0	0	0	62	2,476	1,823	2,441	1,974	4,894	18.2
2–3	0	0	0	0	16	622	458	613	496	1,230	12.7
3–5	0	0	0	0	3	139	102	137	111	274	1.5
5–6	0	0	0	0	4	141	104	139	112	279	4.2
6–8	0	0	0	0	0	0	0	0	0	0	
8–10	0	0	0	0	0	0	0	0	0	0	
10–15	0	0	0	0	0	0	0	0	0	0	
15–20	0	0	0	0	0	0	0	0	0	0	
20–30	0	0	0	0	0	0	0	0	0	0	
> 30	0	0	0	0	0	0	0	0	0	0	
% of total					0.2	18.4	7.0	10.5	6.8	16.6	

households that spend in net terms, only spend, and households that receive in net terms, only receive. Under this assumption, **E** takes the form:

$$\mathbf{E} = \begin{bmatrix} 0 & 0 & \times & \times & \times \\ 0 & 0 & \times & \times & \times \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}. \tag{8}$$

After adjustment for capital income, six spending and four receiving classes remained, leaving twenty-four informal transactions to be estimated. This systems is still not solvable based on ten row and column totals, so that a RAS balancing procedure was applied. The matrix of informal transactions coefficients derived in this way is shown in Table III. **E** is calculated from this matrix by dividing each column by total household income.

The choice of disaggregation of the consumption and income data described above was purely determined by the availability of data. Therefore, for example, our SAM contains current annual savings by income class, but not ownership of assets.[5] Factors such as education and land ownership, which strongly influence income distribution, do not feature in our analysis. Also not covered, but equally important for

[5] Pyatt et al. (1977, p. 48) and Bulmer-Thomas (1982, p. 5) remark that a SAM which is defined purely in flow, but not in stock terms, does not reflect the fact that the distribution of wealth underlies the flow of profits and savings. Using such a SAM, an analysis of, for example, a policy aiming at forcing the diversion of some savings towards a social fund would not be fully comprehensive, because the location and magnitude of assets, from which these additional savings would be diverted, is unknown.

real-world policy analysis are, for example, the availability and mobility of skilled labor, the distribution across occupations, and the regional concentration of industry sectors. Like many other models, a SAM-based analysis is only as comprehensive as the underlying data set.

IV. A MIYAZAWA ANALYSIS OF THE BRAZILIAN ECONOMY

Based on the data sources described in the previous section, an investigation into inter-household relations of income distribution and formation was undertaken for the Brazilian economy of 1995. In the following, a few of the multiplier measures introduced in Section II are quantified.

A. *Inter-income-group Matrices*

The simplest interrelational measure is the matrix **VBC** of inter-income-group coefficients, which is given in Tables IV–VI for inter-industry systems of increasing closure. Each element $(\mathbf{VBC})_{ij}$ represents the direct increase of income for income class i as a consequence of additional income spent by income class j, via one formal income formation loop. In Table IV, **B** contains only industrial interactions. **B** as in Table V is augmented by capital flows, which are thus seen to facilitate industrial production in the longer run, and, therefore, are treated endogenously as inter-industry flows. In Table VI, capital flows and foreign industries participate in the endogenous production process. The systems represented in Tables V and VI thus incorporate additional feedbacks via capital investment and trade, which do not feature in the purely domestic, current inter-industry system in Table IV, where they act as leakages.

As a result of the consecutive closure, coefficients monotonically increase. Capi-

TABLE IV

MATRIX **VBC** OF INTER-INCOME-GROUP COEFFICIENTS, WITH **B** INCLUDING ONLY INTER-INDUSTRY COEFFICIENTS

Income class	< 2	2–3	3–5	5–6	6–8	8–10	10–15	15–20	20–30	> 30
< 2	0.083	0.079	0.074	0.066	0.069	0.063	0.060	0.056	0.055	0.042
2–3	0.026	0.024	0.023	0.021	0.022	0.021	0.020	0.019	0.019	0.015
3–5	0.052	0.048	0.046	0.042	0.045	0.042	0.040	0.039	0.038	0.030
5–6	0.019	0.018	0.017	0.016	0.017	0.015	0.015	0.014	0.014	0.011
6–8	0.036	0.034	0.033	0.030	0.032	0.030	0.029	0.028	0.028	0.022
8–10	0.033	0.031	0.030	0.027	0.029	0.027	0.026	0.026	0.025	0.020
10–15	0.039	0.036	0.035	0.032	0.034	0.032	0.031	0.030	0.030	0.024
15–20	0.041	0.038	0.037	0.034	0.036	0.033	0.032	0.032	0.031	0.025
20–30	0.041	0.039	0.037	0.034	0.036	0.034	0.033	0.033	0.032	0.027
> 30	0.167	0.153	0.150	0.140	0.148	0.139	0.137	0.139	0.135	0.127

TABLE V

MATRIX **VBC** OF INTER-INCOME-GROUP COEFFICIENTS, WITH **B** INCLUDING INTER-INDUSTRY AND CAPITAL COEFFICIENTS

Income class	< 2	2–3	3–5	5–6	6–8	8–10	10–15	15–20	20–30	> 30
< 2	0.110	0.109	0.106	0.101	0.101	0.091	0.090	0.085	0.081	0.062
2–3	0.036	0.035	0.035	0.034	0.034	0.031	0.031	0.030	0.028	0.022
3–5	0.072	0.071	0.070	0.069	0.069	0.062	0.063	0.061	0.058	0.045
5–6	0.027	0.027	0.026	0.026	0.026	0.023	0.023	0.023	0.021	0.016
6–8	0.051	0.051	0.050	0.050	0.050	0.045	0.045	0.044	0.042	0.033
8–10	0.047	0.046	0.046	0.045	0.046	0.041	0.042	0.040	0.038	0.031
10–15	0.055	0.054	0.054	0.053	0.054	0.049	0.049	0.048	0.045	0.037
15–20	0.058	0.058	0.058	0.057	0.057	0.052	0.052	0.051	0.048	0.039
20–30	0.061	0.060	0.060	0.060	0.060	0.054	0.055	0.054	0.051	0.042
> 30	0.249	0.247	0.249	0.251	0.250	0.225	0.231	0.230	0.217	0.189

TABLE VI

MATRIX **VBC** OF INTER-INCOME-GROUP COEFFICIENTS, WITH **B** INCLUDING INTER-INDUSTRY, CAPITAL, AND TRADE COEFFICIENTS

Income class	< 2	2–3	3–5	5–6	6–8	8–10	10–15	15–20	20–30	> 30
< 2	0.127	0.126	0.123	0.118	0.118	0.106	0.105	0.100	0.095	0.073
2–3	0.041	0.041	0.040	0.040	0.040	0.036	0.036	0.035	0.033	0.026
3–5	0.083	0.082	0.081	0.080	0.080	0.072	0.073	0.070	0.067	0.052
5–6	0.031	0.031	0.030	0.030	0.030	0.027	0.027	0.026	0.025	0.019
6–8	0.059	0.058	0.058	0.057	0.058	0.052	0.053	0.051	0.048	0.038
8–10	0.054	0.053	0.053	0.053	0.053	0.048	0.048	0.047	0.044	0.035
10–15	0.063	0.063	0.062	0.062	0.062	0.056	0.057	0.055	0.052	0.042
15–20	0.067	0.067	0.067	0.066	0.066	0.060	0.060	0.058	0.055	0.044
20–30	0.070	0.070	0.069	0.070	0.069	0.063	0.064	0.062	0.059	0.048
> 30	0.285	0.284	0.286	0.289	0.287	0.258	0.265	0.262	0.248	0.213

tal investment and trade have approximately a 30 percent and 10 percent effect on coefficients, respectively. Notwithstanding their different magnitudes, all inter-income-group matrices show a similar structure: one R$ earned and spent by higher-income classes does not generate as much additional income in the next round as the same amount earned and spent by a lower-income class. This result becomes obvious considering that higher incomes attract higher tax rates. Since the receiving body—the government—is still exogenous to the system, these tax expenditures leak from the system. The second finding is that higher-income classes benefit dispropotionately more from income earned and spent by all classes than do lower-income classes. This holds independent of the class in which the expenditure occurred.[6] This highly skewed distribution is a result of the concentration of surplus income, which is in turn a consequence of the distribution of ownership of the productive capital.

As already found by Willumsen (1990) and Cavalcanti (2001) using aggregated 1975 and 1995 Brazilian SAMs respectively, income generated by operational surplus (capital income) is always larger than salary (labour) income. This finding holds both for traditional and "modern" industries (see Lenzen and Schaeffer 2004). As Baer, da Fonseca, and Guilhoto (1987) demonstrate, the share of salaries in value added has decreased markedly between 1959 and 1980 in most sectors. The fact that agriculture yields even higher capital income than "modern" industries is due to significant land rents (Willumsen 1990). Our results show that the main production-related income, that is operational surplus, is generated predominantly by the poor, but earned predominantly by the rich.

B. *Interrelational Multiplier*

The matrix **VBC** reflects just one income-consumption-production-income cycle. The cumulative fate of an exogenous income injection through an infinite number of such cycles is described by Miyazawa's interrelational income multiplier **K**. This multiplier is given in Table VII for the inter-income-group matrix in Table VI (including capital and trade flows). Each element K_{ij} now represents the *total* increase of income for income class j as a consequence of additional income spent by income class i, via an infinite number of formal income formation loops. The diagonal elements contain the initial exogenous income injection, and are therefore all larger than 1. Basically, the general disparity between poor and rich households that is already evident in Tables IV–VI persists throughout consecutive cycles, however total coefficients are about four times larger in Table VII.

Note that neither in the inter-income-group matrices in Table IV–VI nor in the interrelational income multiplier in Table VII, do coefficients relating to income spent by a particular class (within columns) increase monotonically across receiving classes. Since all coefficients refer to a whole income class, this is due to these classes varying in physical size, as shown in Table II. The effect of class size can be removed by dividing row-wise by the number of households contained in the respective receiving class (compare Rose and Beaumont 1988, 1989). The result of this normalization is shown in Table VIII, where all coefficients now represent income received *per household*. Two additional manipulations have been carried out: first, in order to generate tangible numbers, each figure was multiplied by 10^6 after dividing by household numbers, so that reference is made not to an exogenous (class-wide) injection of R$1, but of R$1 million. Second, the effect of the initial

[6] Gini coefficients for different columns in **VBC** vary only slightly between 0.626 (< 2) and 0.663 (> 30).

TABLE VII

INTERRELATIONAL INCOME MULTIPLIER $\mathbf{K} = [\mathbf{I} - \mathbf{VBC}]^{-1}$, WITH **B** INCLUDING INTER-INDUSTRY, CAPITAL, AND TRADE COEFFICIENTS

Income class	< 2	2–3	3–5	5–6	6–8	8–10	10–15	15–20	20–30	> 30
< 2	1.473	0.470	0.464	0.457	0.457	0.410	0.414	0.398	0.379	0.302
2–3	0.158	1.157	0.156	0.154	0.154	0.139	0.140	0.136	0.129	0.103
3–5	0.320	0.317	1.315	0.312	0.312	0.281	0.284	0.274	0.261	0.209
5–6	0.119	0.118	0.117	1.116	0.116	0.105	0.106	0.102	0.097	0.077
6–8	0.230	0.229	0.227	0.225	1.225	0.203	0.205	0.199	0.189	0.152
8–10	0.211	0.209	0.208	0.206	0.206	1.186	0.188	0.182	0.173	0.139
10–15	0.248	0.246	0.245	0.243	0.243	0.219	1.222	0.215	0.204	0.164
15–20	0.264	0.262	0.261	0.259	0.258	0.233	0.236	1.228	0.217	0.175
20–30	0.278	0.276	0.274	0.273	0.272	0.245	0.249	0.241	1.229	0.185
> 30	1.163	1.155	1.151	1.148	1.145	1.031	1.047	1.019	0.968	1.795

TABLE VIII

INTERRELATIONAL INCOME MULTIPLIER $\mathbf{K} = [\mathbf{I} - \mathbf{VBC}]^{-1}$, WITH **B** INCLUDING INTER-INDUSTRY, CAPITAL, AND TRADE COEFFICIENTS, EXPRESSED IN *ADDITIONAL* INCOME IN R$ PER HOUSEHOLD FROM AN EXOGENOUS INJECTION OF R$1 MILLION INTO EACH CLASS

Income class	< 2	2–3	3–5	5–6	6–8	8–10	10–15	15–20	20–30	> 30
< 2	0.020	0.020	0.020	0.019	0.019	0.017	0.017	0.017	0.016	0.013
2–3	0.032	0.032	0.031	0.031	0.031	0.028	0.028	0.027	0.026	0.021
3–5	0.053	0.052	0.052	0.052	0.052	0.046	0.047	0.045	0.043	0.035
5–6	0.074	0.074	0.073	0.072	0.072	0.065	0.066	0.064	0.060	0.048
6–8	0.092	0.091	0.091	0.090	0.090	0.081	0.082	0.079	0.075	0.061
8–10	0.119	0.119	0.118	0.117	0.117	0.105	0.107	0.103	0.098	0.079
10–15	0.157	0.156	0.155	0.154	0.154	0.139	0.140	0.136	0.129	0.104
15–20	0.244	0.242	0.240	0.238	0.238	0.214	0.217	0.210	0.200	0.161
20–30	0.325	0.323	0.321	0.319	0.319	0.287	0.291	0.282	0.268	0.217
> 30	0.914	0.907	0.905	0.902	0.899	0.810	0.823	0.801	0.760	0.624

injection has been removed (diagonal elements), so that coefficients show *additional* income (compare Rose and Beaumont 1988, 1989).

Coefficients now increase monotonically within columns, demonstrating that each income class benefits less from the income formation process than the next higher class. As with previous matrices, variations across rows are smaller than variations across columns, thus once again illustrating that money spent homogeneously will predominantly reach rich households. So far, all results were presented for the formal income formation process. The effect of the informal economy characterised by matrix **E** is shown in Table IX. A preliminary comparison of coefficients shows

TABLE IX

INTERRELATIONAL INCOME MULTIPLIER $\mathbf{K} = [\mathbf{I} - \mathbf{E} - \mathbf{VBC}]^{-1}$, WITH **B** INCLUDING INTER-INDUSTRY, CAPITAL, AND TRADE COEFFICIENTS, EXPRESSED IN *ADDITIONAL* INCOME IN R$ PER HOUSEHOLD FROM AN EXOGENOUS INJECTION OF R$1 MILLION INTO EACH CLASS

Income class	< 2	2–3	3–5	5–6	6–8	8–10	10–15	15–20	20–30	> 30
< 2	0.027	0.027	0.027	0.027	0.027	0.030	0.028	0.028	0.026	0.020
2–3	0.042	0.042	0.041	0.041	0.041	0.045	0.042	0.043	0.039	0.031
3–5	0.062	0.061	0.061	0.060	0.060	0.061	0.059	0.059	0.055	0.043
5–6	0.089	0.088	0.087	0.086	0.087	0.090	0.086	0.086	0.080	0.063
6–8	0.105	0.104	0.104	0.103	0.103	0.104	0.100	0.100	0.093	0.074
8–10	0.137	0.136	0.135	0.134	0.134	0.135	0.131	0.129	0.121	0.096
10–15	0.180	0.179	0.177	0.176	0.176	0.178	0.172	0.171	0.159	0.127
15–20	0.279	0.277	0.275	0.273	0.273	0.275	0.266	0.264	0.247	0.196
20–30	0.372	0.370	0.368	0.365	0.366	0.368	0.357	0.354	0.331	0.264
> 30	1.046	1.038	1.035	1.031	1.031	1.037	1.007	1.002	0.936	0.756

an increase between 15 percent and 50 percent over those in Table VIII, which is due to the existence of a parallel (informal) cycle. However, a closer examination reveals that the increase of multipliers is higher for lower-income classes, and especially for receipts from higher-income households. This is not surprising, since it reflects the structure of the informal economy as assumed and justified in Section III. Distributive issues are difficult to conclude from numbers, so the effect of the informal cycle is illustrated further in the following.

Employing the series expansion of the lower row of equation (1),

$$\boldsymbol{y} = \mathbf{K}\boldsymbol{g} = [\mathbf{I} + \mathbf{VBC} + (\mathbf{VBC})^2 + \dots]\boldsymbol{g}, \tag{9}$$

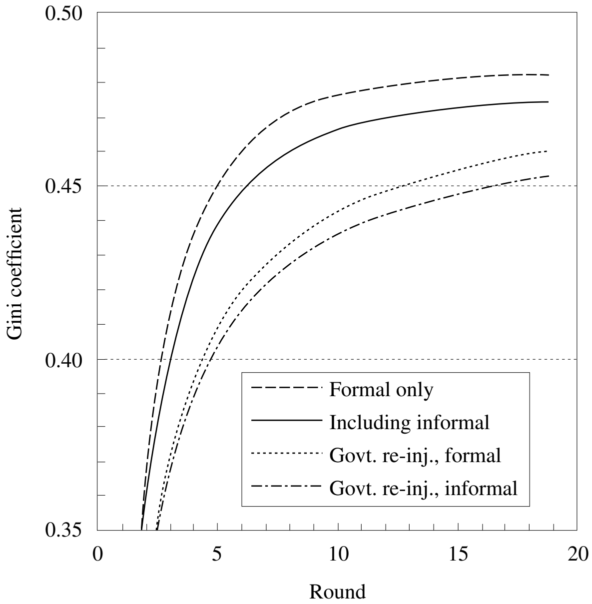
changes in the Gini index of cumulative incomes [$\mathbf{I}\boldsymbol{g}$, $(\mathbf{I} + \mathbf{VBC})\boldsymbol{g}$, etc. in equation (9)] can be traced throughout spending rounds[7] for an initial, perfectly equitable exogenous income injection of g_i = R$1 per capita (or R$170 million for the whole

[7] The notion of spending rounds used here for **VBC** cycles does not necessarily imply a temporal succession. There exists no uniform time lag between two complete **VBC** cycles, because inter-industry transactions A_{ij} contained in the Leontief inverse $\mathbf{B} = \mathbf{I} + \mathbf{A} + \mathbf{A}^2 + \dots$ are themselves lagged over a range of periods. For example, assuming that each inter-industry, earning and consumptive transaction takes a constant period of time, the expansion of the interrelational multiplier **K** can be sorted into simultaneous processes as follows:

$$\begin{aligned}\mathbf{K} &= \mathbf{I} + \mathbf{VBC} + (\mathbf{VBC})^2 + \dots \\ &= \mathbf{I} + \mathbf{VC} + \mathbf{VAC} + \mathbf{VA}^2\mathbf{C} + \mathbf{VA}^3\mathbf{C} + \mathbf{VA}^4\mathbf{C} + \dots \\ &\quad + \mathbf{VCVC} + \mathbf{VCVAC} + \mathbf{VACVC} + \mathbf{VACVAC} + \mathbf{VA}^2\mathbf{CVC} + \mathbf{VCVA}^2\mathbf{C} + \dots \\ &\quad + \mathbf{VCVCVC} + \dots,\end{aligned}$$

where **I** represents the initial exogenous injection, **VC** the immediate income effect of the production of commodities that are demanded from that injection (1 step), **VAC** the income arising out of the production of supplies to industries producing these demanded commodities (2 steps), $\mathbf{VA}^2\mathbf{C}$ from the suppliers of suppliers (3 steps), **VCVC** from the re-spending of **VC** (3 steps), and so on.

Fig. 1. Change of the Gini Index of Cumulative Incomes over Spending-Production-Earning (**VBC**) Cycles, Resulting from an Initial, Perfectly Equitable Exogenous Injection of R$1/Capita by the Government.

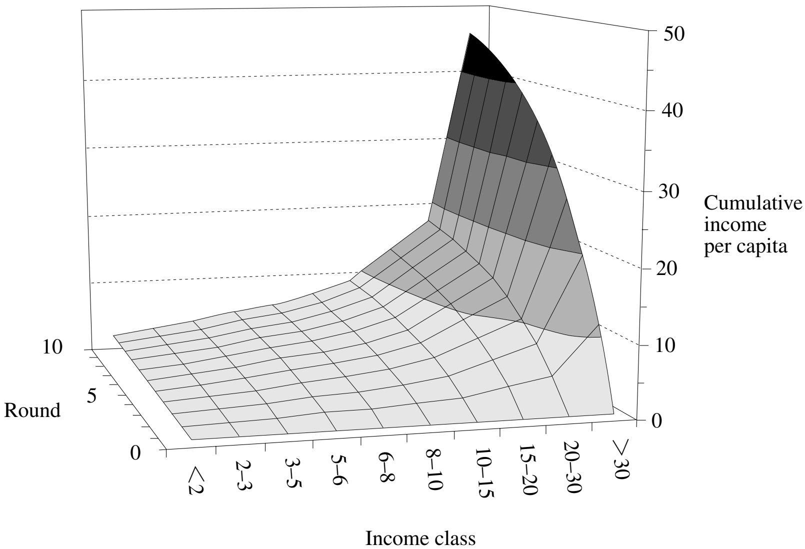


Note: All curves originate from point (0,0).

population) by the government.[8] These cumulative changes are depicted in Figure 1. The initial injection **I*g*** is equitable, and, therefore, exhibits a Gini index of 0. As this income is re-spent, the Gini index (calculated from vectors of cumulative incomes $[\mathbf{I} + \mathbf{VBC}]\boldsymbol{g}$, $[\mathbf{I} + \mathbf{VBC} + (\mathbf{VBC})^2]\boldsymbol{g}$, etc.) increases rapidly as income is diverted from poor to rich households. The upper two curves in Figure 1 represent a case where leaked income (tax) is not re-injected by the government, so that the amount re-spent by households decreases after each round. As a result, cumulative incomes, and with these the Gini index, converge to their final value. In calculating the lower two curves it was assumed that tax income received by the government was not leaked, but re-injected equitably, so that in each round, R$170 million are spent by all agents. Cumulative incomes increase linearly in this case, but the continuous equitable re-injection of tax revenue (which is paid predominantly by rich

[8] This scenario is not meant to reflect a realistic policy, but a homogeneous unity perturbation, from which a step response can be calculated, which is indicative for policies aimed at affecting incomes equitably (compare with da Fonseca and Guilhoto [1987], who examine the sectoral effects of the [exogenous] Brazilian government's economic strategies).

Fig. 2. Change of Per Capita Cumulative Incomes over Spending-Production-Earning (**VBC**) Cycles Including the Informal Economy, Resulting from an Initial, Perfectly Equitable Exogenous Injection of R$1/Capita by the Government



households) causes the Gini index to be lower than in the case without re-injection. It is interesting to see that in both cases, the inclusion of the informal economy shifts the final income distribution to a more equitable outcome, represented by a lower Gini index.

The meaning of the increase in the Gini index for the income redistributive processes is illustrated again in Figure 2 for the case without tax re-injection, but including the informal economy (solid line in Figure 1). The initial equitable injection represented by the vector **I*g*** = (R$1, . . . , R$1) is marked as 10 points along the horizontal line at the "bottom of the slope" (round 0). After 10 rounds, the *average* increase in cumulative income is R$10 per capita. With successive rounds however, the cumulative income of the lower-income classes increases below average, at the cost of boosting the highest incomes to above-average values. The cumulative income distribution across classes at round 10 has a Gini index of 0.466, as shown in Figure 1.

Interrelational multipliers for income classes have been estimated previously for other countries (India: Gregory and Sinha [1984]; Parikh and Thorbecke [1996]; Austria: Lager 1988; Kenya: Bigsten [1995]). However, these authors present only **K** matrices for whole classes as seen in Table VII, and do not document enough information to derive a per-household **K** matrix as in Tables VIII and IX. Due to different class sizes in the various applications, a direct comparison of these studies with ours is not warranted. Only Rose and Beaumont present per-household interrelational multipliers for West Virginia (Rose and Beaumont 1988) and the United States (Rose and Beaumont 1989). The nominal incomes of their classes exhibit a spread that is similar to that of our classes, but are about twenty-five times higher (U.S.$5,000–75,000). The trends in Rose and Beaumont's **K** matrices are identical to those in Tables VIII and IX, but surprisingly, the variations across columns are three times larger. It appears that the rich in the United States benefit (at least in the 1980s) to a much greater extent from the income flow than the rich in Brazil. Nevertheless, the distribution of households across income classes is more equitable in the United States, which is expressed in lower Gini coefficients of 0.458 (West Virginia) and 0.477 (the United States).

C. *Extension to Environmental Factors*

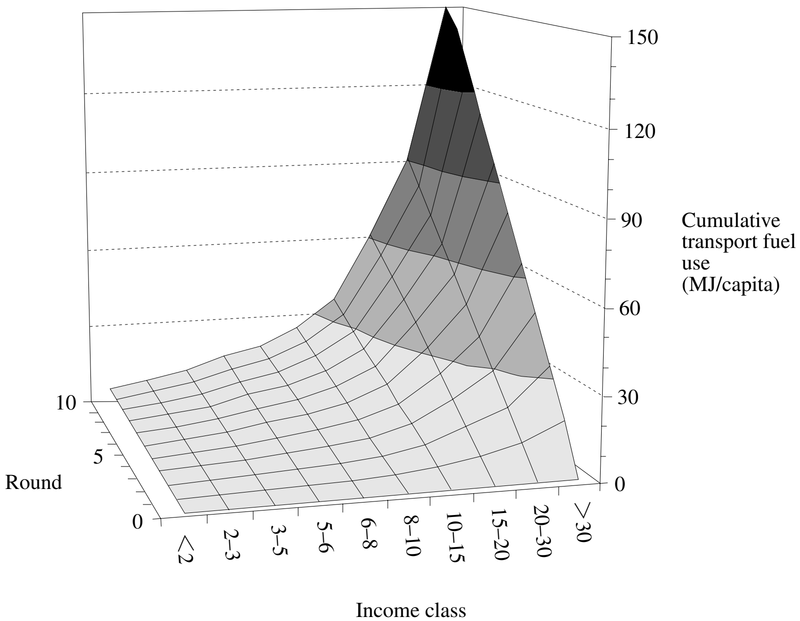
As a final illustration of the usefulness of interrelational income measures, we extend Miyazawa and Masegi's initial idea towards environmental and resource issues, and show how this extension enables exploring interactions between the income formation process and environmental pressure. Let $\boldsymbol{q}$ be a $1 \times n$ vector of direct requirements of an environmental factor for the industrial production in n industries, per unit of total industry output. Examples for environmental factors include the use of resources such as fuels, water and land, and pollution such as emissions into the atmosphere. The total environmental loading Q (scalar) of the total output $\boldsymbol{x}$ generated by an exogenous income injection $\mathbf{I}\boldsymbol{g}$ is then (see equation [1]),

$$Q = \boldsymbol{qx} = \boldsymbol{q}\mathbf{BCK}\boldsymbol{g} = \boldsymbol{q}\mathbf{BC}[\mathbf{I} + \mathbf{VBC} + (\mathbf{VBC})^2 + \ldots]\boldsymbol{g}. \tag{10}$$

The term $\boldsymbol{q}\mathbf{B}$ is the total environmental multiplier of industries, and $\boldsymbol{q}\mathbf{BC}$ is the total environmental multiplier of income classes.

Figures 3 and 4 show cumulative amounts ($\boldsymbol{q}\mathbf{BCI}\boldsymbol{g}$, $\boldsymbol{q}\mathbf{BCVBC}\boldsymbol{g}$, etc. in equation [10]) of transport fuels (petrol and sugar-cane-based alcohol) and electricity that are needed to satisfy final demand resulting from an initial, perfectly equitable exogenous income injection of R$1/capita, and continuous equitable re-injection of the tax revenue by the government. The vector $\boldsymbol{q}$ of sectoral fuel consumption was derived from energy statistics (Schechtman, Szklo, and Sala 1999; Tolmasquim and Szklo 2000). Once again, the "bottom of the slope" (round 0) represents the initial injection $\{\boldsymbol{q}_i \times (\mathbf{BCI}\boldsymbol{g})_i\}_{i=1,\ldots,10}$. This bottom line in Figure 3 shows that rich households can afford to spend a slightly larger part of their income on mobility and transport-intensive commodities than poor households, and hence require more transport fuels. This disparity is exacerbated during consecutive spending rounds, since, as shown in Figure 2, the initial equitable income is redistributed in favour of the rich. After 10 rounds, the richest 2.7% of the population have used 27% of total

Fig. 3. Change of Per Capita Cumulative Transport Fuel Use over Spending-Production-Earning (**VBC**) Cycles Including the Informal Economy, Resulting from an Initial, Perfectly Equitable Exogenous Injection of R$1/Capita by the Government

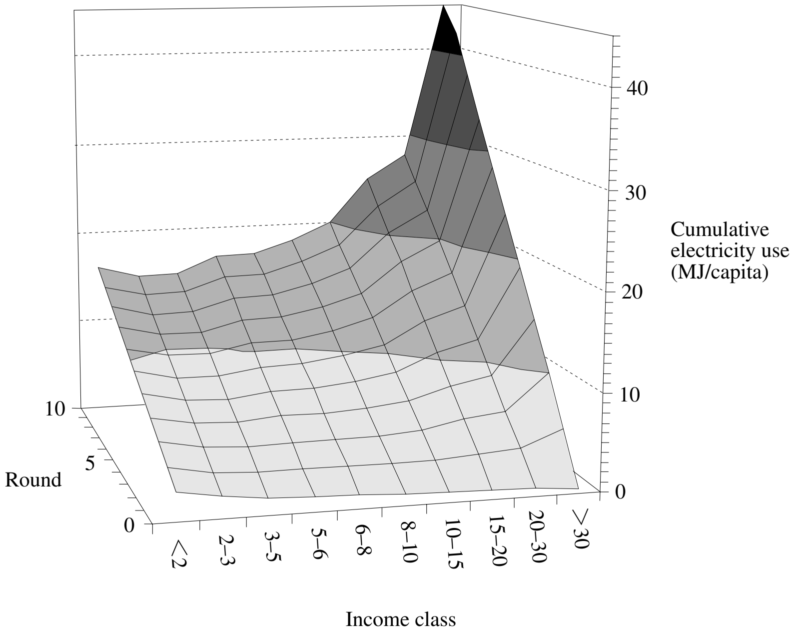


Note: MJ = megajoules.

transport fuels required for the entire cumulative consumption, leaving 8% to the poorest 54%. The Gini coefficient of this fuel distribution is 0.562, which is higher than that of the monetary distribution of this scenario (0.436; see Figure 1). The total amount of transport fuels embodied in the commodities consumed during the first 10 spending rounds is about 2,700 terajoules (TJ). Since poor households tend to spend a smaller part of their income on mobility, this total would be smaller if the income redistribution was more equitable.

A quite different picture results from examining electricity use (see Figure 4). Poor households have to spend a larger part of their income on electricity than rich households, in order to satisfy their basic needs (see bottom line). However, only one **VBC** cycle is sufficient to raise the per capita use of electricity by the rich above that by the poor. After 10 rounds, each rich person has used three times more electricity than each poor person. Because of the relatively high propensity of the poor to consume electricity, this distribution is not as unequal as the one shown in Figure 3 for transport fuels. Its Gini coefficient is 0.075, and the richest 2.7% (poorest 54%) of the population are responsible for 17% (50%) of the total electricity

Fig. 4. Change of Per Capita Cumulative Electricity Use over Spending-Production-Earning (**VBC**) Cycles Including the Informal Economy, Resulting from an Initial, Perfectly Equitable Exogenous Injection of R$1/Capita by the Government



Note: MJ = megajoules.

used during the first 10 spending rounds (2,900 TJ). Since poor households tend to spend a larger part of their income on electricity, this total would be larger if the income redistribution was more equitable.

V. CONCLUSIONS

In this work, we have generalised Miyazawa and Masegi's original idea of interrelational income multiplier measures with regard to three aspects. First, we have demonstrated the effect of system closure on the inter-income-group matrix. Second, we have formalised the inclusion of inter-household transactions, or the informal economy, into Miyazawa's calculus. Third, we have extended the interrelational multiplier to include environmental factors.

Using an environmentally extended SAM constructed for the Brazilian economy as of 1995, we have shown that income is heavily skewed towards a small fraction of the population, who own the means of production, and hence benefit from operational surplus. Furthermore, governmental transfer payments targeted at relieving poor households are ultimately received by high-income households after only a few spending and earning rounds, so that higher-order redistributive cycles appear to undercut efforts to narrow income disparities.

We therefore agree with Cavalcanti (2001), who states that the concentration income tendency benefiting income groups whose earnings come from capital introduces a vicious cycle in a way that the considerable degree of control on the means of production by capital owners will enhance their capacity to protect their gains and contribute to the deterioration of the distribution pattern. In fact, it appears that during the past twenty years not much has changed in these respects, since Willumsen (1990) remarks that already in 1975, capitalists and middle class always benefit more than any other class, no matter the type of technology. Since capital income constitutes a large proportion of income, this circumstance reflects the continuing unequal ownership of the means of production.

Redistributive cycles also cause disparities in terms of energy use, with rich households always requiring more per capita than poor households. However, the effect of income distribution on total energy consumption—and hence also on a range of emissions—depends critically on consumer preferences, as demonstrated in the comparison between transport fuels and electricity: if environmental factor intensities increase with income, then the present redistributive cycles increase environmental pressure, and vice versa. As shown in previous studies, the total energy and energy-related CO_2 intensity of household consumption increase with income in Brazilian capital cities (Cohen, Lenzen, and Schaeffer 2004), but decrease with income in rural areas (Lenzen and Schaeffer 2004), because poor rural households consume substantial amounts of firewood and charcoal. The effect of income redistribution on the environment depends therefore not only on the environmental factor, but also on location. Therefore, a complex interaction exists between processes that generate income and those that stress resources and the environment. Policies aimed at alleviating either income disparities or environmental pressure have to take into account the trade-offs that are inherent in these interactions, in order to arrive at outcomes that achieve one goal without jeopardizing the other.

REFERENCES

Azzoni, Carlos Robert. 1997. "Distribuição pessoal de renda nos estados e desigualdade de renda entre estados no Brasil—1960, 1970, 1980 e 1991." *Pesquisa e Planejamento Econômico* 27, no. 2: 251–77.

Baer, Werner; Manuel A. R. da Fonseca; and Joaquim J. M. Guilhoto. 1987. "Structural Changes in Brazil's Industrial Economy, 1960–80." *World Development* 15, no. 2: 275–86.

Bigsten, Arne. 1995. "Social Accounting Matrices and Income Distribution Analysis in Kenya." In *Social and Demographic Accounting*, ed. Geoffrey J. D. Hewings and Moss Madden. Cambridge: Cambridge University Press.

Bonelli, Regis, and Paulo Vieira da Cunha. 1982. "Mudanças nas estruturas de produção, renda e consumo, e crescimento econômico no Brasil no período 1970/75." *Pesquisa e Planejamento Econômico* 12, no. 3: 807–49.

Bulmer-Thomas, V. 1982. *Input-Output Analysis in Developing Countries: Sources, Methods and Application*. Chichester: John Wiley & Sons.

Cavalcanti, José Euclides Alhadas. 1997. "Distribuição setorial da renda: Seus efeitos de indução na economia brasileira." *Pesquisa e Planejamento Econômico* 27, no. 1: 141–84.

———. 2001. "Income Distributive Effects in the Brazilian Economy." *Economic Systems Research* 13, no. 3: 275–87.

Cohen, C. A. M. J.; Manfred Lenzen; and Roberto Schaeffer. 2004. "Energy Requirements of Households in Brazil." *Energy Policy*. In press.

da Fonseca, Manuel Alcino R., and Joaquim José Guilhoto. 1987. "Uma análise dos efeitos econômicos de estratégias setoriais." *Revista Brasileira de Economia* 41, no. 1: 81–98.

de Andrade, S. C., and S. Najberg. 1997. *Uma matriz de contabilidade social atualizada para o Brasil*. Textos para Discussão 58. Rio de Janeiro: Área de Planejamento, Departamento Econômico.

Ghosh, A., and A. Sengupta. 1984. "*Income Distribution and the Structure of Production in an Input-Output Framework*." Paper presented at the Seventh International Conference on Input-Output Techniques, New York.

Guilhoto, J. J. M.; P. H. Z. da Conceição; and F. C. Crocomo. 1996. "Estruturas de produção, consumo e distribuição de renda na economia brasileira: 1975 e 1980 comparados." *Economia & Empresa* 3, no. 3: 33–46.

Gregory, M., and R. Sinha. 1984. "Income Distribution in a Macro-economic Model: Some Estimates for India." In *Towards Income Distribution Policies: From Income Distribution Research to Income Distribution Policy in LDS's*, ed. Hans Peter Nissen. EADI Book Series 3. Tilburg: European Association of Development Research and Training Institutes.

Instituto Brasileiro de Geografia e Estatística. 1997. *Matriz de insumo-produto Brasil 1995*. Rio de Janeiro: Ministério de Planejamento e Orçamento.

———. 1999. *Pesquisa de orçamento familiares*. Rio de Janeiro: Ministério da Fazenda.

———. "Censo demográfico de 2000." Banco de dados agregados—Sistema IBGE de recuperação automática, SIDRA. http://www.sidra.ibge.gov.br/bda/tabela/protabl.asp?z=t&o=2.

Katz, Joseph L. 1980. "The relationship between Type I and Type II Income Multipliers in an Input-Output Model." *International Regional Science Review* 5, no. 1: 51–56.

Lager, Christian. 1988. "The Use of a Social Accounting Matrix for Comparative Static Equilibrium Modelling." In *Input-Output Analysis: Current Developments*, ed. Maurizio Ciaschini. London: Chapman and Hall.

Lenzen, Manfred, and Roberto Schaeffer. 2004. "Environmental and Social Accounting for Brazil." *Environmental and Resource Economics* 27, no. 2: 201–26.

Miller, Ronald E. 1980. "The Relationship between Type I and Type II Income Multipliers in an Input-Output Model: A Comment." *International Regional Science Review* 5, no. 2: 185–88.

Miyazawa, Kenichi. 1968. "Input-Output Analysis and Interrelational Income Multiplier as a Matrix." *Hitotsubashi Journal of Economics* 8, no. 2: 39–58.

———. 1976. *Input-Output Analysis and the Structure of Income Distribution*. Berlin: Springer-Verlag.

Miyazawa, Kenichi, and Masegi Shingo. 1963. "Interindustry Analysis and the Structure of Income-Distribution." *Metroeconomica* 15, no. 2: 89–103.

Parikh, Alka, and Erik Thorbecke. 1996. "Impact of Rural Industrialization on Village Life and Economy: A Social Accounting Matrix Approach." *Economic Development and Cultural Change* 44, no. 2: 351–77.

Paukert, Felix; Jiri Skolka; and Jef Maton. 1976. "Redistribution of Income Patterns, Consumption, and Employment." In *Advances in Input-Output Analysis*, ed. Karen R. Polenske and Jiri V. Skolka. Cambridge, Mass.: Ballinger Publishing Co.

Pyatt, Graham; Alan Roe; Jeffery Round; Robert Lindley; and Richard Stone. 1977. *Social Accounting for Development Planning with Special Reference to Sri Lanka*. Cambridge: Cambridge University Press.

Rose, Adam Zachary, and Paul Beaumont. 1988. "Interrelational Income Distribution Multipliers for the West Virginia Economy." *Journal of Regional Science* 28, no. 4: 461–75.

———. 1989. "Interrelational Income Distribution Multipliers for the U.S. Economy." In *Frontiers of Input-Output Analysis*, ed. Ronald E. Miller, Karen R. Polenske, and Adam. Z. Rose. New York: Oxford University Press.

Schechtman, R.; A. Szklo; and J. Sala. 1999. *Determinação das emissões de carbono derivadas do sistema energético brasileiro—Abordagem bottom-up*. Technical Report, Projeto BRA/95/G31. Rio de Janeiro: MCT/COPPE/Universidade Federal do Rio de Janeiro.

Sinha, Anushree; K. A. Siddiqui; and N. Sangeeta. 2000. "SAM Multiplier Analysis of Informal Households: Application to an Indian Archetype Economy." Paper prepared for the Thirteenth International Conference on Input-Output Techniques, Macerata, Italy, August 21–25. http://policy.rutgers.edu/cupr/iioa/iioa.htm.

Stone, Richard. 1961. *Input-Output and National Accounts*. Paris: Organisation for Economic Co-Operation and Development.

Székely, Miguel. 2001. "The 1990s in Latin America: Another Decade of Persistent Inequality, but with Somewhat Lower Poverty." Working Paper #454. Washington, D.C.: Inter-American Development Bank.

Tolmasquim, Mauricio Tiomno, and Alexandre Salem Szklo. 2000. *A matriz energética brasileira na virada do milênio*. Rio de Janeiro: COPPE/UFRJ.

Weisskopf, R. 1976. "Income Distribution and Export Promotion in Puerto Rico." In *Advances in Input-Output Analysis: Proceedings of the Sixth International Conference on Input-Output Techniques, Vienna, April 22–26, 1974*, ed. Karen R. Polenske and Jiri V. Skolka. Cambridge, Mass.: Ballinger Publishing Co.

Willumsen, Maria J. F. 1990. "The Impact of Production Structure on Income Distribution: A Multiplier Approach." *Review of Regional Studies* 20, no. 3: 12–22.