The Rate of Surplus Value in Puerto Rico

Edward N. Wolff

New York University

Puerto Rico's transformation from a preindustrial to an industrialized economy in the period 1948–63 provides an opportunity to measure the impact of technological change on several basic parameters in a Marxian economic framework. The rate of surplus value (estimated using the Morishima-Seton transformation) remains relatively stable at 0.97 in 1948 and 0.93 in 1963, while the organic composition falls from 2.75 to 2.09. The stability in the rate of surplus value results from a 63 percent average fall in labor values counterbalanced by a 143 percent rise in labor's consumption. The rate of surplus value, when adjusted for trade flows, jumps to 1.31 in 1948 and 1.18 in 1963, due to Puerto Rico's large balance-of-trade deficit and the relative import intensity of labor's consumption.

In *Economic Philosophy*, Joan Robinson makes the following remarks about Marx's theory of value: " . . . The whole argument [of value] appears to be metaphysical. It provides a typical example of the way metaphysical ideas operate. Logically it is a mere rigmarole of words but for Marx it was a flood of illumination and for latter-day Marxists a source of inspiration" (1962, p. 39).

Leontief is more positive on the accomplishments of Marx: "Marx was the great character reader of the capitalist system" (1968, p. 98). But he adds, "As many individuals of this type, Marx had also his rational theories, but these theories in general do not hold water" (p. 98).

This paper sets out to give an algebraically consistent and empirically operational estimation of the rate of surplus value.[1] The rate of surplus

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[1] Similar procedures were employed by Okishio for the 1951 Japanese economy and Kýn, Sekerka, and Hejl for the 1962 Czech economy. Their results are cited in the text for reasons of comparison.

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value is computed for the years 1948 and 1963 in Puerto Rico, and the change in the rate of surplus value is decomposed into three effects: the first from technological change, the second from a rising real wage, and the third from a change in the pattern of consumption. Additional observations on the transformation from market prices to labor values, the organic composition of capital, and the treatment of imports are also included. Finally, labor values are considered in their dual form as employment multipliers, and policy implications are drawn.

Puerto Rico was chosen for this study because of the tremendous transformations the economy underwent during these years.[2] Between 1948 and 1963, real per capita income more than doubled, as did labor productivity. Investment increased as a share of GNP from 12.5 to 20 percent. Agriculture (including food processing) fell as a share of value added from 29 to 18 percent, and manufacturing rose from 15 to 22 percent. Puerto Rico became transformed from a plantation economy to a modern industrial economy. The magnitude and scope of the changes in the Puerto Rican economy thus provide a significant test of the effect of technological change on the rate of surplus value

I. The Model

In order to compute the rate of surplus value, input/output flows in market prices (hereafter prices) must be converted into input/output flows in labor values (hereafter values). Two steps are needed. The first step is to transform the input/output flow table in price terms into an accounting framework conformable with Marxian theory.

The original input/output tables[3] are arranged as follows: (i) A, 26×26 matrix of total interindustry flows. (ii) U, 8×26 matrix of value added by sector, showing wages, profits, rent, interest, transfers, taxes, depreciation, and other value added. (iii) F, 26×6 flow matrix showing household consumption, capital formation (plant and equipment investments), net inventory change, government expenditures, exports, and imports (as a negative flow). Thus:

$$\sum_{j=1}^{26} A_{ij} + \sum_{j=1}^{6} F_{ij} = X_i, \tag{1}$$

$$\sum_{i=1}^{26} A_{ij} + \sum_{i=1}^{8} U_{ij} = X_j. \tag{2}$$

The value-added matrix U is aggregated into three rows: W, wages; S, surplus, including profits, rents, interest, transfers, taxes, and other value

[2] An additional consideration was the availability of input/output data for both 1948 and 1963.

[3] See Weisskoff et al. (1971), technical appendices, for a description of the data.

added; and D, depreciation. In Marxian theory, depreciation is considered endogenous, since constant capital includes both produced inputs (intersectoral flows) and the depreciation of fixed capital. Thus, D becomes an endogenous row. In order to create a column corresponding to D, the gross capital formation column is split proportionately into N, depreciation, and net capital formation[4] such that $\Sigma N = \Sigma D$. Let (iv) $B = \begin{bmatrix} A & N \\ D & \end{bmatrix}$ the adjusted 27-order interindustry flow matrix.

The household consumption column in F, moreover, is split proportionately into workers' consumption, C, and capitalists' consumption, such that $\Sigma C = \Sigma W$.[5] To capitalist consumption are added net capital formation, net inventory change, government, and exports less imports to form K, the surplus consumption column. Thus:

$$\sum_{j=1}^{27} B_{ij} + C_i + K_i = Z_i, \tag{3}$$

$$\sum_{i=1}^{27} B_{ij} + W_j + S_j = Z_j. \tag{4}$$

With the input/output flow matrices in price terms arranged in a form consistent with Marxian theory, the second step is to transform the flows from prices to values. A transformation scheme worked out by Morishima and Seton (1961) is employed.

Define the 27-order matrix of row coefficients Q such that

$$Q_{ij} = \frac{B_{ij}^p}{Z_i^p} = \frac{B_{ij}^v}{Z_i^v}, \tag{v}$$

where the superscrpits p and v refer to prices and values, respectively. Define the 27-order matrix R, such that

$$R_{ij} = \frac{C_i^p}{Z_i^p} \cdot \frac{W_j^p}{\Sigma W^p} = \frac{C_i^v}{Z_i^v} \cdot \frac{W_j^v}{\Sigma W^v}. \tag{vi}$$

Thus, R_{ij} shows the proportion of output of each sector i consumed out of wages by workers of sector j. Define r such that

$$W^v + S^v = rW^v \tag{vii}$$

[4] In principle, a capital coefficient matrix should be used to determine the actual composition of the depreciation column. Such matrices are unavailable for Puerto Rico.

[5] Three assumptions are implicit in this: (1) Workers do not save. (2) The pattern of consumption is the same for worker and capitalist. (A preferable procedure, if data were available, is to estimate the consumption mix of worker and capitalist separately.) (3) The value of labor power is equivalent to the average consumption of labor.

TABLE 1

RATIO OF PROFITS TO WAGES, LABOR VALUES TO PRICES, AND DISTRIBUTION OF WORKER CONSUMPTION IN PRICE TERMS FOR 1948

	Profits/ Wages (1)	Values/ Prices (2)	Distribution of Consumption (3)
1. Agriculture (excluding cane) ..	5.3198	0.4272	0.0606
2. Sugarcane	−0.0204	1.3739	0.0
3. Sugar milling	0.6498	1.2391	0.0005
4. Processed foods.....	0.6478	0.7542	0.3483
5. Textiles	0.2737	1.1762	0.0668
6. Leather	0.0	0.0	0.0233
7. Furniture	0.7851	0.8746	0.0130
8. Paper products	−0.4072	1.5920	0.0002
9. Printing	0.1633	1.3657	0.0055
10. Chemical.....	2.0859	0.7045	0.0311
11. Nonmetal	0.8957	0.9215	0.0028
12. Petroleum and coal	0.0	0.0	0.0053
13. Metal industries	0.6687	0.9666	0.0471
14. Mining	0.0	0.0	0.0
15. Other manufacturing.....	−0.0550	1.0428	0.0289
16. Construction	0.1003	1.1404	0.0
17. Hotels and restaurants	0.6463	0.8192	0.0821
18. Electricity	1.0051	0.8304	0.0058
19. Water and sanitation	0.1970	1.1813	0.0013
20. Communication	0.1158	1.3119	0.0011
21. Trade	1.1626	0.8112	0.0005
22. Business services	1.4095	0.8434	0.0247
23. Personal services	1.0905	0.8504	0.0384
24. Real estate	27.7849	0.4123	0.0759
25. Transport	0.3141	1.0720	0.0639
26. Government services	−0.0105	1.4016	0.0728
27. Depreciation	0.0	1.0553	0.0
28. Totals	0.5907	1.0000	1.0000

Hence, the rate of surplus value[6] is equal to $r - 1$. As a result,

$$[1/r\, I - (I - Q')^{-1}R']\, Z = 0 \tag{5}$$

and

$$\Sigma z^p = \Sigma z^v \tag{6}$$

give the rate of surplus value and the vector of labor values.

II. Preliminary Observations

a) Columns 1 and 2 of table 1 show the ratio of profits (surplus in price terms) to wages (also in price terms) and the ratio of values to prices by sector for 1948.[7] (Row 28 shows the weighted average of profits to wages and of values to prices.) It is evident that the ratio of values to prices tends to be low when the ratio of profits to wages is high, and vice versa.

[6] It is implicitly assumed that the rate of surplus value is the same in each sector.

[7] All computations were performed using the packaged program MOTHER, developed at the Harvard Economic Research Project.

TABLE 2

RATIO OF PROFITS TO WAGES, LABOR VALUES TO PRICES, AND DISTRIBUTION OF WORKER CONSUMPTION IN PRICE TERMS FOR 1963

	Profits/ Wages (1)	Values/ Prices (2)	Distribution of Consumption (3)
1. Agriculture (excluding cane)	4.1644	0.4709	0.0507
2. Sugarcane	0.3799	1.1901	0.0
3. Sugar milling	0.6363	1.1116	0.0174
4. Processed foods	2.2163	0.7256	0.2350
5. Textiles	0.3022	1.2330	0.0718
6. Leather	0.3011	1.2068	0.0171
7. Furniture	0.3100	1.1047	0.0248
8. Paper products	0.0361	1.3468	0.0029
9. Printing	0.3573	1.2145	0.0060
10. Chemical	2.3202	0.7399	0.0374
11. Nonmetal	0.6638	1.0443	0.0019
12. Petroleum and coal	1.6108	0.9515	0.0247
13. Metal industries	0.8571	0.9565	0.0776
14. Mining	0.2694	1.1092	0.0
15. Other manufacturing	0.4164	1.0823	0.0249
16. Construction	0.2957	1.1910	0.0
17. Hotels and restaurants	1.0141	0.9123	0.0268
18. Electricity	0.9747	0.9516	0.0138
19. Water and sanitation	0.8433	0.9911	0.0044
20. Communication	0.6873	1.0618	0.0043
21. Trade	1.1574	0.8613	0.0
22. Business services	0.6265	1.1132	0.0201
23. Personal services	0.6063	1.0442	0.0913
24. Real estate	7.6040	0.5761	0.0962
25. Transport	0.9110	0.9952	0.0615
26. Government services	0.0000	1.4504	0.0895
27. Depreciation	0.0	1.1159	0.0
28. Totals	0.7529	1.0000	1.0000

Agriculture (1), chemicals (10), and real estate (24) have the highest profit-to-wage ratios and the lowest value-to-price ratios; sugarcane (2), paper products (8), printing (9), communications (20), and government services (26) show, with the exception of other manufacturing (15) and trade (21), the lowest ratios of profits to wages and the highest ratios of value to price. The correlation coefficient, as a measure of association, between the two sets of ratios (with the weighted means used instead of the unweighted) is $-.5102$. Columns 1 and 2 of table 2 give the same sets of ratios for 1963. The four sectors with the highest ratios of profits to wages—agriculture (1), processed foods (4), chemicals (10), and real estate (24)—yield the lowest ratios of value to price; sugarcane (2), textiles (5), leather (6), paper (8), printing (9), construction (16) and government services (26), on the other hand, show the lowest ratios of profits to wages, with the exception of furniture (7) and mining (14), and the highest ratios of value to price. The correlation coefficient (using the weighted means) between the two vectors of ratios is $-.7559$.

The strong inverse relation between the profit-wage ratio and the value-

TABLE 3

RATE OF SURPLUS VALUE AND PROFIT-TO-WAGE RATIO

	Rate of Surplus Value	Profits/Wages (in Prices)
1948	0.9729	0.5907
1963	0.9328	0.7529

price ratio can be explained as follows: The eigenvalue transformation here employed is mathematically equivalent to an iterative algorithm which first distributes the surplus proportionately to the wages in each sector, then distributes the resulting gross outputs across the rows of B, C, and K, and finally adjusts the wage flows in each sector such that total wages is equal to total (adjusted) worker consumption. Thus, in the first step, the gross output of those sectors with a ratio of profits to wages exceeding the overall average is lowered, and the gross output of those sectors with a ratio below the average is raised. In the second step, the gross output of those sectors using inputs whose gross output is raised in the first step (that is, with an initially low ratio of profits to wages) is raised, and vice versa. In net, it appears that the final ratio of value to price depends primarily on the initial ratio of profits to wages—that is, on the first step of the first iteration.[8]

b) In table 3 are shown the rate of surplus value and the ratio of profits to wages (in price terms) for 1948 and 1963.

There are two striking results. The first is that the rate of surplus value is almost constant in the two years, falling by 4.1 percent. The second is the high level of surplus value, around 0.95. This compares with a rate of surplus value of 0.93 for the Japanese economy in 1951 and 1.35 for the 1962 Czechoslovakian economy.[9] The ratio of profits to wages, on the other hand, changes considerably, rising by 27.5 percent, and is substantially lower than the rate of surplus value. The ratio of profits to wages is thus a poor proxy for the rate of surplus value, in terms of absolute amount, magnitude of change, and even direction of change.

The reason that the rate of surplus value is higher than the profit-to-wage ratio in the two years becomes apparent in examining column 3 of tables 1 and 2—the composition of worker consumption (in current prices). Workers tend to consume those products whose labor value is less than its price. In 1948 the chief consumption items are agriculture (1),

[8] This iteration was also performed. Convergence occurred in 15 iterations for the 1948 table and 11 for the 1963 table.

[9] See Okishio (1959) and Kýn, Sekerka, and Hejl (1967). The rate of surplus value for Japan refers only to manufacturing industries. In the case of the Czech economy, it is not clear whether depreciation is treated as part of material cost or as part of surplus value added. The relatively high rate of surplus value for the Czech economy might be accounted for by the latter.

TABLE 4

ORGANIC COMPOSITION OF CAPITAL

	Constant/Variable Capital (Value Terms)	Constant/Variable Capital (Price Terms)
1948	2.7479	2.4423
1963	2.0866	1.9706
Change	−24.1%	−19.3%

processed foods (4), textiles (5), metals (13), hotels and restaurants (17), real estate (24), transport (25), and government services (26). Only three of these sectors have a ratio of value to price greater than 1. In 1963, the principal consumption items are agriculture (1), processed foods (4), textiles (5), metals (13), personal services (23), real estate (24), transport (25), and government services (26). Here, too, only three of these sectors have a value-to-price ratio greater than 1. The correlation coefficient between the ratios of value to price and the sectoral consumption shares is −.5102 in 1948 and −.4612 in 1963.[10] Thus, though workers consume a relatively high proportion of gross domestic product in real terms, the proportion is relatively less in terms of embodied labor. As a result, the cost of reproducing the worker is less in labor-value terms than in market-price terms. Hence, the rate of surplus value is greater than the ratio of profits to wages.

c) Table 4 shows the organic composition of capital in value and price terms for 1948 and 1963.[11] The striking result is that the organic composition falls considerably during the two periods in both price and value terms. Marx argues that the organic composition tends to rise over time since new technology, on average, embodies a higher constant capital-to-labor ratio in physical terms (that is, a higher technical composition). Marx does acknowledge, however, the presence of an offsetting tendency—namely, that as technology advances, the value of inputs tends to fall, since the labor embodied in these inputs declines (Marx 1967, p. 236). In other words, even though the technical composition rises the labor value of the new means of production tends to decline. The decline in the organic composition seems due to the latter effect outweighing the former.

[10] In 1948, we omit leather (6), petroleum and coal (12), and mining (14), which consist exclusively of noncompetitive imports. In both years we use the weighted mean of value to price.

[11] Here we use the ratio of constant to variable capital for the organic composition. The preferable concept is the ratio of the stock of capital plus the value of produced inputs consumed during and the depreciation occurring in one turnover period to the wages advanced in one turnover period (see Marx [1967, p. 158]). Since capital coefficients and turnover data are unavailable, the ratio of the value of produced inputs and depreciation per annum to the wages paid out per annum is used instead.

TABLE 5

SURPLUS IN PRICE AND VALUE TERMS (THOUSANDS)

	Surplus (Value)	Surplus (Price)
1948	284,130	206,013
1963	1,125,461	980,558

d) Table 5 shows the surplus in price and value terms for 1948 and 1963. Marx argues that total surplus value equals total profits, given that total values equal total prices (Marx 1967, p. 138). Many economists have pointed out the inconsistency of these two propositions (see Sweezy 1968, chap. 7). Here total surplus value exceeds total profits for both 1948 and 1963.

III. Exports and Imports

The presence of imports creates a special problem in the transformation of prices to values. Since inputs are not produced domestically, they cannot be valued according to the amount of (domestic) labor embodied in them. Imports can, however, be valued according to the labor costs involved in obtaining them—namely, the labor embodied in exports. In order to take this into account analytically, the interindustry flow matrix can be augmented with an endogenous import row and export column. Let

$$B = B_d + B_m, \tag{viii}$$

$$C = C_d + C_m, \tag{ix}$$

$$K = K_d + K_m, \tag{x}$$

where subscripts d and m indicate domestically produced and imported goods, respectively. Let E be the vector of exports, and

$$L_d = K_d - E,^{12} \tag{xi}$$

$$L_m = K_m. \tag{xii}$$

Define:

$$(\bar{B}_m)_j = \sum_{i=1}^{27} (B_m)_{ij}, \tag{xiii}$$

$$\bar{C}_m = \Sigma C_m, \tag{xiv}$$

$$\bar{L}_m = \Sigma L_m. \tag{xv}$$

[12] Note that there are no direct imports into exports.

Also,

$$\tilde{B} = \begin{bmatrix} B_d & E \\ \bar{B}_m & 0 \end{bmatrix}, \qquad \text{a 28-order matrix;} \tag{xvi}$$

$$\tilde{C} = \begin{bmatrix} C_d \\ \bar{C}_m \end{bmatrix}, \qquad \text{a } 28 \times 1 \text{ vector;} \tag{xvii}$$

$$\tilde{L} = \begin{bmatrix} L_d \\ \bar{L}_m \end{bmatrix}, \qquad \text{a } 28 \times 1 \text{ vector;} \tag{xviii}$$

$$\tilde{W} = (W\ 0), \qquad \text{a } 1 \times 28 \text{ vector;} \tag{xix}$$

$$\tilde{S} = (S\ 0), \qquad \text{a } 1 \times 28 \text{ vector.} \tag{xx}$$

Thus,

$$\sum_{j=1}^{28} \tilde{B}_{ij} + \tilde{C}_i + \tilde{L}_i = \tilde{Z}_i \qquad i = 1, 28, \tag{7}$$

$$\sum_{i=1}^{28} \tilde{B}_{ij} + \tilde{W}_j + \tilde{S}_j = \tilde{Z}_j \qquad j = 1, 27. \tag{8}$$

As indicated by equation (8), it is not necessary that total imports equal total exports in price terms in order to transform prices into values. However, when the transformation is performed, the total labor value of imports is forced equal to the total labor value of exports, since the value of imports is implicitly defined in this way. We therefore set

$$Q_{ij} = \frac{\tilde{B}_{ij}}{\tilde{Z}_i}, \tag{xxi}$$

$$\tilde{R}_{ij} = \frac{\tilde{C}_i}{\tilde{Z}_i} \cdot \frac{\tilde{W}_j}{\Sigma \tilde{W}_j}. \tag{xxii}$$

Thus,

$$[1/r\, I - (I - \tilde{Q}')^{-1} R']\, Z^v = 0, \tag{9}$$

$$\sum_{i=1}^{27} \tilde{Z}_i^p = \sum_{i=1}^{27} Z_i^v.^{13} \tag{10}$$

The rate of surplus value in 1948 jumps to 131.35 percent and the rate of surplus value in 1963 to 118.47 percent. The reason for this is as follows: In 1948 there is a very large balance-of-trade deficit, with a ratio of imports less exports to imports of 0.37. When transformed to labor values, imports become significantly depreciated in relation to domestically produced goods. In fact, the ratio of imports in labor value terms to imports in prices is only 0.68. Workers, moreover, consume a higher percentage of imports than the recipients of the surplus: $\bar{C}_m / \Sigma C = 0.41$,

[13] Note that imports (and therefore exports) are excluded in equating total values to total prices.

whereas $\bar{L}_m/L = 0.20$. The labor value of wage goods is thus significantly reduced, and the rate of surplus value, as a result, increases. Marx, in fact, argues that foreign trade cheapens the necessities of life and thereby raises the rate of surplus value (1967, p. 237). In 1963 the trade deficit is smaller, with a ratio of imports less exports to imports of 0.16. The ratio of imports in value terms to imports in price terms is 0.84; $\bar{C}_m/\Sigma C = 0.39$; and $\bar{L}_m/\Sigma L = 0.15$. Thus, the rate of surplus value also rises in 1963, but not as much as in 1948.

The results presented in this section do not, it is felt, accurately reflect the rate of exploitation in Puerto Rico because of the extreme sensitivity of the rate of surplus value to the balance of trade deficit, the ambiguous meaning of the balance of trade for Puerto Rico,[14] and the unreliability of the trade data for the island (especially imports in 1948). In Section IV, the model presented in Section I is again employed.[15] It is felt, nonetheless, that this section fills an important gap in Marxian value theory.

IV. Relative Surplus Value

Consumption per worker rises from $867 in 1948 to $2,107 in 1963.[16] Though the real wage increases by 143 percent, the man-years, in labor value terms, embodied in the per worker consumption basket (the ratio of variable capital to variable capital plus surplus value) rises from 0.5069 to only 0.5174—that is, by 2.6 percent. In both 1948 and 1963, in other words, the annual consumption per worker (his cost of reproduction) is the equivalent of approximately one-half a man-year of labor. This, moreover, is equivalent to a constant rate of surplus of approximately 100 percent. The uniformity of the rate of surplus value in the face of the tremendous increase in the real wage is accounted for by an increase in relative surplus value. This, in turn, is due to two factors: (1) the fall in the labor value of the means of production used in producing wage goods; (2) the fall in the labor value of the means of subsistence, partly a consequence of factor 1.

Column 1 of table 6 shows the labor value of the product of each sector in 1948, column 2, the labor value of the product of each sector in 1963,

[14] Puerto Rico's currency is American dollars, and its major trading partner is the United States.

[15] Two clarifications of the model are in order. First, competitive imports are valued according to the labor value of domestic substitutes. Second, noncompetitive imports can be valued only in terms of exports since there is no domestic production of them. Therefore, an endogenous noncompetitive import row is added, and exports are divided proportionately into an endogenous and exogenous component such that the sum of noncompetitive imports equals the sum of endogenous exports.

[16] All price flows in this section, unless otherwise noted, are in constant 1963 prices. Price indices were computed by sector and supplied by Richard Weisskoff.

TABLE 6

LABOR VALUE OF SECTORAL OUTPUT FOR 1948 AND 1963 AND RATIO BETWEEN 1963 VALUES AND 1948 VALUES

	1948 Labor Values (1)	1963 Labor Values (2)	Ratio of Col. 2/Col. 1 (3)
1. Agriculture (excluding cane) ..	0.3415	0.1248	0.3654
2. Sugarcane	1.0983	0.3154	0.2871
3. Sugar milling	0.8693	0.2946	0.3389
4. Processed foods.....	0.5291	0.1923	0.3634
5. Textiles	0.8252	0.3267	0.3960
6. Leather	0.0	0.3198	0.0
7. Furniture	0.6136	0.2928	0.4771
8. Paper products	1.1169	0.3569	0.3195
9. Printing	0.9581	0.3219	0.3359
10. Chemical.....	0.4943	0.1961	0.3967
11. Nonmetal	0.6465	0.2768	0.4281
12. Petroleum and coal	0.0	0.2522	0.0
13. Metal industries	0.6781	0.2535	0.3738
14. Mining	0.0	0.2939	0.0
15. Other manufacturing	0.7316	0.2868	0.3920
16. Construction	0.7500	0.3156	0.4208
17. Hotels and restaurants	0.5127	0.2418	0.4716
18. Electricity	0.6117	0.2522	0.4123
19. Water and sanitation	0.8702	0.2627	0.3018
20. Communication	0.9664	0.2814	0.2912
21. Trade	0.6833	0.2282	0.3340
22. Business services	0.5865	0.2950	0.5030
23. Personal services	0.5322	0.2767	0.5200
24. Real estate	0.2867	0.1527	0.5325
25. Transport	0.7897	0.2637	0.3340
26. Government services	0.9776	0.3844	0.3932
27. Depreciation	0.7162	0.2957	0.4129
28. Totals	0.7110	0.2650	0.3727

and column 3, the ratio of the two.[17] We can see that the value of output of every sector declines.[18] The ratios range from a high of 0.5325 (indicating a relatively small decline) in real estate (24) to a low of 0.2871 in sugarcane (2). Other large falls occur in paper products (8), water and sanitation (19), and communications (20). The fall in the ratio of total output in thousands of 1963 dollars to total embodied labor in man-years is from 0.7110 to 0. 2650 (row 28).

The movement of the rate of surplus value over time can be decomposed into three components: the effect of technological change, the effect of a change in total per worker consumption, and the effect of a change in

[17] Labor value is defined here as the number of man-years embodied in the output of a sector per $1,000 of sectoral output. The preferable concept is the labor embodied in one (physical) unit of output. Constant prices are used as a proxy for physical units, since disaggregated commodity flow matrices are unavailable. (See Morishima and Seton [1961] for an analysis of the error resulting from aggregation.)

[18] Sectors 6, 12, and 14 do not exist in 1948 and are excluded from the comparison.

TABLE 7

RATES OF SURPLUS VALUE FROM ALTERNATIVE ASSUMPTIONS

	1948 Cons./ Worker 1948 Cons. Mix 1948, 1948	1948 Cons./ Worker 1963 Cons. Mix 1948, 1963	1963 Cons./ Worker 1948 Cons. Mix 1963, 1948	1963 Cons./ Worker 1963 Cons. Mix 1963, 1963
1948 technology				
1948	0.9729	1.1598	*	*
1963 technology				
1963	3.8974	3.6976	1.0151	0.9328

* The 1963 level of consumption per worker would absorb more than the total gross domestic product in 1948.

the pattern of consumption. These effects cannot be measured independently, since the transformation from prices to values depends not only on technology (the interindustry flows) but on total consumption as well as on the sectoral consumption mix. (This is evident from eq. [5] where r and Z^v depend on R.) "Experiments" can, however, be performed by computing the rate of surplus value that would result from various combinations of these three effects. Let

$$Q_{ij}^a = \frac{B_{ij}^a}{Z_{ij}^a}, \qquad a = 1948, 1963. \tag{xxiii}$$

Let T^{1948} equal total employment in 1948 (which equals 551,370) and T^{1963} equal total employment in 1963 (which equals 617,987). Define

$$C_i^{bc} = \frac{C_i^b}{\Sigma C^b} \cdot \Sigma C^c \cdot \frac{T^b}{T^c}, \qquad \begin{array}{l} b = 1948, 1963, \text{ and} \\ c = 1948, 1963. \end{array} \tag{xxiv}$$

$$R_{ij}^{abc} = \frac{C^{bc}}{Z_i^a} \cdot \frac{W_j^a}{\Sigma W^a} \qquad \begin{array}{l} a = 1948, 1963, \\ b = 1948, 1963, \text{ and} \\ c = 1948, 1963. \end{array} \tag{xxv}$$

Eight rates of surplus value are generated by

$$\{1/r^{abc} - [I - (Q^a)']^{-1} (R^{abc})'\} Z^v = 0. \tag{11}$$

These are shown in table 7.

The effect of technical change on the rate of surplus value becomes apparent from column 1. If the consumption per worker and the consumption mix remained constant between 1948 and 1963, the rate of surplus would jump by 390 percent. This shows the tremendous effect technical change has on relative surplus value. The switch to the 1963 level of worker consumption and the 1963 consumption mix dramatically reduces the rate of surplus value to 0.9328. The increased consumption of labor absorbs, as it were, the additional surplus generated by technical change.

The effect of the change in consumption pattern is also interesting. With 1948 technology, the shift from the 1948 to 1963 consumption mix (row 1, cols. 1 and 2) raises the rate of surplus value. With 1963 technology and 1948 consumption per worker, the shift from the 1963 to 1948 consumption mix (row 2, cols. 2 and 1) raises the rate of surplus. With 1963 technology and 1963 consumption per worker (row 2, cols. 4 and 3), the result is the same. The change in the sectoral distribution of consumption away from the actual distribution thus raises the rate of surplus value in the Puerto Rican case. Moreover, the change in the rate of surplus value from the shift in consumption mix is relatively small. This is probably due to the relatively small change in the consumption distribution,[19] rather than to the insensitivity of the rate of surplus value to the pattern of consumption.

V. Employment Multipliers

As Morishima has demonstrated, labor values are equivalent to employment multipliers (1973, chap. 1). Thus the labor value of a product is identical with the direct plus indirect labor required to produce it. In 1948, expenditures on sugarcane (2), paper (8), printing (9), communication (20), and government services (26) would have been effective in promoting employment, while in 1963 those on sugarcane (2), textiles (5), leather (6), paper (8), printing (9), construction (16), and government services (26) would have been likewise effective. On the other hand, final demand purchases of agriculture (1), processed foods (4), chemicals (10), hotels and restaurants (17), business services (22), personal services (23), and real estate (24) would have generated little employment in 1948, and those of agriculture (1), processed foods (4), chemicals (10), and real estate (24) little employment in 1963. For an open economy like that of Puerto Rico, promoting exports of those products with high labor values and underplaying exports of those with low labor values could prove effective in increasing overall employment.

VI. Summary and Conclusions

The startling result from this study is the relative stability of the rate of surplus value and its surprisingly high level, despite massive industrialization and the radical transformation of a society. On the basis of this result, it might be hypothesized that the rate of surplus value remains a relatively constant magnitude in a society over time (and across certain kinds of societies, as evidence from the Japanese economy seems to

[19] The sum of the absolute values of the differences of the consumption shares is a meager 0.0464.

indicate). Additional empirical work is needed to corroborate or refute this claim.

The movement of the rate of surplus value in Puerto Rico between 1948 and 1963 can be dissected into three components. First, technological change (especially the tremendous increase in productivity) dramatically raises the rate of surplus value. Second, a shift from the 1948–63 consumption mix results in a slight decline in the rate of surplus value. Third, the increased level of per worker consumption in 1963 results in a sharp drop in the rate of surplus value. Thus, increased productivity counteracts the effect of increased consumption and a new consumption mix on the rate of surplus value.

Additional findings are as follows: First, the discrepancy between the rate of surplus value and the profit-to-wage ratio is found to be quite large. This is accounted for by the high inverse association between the sectoral ratio of value to price and the sectoral consumption share. Second, the organic composition of capital falls considerably during this period of dramatic industrial change. Third, if imports are valued according to the labor value of exports, a tremendous jump in the rate of surplus value is observed. This is accounted for by the large deficit in Puerto Rico's balance of trade and the relative import intensity of worker's consumption.

The work presented in this paper represents a first attempt at the estimation of the rate of surplus value. If appropriate data are available, refinements in the method may be made. First, differential turnover periods by sector may be included in the estimation of the rate of surplus value. Second, better estimates of the depreciation row and column may be made if capital coefficients are available. Third, a distinction between productive and unproductive labor can be drawn and its effect on the rate of surplus value determined. Fourth, different consumption patterns might be estimated for workers and capitalists. Fifth, if manpower matrices are available, adjustments might be made for different occupational groups, requiring different costs of reproduction and consuming different baskets of goods (and perhaps suffering different rates of exploitation by occupation and sector). Estimates might also be made of the "surplus" content of managerial wages. Sixth, adjustments might be made for total hours worked per year by sector, occupation, and year. Data on hours per day worked, vacation time, and holidays are required.

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