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EMPLOYMENT, PRODUCTIVITY AND IMPORT SUBSTITUTION

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The purpose of this paper is to examine the relationship between productivity growth and employment growth. Such an examination has been done analytically in Part I and empirically in Part II. In Part III some policy implications have been discussed which are relevant to the employment problem and to the relationship between employment and productivity growth and the import substitution strategy of development. The general characteristics of import substitution have been detailed at length in preceding research memoranda in this series. Attention here has been concentrated on the implications of these characteristics for employment growth, and its relationship to productivity growth in countries pursuing such a strategy.

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Employment, Productivity and Import Substitution

The purpose of this paper is to examine the relationship between productivity growth and employment growth. Such an examination will be done analytically in Part I and empirically in Part II. In Part III some policy implications will be discussed which are relevant to the employment problem and to the relationship between employment and productivity growth and the import substitution strategy of development. The general characteristics of import substitution have been detailed at length in preceding research memoranda in this series. Attention here will be concentrated on the implications of these characteristics for employment growth, and its relationship to productivity growth in countries pursuing such a strategy.

Attention will be limited to employment in the manufacturing sector. Evidently in most countries the attack on the employment problem must include policies for the agriculture, service, and other sectors. Problems in these sectors are not discussed here, partly because import substitution affects employment in manufacturing more directly than in other sectors, and partly because the present paper must be of finite length. There are many aspects of the employment problem itself not discussed. Chief among these are problems of its definition

and measurement, and of the characteristics (e.g., age, education, etc.) of the unemployed. Such matters are of course important, but are beyond the scope of the present effort.

I. Employment and Productivity Growth

The rate of growth of labor productivity is usually measured as the difference between the growth rates of output and employment. This means of measurement of productivity growth creates a temptation to conclude that the more rapid the rate of growth of productivity the less rapid the rate of growth of employment. That such a temptation must not be yielded to is evident for at least two reasons. Most evident of course is the fact that output growth is not independent of productivity growth. Virtually all indices show that output growth and productivity growth move very closely together, so that in general we expect that the greater is productivity growth, the greater is output growth. Any effort, therefore, to dampen productivity growth to encourage employment growth is much more likely to reduce output growth than to increase employment growth. If we seek to maintain the rate of growth of output by compensating with increased inputs for the reduced productivity growth, problems will appear except under strong assumptions. It is unlikely that we can reduce that part of the growth of labor productivity not due to substitution without also reducing the productivity of capital and material inputs. To maintain

the growth rate of output would mean therefore an increased rate of investment, increased demand for foreign exchange, increased inputs of managerial and entrepreneurial talent. If this were possible, presumably it would already have been done. So it is appropriate to conclude that reducing labor productivity growth means reducing output growth.

Of much greater importance is the second reason. The calculation of employment growth as the difference between output and productivity growth represents the outcome of a process, not the process. To understand how productivity growth affects employment some attention to the nature of that process is necessary.

To fix ideas consider the production function

1.) $Q = F(K, L, t)$

where Q refers to real output, K and L to capital and labor inputs, and t to time. Homogeneity of the first degree in capital and labor is assumed, but evidently the function is not homogeneous of degree one in all arguments, i.e., including time. Converting to logs, differentiating with respect to time, and writing r_Q, r_K, and r_L for the proportionate rates of growth of output, capital, and labor, the familiar growth equation emerges

2.) $r_Q = ar_K + br_L + r_P$

where a and b are elasticities of production and r_P the rate of growth of output due to the passage of time ($\frac{1}{Q}\frac{dQ}{dt}$). Thus r_P represents Hicks neutral productivity growth, and the marginal product of labor and capital will grow due to the passage of time at the same rate as does output due to the passage of time.

The rate of growth of the marginal product of labor is (σ is the elasticity of substitution).[1]

$$3.) \quad r_{PL} = \frac{a}{\sigma}(r_K - r_L) + r_P$$

In equilibrium the rate of growth of the wage rate will equal that of the marginal product of labor. So rewrite 3.) using r_W in place of r_{PL} and get

$$r_W = \frac{a}{\sigma} r_K - \frac{a}{\sigma} r_L + r_P$$

$$4.) \quad r_L = r_K + \frac{\sigma}{a}(r_P - r_W)$$

Expression 4 shows that the greater is r_P, given r_W, the greater will be the growth of the demand for labor. If $\sigma = 1$ and r_W is zero, employment growth will exceed productivity growth, since a is less than unity. If σ is zero however, the last term of 4.) is zero, and employment growth will be limited to the rate of growth of capital.

The economic rationale of Expression 4 is that the increase in labor's productivity, while the wage rate is constant, raises the marginal product of labor above the wage rate, and thereby leads the profit maximizing producer to hire more

labor. Employment will continue to rise until the marginal product is pushed back down to the level of the unchanged wage rate. The labor market equilibrates to the increased productivity by increased employment rather than by rising wage rates. Thus the greater is productivity growth in a situation where the supply curve of labor is horizontal and $\sigma > 0$, the greater will be the growth of employment.

If 4 is substituted into 2, then

$$r_Q = ar_K + b\left\{r_K + \frac{\sigma(r_P - r_W)}{a}\right\} + r_P$$

5) $$= r_K + b\sigma\left(\frac{r_P - r_W}{a}\right) + r_P$$

Now subtract Expression 4) from 5), and

$$r_Q - r_L = r_K + b\sigma\left(\frac{r_P - r_W}{a}\right) + r_P - r_K - \frac{\sigma(r_P - r_W)}{a}$$

$$= \frac{b\sigma}{a}r_P - \frac{b\sigma}{a}r_W + r_P - \frac{\sigma}{a}r_P + \frac{\sigma}{a}r_W$$

$$= r_P\left(\frac{b\sigma}{a} + 1 - \frac{\sigma}{a}\right) + r_W\left(\frac{\sigma}{a} - \frac{b\sigma}{a}\right)$$

$$= r_P\left(\frac{b\sigma - \sigma + a}{a}\right) + r_W\left(\frac{\sigma - b\sigma}{a}\right)$$

$$= r_P\left(\frac{\sigma(b - 1)}{a} + 1\right) + r_W\left(\frac{\sigma(1 - b)}{a}\right)$$

$$= r_P(1 - \sigma) + \sigma r_W$$

6) $$r_L = r_Q - r_P(1 - \sigma) - \sigma r_W$$

7) $$r_L = r_Q - r_P + \sigma(r_P - r_W)$$

Expression 6 shows that only if the elasticity of substitution is unity and the rate of growth of wage rates zero, will employment and output grow at the same rate. This rate is higher than would be the case were wage rates to rise along with productivity. If σ exceeds unity, the neutral increase in productivity with constant wage rates results in employment growing more rapidly than output, and observed labor productivity falls, despite the upward shift in labor's productivity curve. In this event, labor's share of output will rise. Therefore a neutral shift, i.e., one which raises the marginal product of labor and capital by the same proportion, will increase labor's share. If then the equilibrating mechanism to rising productivity is increased employment, rather than increased wage rates, and if $\sigma > 1$, the neutral shift ultimately becomes labor using. The opposite result holds if $\sigma < 1$.

Expression 7 shows the content of the argument noted in the first paragraph of this section. The rate of growth of employment is equal to the difference between the rate of growth of output and productivity if either the elasticity of substitution is zero or if wage rates rise at the same rate as does productivity. Crucial to the effect of productivity growth on employment is therefore the extent of substitutability between capital and labor and the behavior of wage rates. Also output must grow, and this implies something about demand as well as about input bottlenecks not reflected in the arguments of the production function. Also non-neutral productivity shifts

qualify the preceding results. These several points may be considered briefly.[2] Attention may be called to the similarity of the preceding results with those obtaining from an analysis of the employment effect of a decline in wage rates with unchanged productivity. Few economists have argued that falling wage rates add to the unemployment problem.

1. Non-neutral Shifts in the Production Function. The introduction of non-neutral shifts into the preceding arguments can be done easily. Neutrality is defined as $r_P = r_{PK}$, where r_{PL} and r_{PK} are rates of growth of the marginal product of labor and capital respectively. Then any bias in the shift would be reflected by the difference between r_{PK} and r_{PL}. Write B for bias and

$$8) \quad B = r_{PK} - r_{PL}$$

Evidently $r_P = ar_{PK} + br_{PL}$, and then

$$9) \quad r_{PL} = r_P - bB$$

Expression 9 is now included in Equations 3 and 4 to get

$$10) \quad r_L = r_K + \frac{\sigma}{a}\left(r_P - r_W - bB\right)$$

If 10) is subtracted from 5)

$$r_Q - r_L = r_P\,(1 - \sigma) + \sigma\, r_W + \frac{\sigma}{a}\, bB$$

and

$$11) \quad r_L = r_Q - r_P\,(1 - \sigma) - \sigma\, r_W - \frac{\sigma}{a}\, bB$$

$$12) \quad r_L = r_Q - r_P + \sigma\left(r_P - r_W - \frac{b}{a}\, B\right)$$

The interpretation of Expression 12) is similar to that of 7). Thus a B in excess of zero will reduce the increase in demand for labor attributable to productivity growth exceeding the growth of the wage rate. Measures of bias are of course difficult, and we also need to know much more about why biasses occur. The hypothesis that B and r_W are positively related is discussed a bit in Part II.

Two related questions merit noting. In almost all manufacturing activities capital's share (a) of value added in the less developed countries is higher than in the more developed countries. Expression 4) above shows that the higher is a the lower is r_L, given the other growth rates and σ. Empirical evidence also suggests that more frequently than not a has been rising in recent years.

From the standpoint of explaining employment growth and of designing policies to facilitate its increase, we need therefore additional understanding of two questions.

a.) Why is a, capital's share, higher in the less developed country than in the advanced country? The fact that a is higher in the developing countries than in advanced countries suggests that the transfer of technology from the latter to the former countries would in fact help relieve the employment problem. Conventional wisdom of course has it the other way. (The lower labor share however could reflect an elasticity of substitution less than unity, if one believed that technology is the same in all countries or that it differed only by the

shift variable.) An exploration of why capital's share is in fact higher in the developing countries may help resolve this issue.

b.) Why does a appear to be rising over time in the manufacturing sector of the developing countries? The answer to this question is not independent of that to the preceding one, but something more is required also.

2. Demand. The preceding arguments show that if employment is to rise with the growth of productivity in a given sector output must also rise; therefore the quantity of the product demanded must rise. Rates of growth of productivity, capital, and demand in the various sectors will differ markedly. To try to follow through on the role that demand plays in this kind of situation, consider first a process in which productivity is growing in one sector, call it Sector A, but not in other sectors B, C, -- and r_K is zero in all sectors. Three outcomes may be identified. First, assume that, as productivity rises in Sector A, wage rates also rise by an equivalent proportion, capacity rises by r_p, and there is no increase in employment. Neither is there a change in cost per unit of output.[3] Demand for Sector A's output must then rise at r_p, or excess capacity will appear and labor released. If wage rates rise with productivity in Sector A, then the failure of the demand curve to shift rightward at rate r_p will result in Sector A releasing labor.

For the second case assume that wage rates remain constant, and equilibrium between wage rates and productivity re-established by increased employment. Labor costs per unit of output again remain unchanged, and capacity increases at a rate equal to $r_p \frac{b\sigma + a}{a}$ as shown in Expression 5 above. Demand must increase at this same proportionate rate or the employment growth obtained above can not be realized. In both of these cases if Sector A were confronted with a perfectly elastic demand curve, because of foreign trade, the demand problem would be readily solved.

A third case would be that in which there is initially no increase in wage rates, in demand, or employment. Then of course profit per unit of output rises and labor's marginal product exceeds the wage rate. Product prices may now be reduced without penalizing profit per unit of output. In this event, the marginal physical product of labor has risen, while the fall in the product price results in constancy of the marginal revenue product. Now what happens depends on the elasticity of demand for the product. If the price elasticity of demand is unity, the quantity of Sector A's product demanded will increase in the same proportion as does capacity, and employment will remain unchanged. If the price elasticity exceeds unity, Sector A's demand for labor will rise, and if the price elasticity is less than unity, employment in Sector A will be reduced. To the price effect on demand should of course be added any income effect operating in the economy. The elasticity concept is not

however entirely adequate here. If, for example, the downward shift in the cost curve due to the increased productivity enables Sector A to enter the export market for the first time, no elasticity measure would tell us what we need to know. It is evident also that employment growth is less in this situation than it would be were no reduction in price necessary. It is also evident that the greater is the elasticity of demand for the product, the greater will be r_L.[4]

If the demand curve must shift rightward under the first two outcomes to prevent employment from falling in consequence of productivity growth, would employment grow more rapidly as demand increased, were r_P zero and output growth due entirely to increased inputs of capital and labor? The answer is yes in one case and no in the other. If wage rates rise with productivity, then the increase in demand (equal to r_P) was necessary to prevent Sector A from releasing labor. Evidently of course if demand shifted at a rate equal to r_P while productivity growth is in fact zero, then demand for labor will grow at a rate equal to that of capital and output, namely r_P. Even here however, suppose that wage rates rise independently of productivity growth, i.e., would rise whether or not productivity increases, a rather common hypothesis. Without productivity growth, the rising wage rate would induce a rising capital labor ratio which would reduce r_L below r_K and r_Q. Similarly, if wage rates rise while productivity and demand are constant, employment would fall. In this case, increasing

productivity would prevent the reduction in employment.

In the case where r_W is zero, we have seen that employment will increase at a rate equal to $r_P\left(\frac{b\sigma + a}{a}\right)$ if demand also grows at this rate. If productivity growth were zero and demand and output grew at this rate, then employment will grow at more or less than this rate depending on the elasticity of substitution. In this case then employment growth is the same irrespective of whether output growth is due to productivity growth or to increased inputs if σ equals unity. It will be higher if $\sigma > 1$ and lower if $\sigma < 1$.

In the third outcome, in which a price reduction is effected, it is evident that, unless real wage rates (or profit rates) fall, the increase in productivity is a necessary (but not sufficient) condition for employment to increase.

3. Other Inputs. Expansion of output in response to productivity growth may be prevented by slow or zero growth in the supply of inputs other than capital and labor. The most obvious of such would be land and imports. It is of course evident that if output is constrained by inputs other than labor, and such inputs are not accessible, output cannot increase. Productivity growth would then produce unemployment. What happens to wage rates would depend on the labor market, and what happens there would in turn affect what happens to profits and to income distribution.

Two points suggest that, even if such a situation exists,

it does not lead to a policy of consciously holding back productivity growth. In the first place, productivity growth is essential for gaining entry into export markets, and increased exports are the most effective way to break the import bottleneck. In the second place, the existence of an import constraint, separate from other constraints, is itself evidence of misallocation of resources. The appropriate policy objective is that of correcting this misallocation, which will itself bring about an increase in productivity and employment. Misallocations are there to be corrected, not appeased.

Constraints in the form of labor of special skills may be a more intractable limiting factor unless foreign staff are available and acceptable. There is some evidence that unemployment of unskilled workers prevails because of the inadequate supply of skilled workers. If the supply and productivity of the latter were fixed while the productivity of the former rose and there existed a fixed ratio between the two, then unemployment of unskilled labor would increase. The correction of the latter would require the production of new skilled workers.

Again here, however, the source of the problem is rather clear, and it is the problem source which should be attacked. In particular, efforts to raise the productivity of unskilled workers will contribute to the breaking of the bottleneck. Thus here also productivity growth itself helps to break the bottleneck that impedes the increase in output. Evident also is the fact that such bottlenecks prevent growth of output,

irrespective of productivity growth, and thereby prevent the growth of employment.

4. Substitutability. Equation 7 shows that if the elasticity of substitution is zero then productivity growth can dampen employment growth. Also of course the greater is σ, the greater is the growth of the demand for labor. Thus the value of σ is central to the argument. A full-scale review of the evidence on the value of the elasticity of substitution requires a separate paper. Some summary observations may be offered to justify the position that very low σ's are not so common as to defeat the employment growth effort of increasing productivity.

a. Efforts to estimate the elasticity of substitution give reason to conclude that a figure between .5 and 1.5 is common. While such estimates are open to many questions, accumulated evidence for both developed and less developed countries all point to the legitimacy of assuming significant substitution between capital and labor as empirically demonstrated. Introduction of lags almost always results in higher estimated values than when no lags are included.

b. In addition to the quantitative evidence, there are other considerations that suggest the existence of significant substitutability. The most obvious and important of this type of evidence is the fact that rising wage rates make the use of aging capital uneconomic more quickly than would be the case if

wage rates were constant. Thus rising wage rates eliminates that employment associated with the quantity of capital that is made uneconomic. A similar point has to do with repair and maintenance. Such activities are among the most labor intensive of activities. As wages in such activities rise, repair costs rise and again capital that might otherwise be maintained and used is abandoned.

c. Where substitution is limited to the pre-construction stage, both the prevailing wage rate and the expected behavior of wage rates are relevant. In those countries where real wages have an established rising trend, it may be expected that entrepreneurs will be induced to anticipate the increased wage rate in the choice of technique. This seems especially likely where the increased real wage is, or is thought to be, a consequence of government policy or union pressure.

d. Substitution between capital and labor can be effected through increasing the time per day that capital is utilized. Gordon Winston[5] has shown the importance of this source of factor substitution, and of the importance of the level and structure of wage rates in explaining why physical capital is used such a small part of the day. Rising wage rates tend to dampen even further the extent to which capital is used in multiple shifts.

e. There is also the factor substitution that takes place via changing composition of output. Rising wage rates discourage the production of products that, for technological reasons,

necessarily use relatively more labor per unit of output and capital than do other products. Evidently concentration on products whose production is necessarily labor intensive is encouraged relative to other commodities by rising wage rates. Hence there is substitution of factors.

All of these considerations lead to the unwisdom of assuming a σ of zero.

Summary. The general conclusion that productivity growth can facilitate employment growth seems fully warranted. That wage rates should not rise as productivity rises, if employment and output growth are paramount objectives is clear. Distribution will change in favor of labor (with constant wage rates) if the elasticity of substitution exceeds unity, will remain unchanged if σ is unity, and will change in favor of capital if it is less than unity. Also employment and output growth are greater, the greater is σ, if productivity growth exceeds the growth of wage rates. Hence in sectors where σ is larger than unity, rising wage rates are especially damaging not only to employment growth, but to output growth and to increasing labor's share of income. Available evidence and argument suggests that σ's in the range of .5 to 1.5 or more are not uncommon.

Demand must increase or the demand curve must be horizontal for the full effect of productivity on employment growth to be realized. If the demand curve shifts as rapidly as

capacity or is horizontal there are no problems. If product prices must be reduced in order to induce the increase in the quantity demanded, employment growth is dampened. The extent of the dampening is limited, if, as a consequence of the reduced product price, export markets become available.

II. Some Empirical Evidence

The preceding arguments do not lend themselves to neat testing. This is due in part to lack of data and in part to the fact that r_p is not directly observable. As already emphasized, if equilibration to the increased productivity occurs entirely via increased employment, observed labor productivity growth can be positive, zero, or negative. Similarly if wage rates rise by less than the increase in productivity, observed productivity growth will understate the extent of the shift in the function. A direct confrontation between observed productivity growth and employment is therefore not a test of the arguments of Part I.

In this Part, two sets of calculations are reviewed. The first has to do with an examination of a demand for labor relationship in the manufacturing sector within countries. The second is a series of labor demand regressions for given sectors across countries. These will be taken up in turn.

1. The arguments of Part I show that the rate of growth

of employment should vary positively with the rate of growth of output (or capital stock) and inversely with rising wage rates and a bias in productivity growth favorable to capital (a positive B in Equation 8). As a (rough) measure of the bias in productivity, changes in capital's share of value added are used. It is of course evident that capital's share can change for reasons other than a bias in productivity growth, but its use does provide a reasonable clue. These considerations suggest the following empirical relationship.

$$13) \quad r_L = a + br_Q + cr_W = dr_{KS}$$

Expectations are that b is positive while both c and d are negative. The argument also implies that a should be zero, i.e., if r_Q, r_W, and r_{KS} are all zero, then r_L should be zero. The constant is therefore suppressed in the regressions shown in Table 1.[6]

An expression similar to 13) can be derived from a production function. To do this however requires such strong assumptions that they are rarely met.[7] Expression 13 is therefore to be considered a purely empirical equation, i.e., its parameters cannot be equated to those in a production function. Still we are entitled, as noted, to expect c and d to be negative. A b larger than unity would suggest decreasing returns, and one smaller than unity increasing returns. A c significantly different from zero and of the right sign is also consistent with an elasticity of substitution in excess of zero.

Data from the manufacturing sector of 15 developing countries were fit to Expression 13. Observations were for the two digit categories of the International Standard Industrial Classification for a given country. Thus we are, in effect, taking each manufacturing sector within a country as an observation from which to estimate the parameters of the equation for that country. Results are shown in Table 1. Several points may be noted.

a. The signs of all coefficients are as expected, a fact of considerable significance when working with data from developing countries.

b. The wage coefficient is significantly different from zero (by usual criteria) in all countries except Dominican Republic and Peru. A minimal statement is fully justified: Wage behavior matters in the understanding of employment.

c. Coefficients of r_{KS} are significantly different from zero (by usual criteria) for all countries except Brazil, Dominican Republic, and Peru. The addition of r_{KS} in almost all instances resulted in major changes in the coefficients of r_Q and r_W when the latter were estimated excluding r_{KS}.

d. The adjusted $\bar{R}^2$'s are all high enough to support a view of consistency between Expression 13 and the real world behavior of wage rates.

e. The size of those wage coefficients significantly different from zero vary from .23 for Chile to 1.31 for India, and all but three exceed .50. Thus the cost of rising wage

TABLE 1

Regression Coefficients of Rates of Growth of Employment on Output, Wages, and Capital's Share by Country

Country	Coefficient of Rate of Growth of Output	Wage Rate	Capital's Share	$\bar{R}^2$
Argentina (1950-60)	.72 (.05)	- .32 (.12)	- .60 (.12)	.87
Brazil (1953-62)	.59 (.06)	- .45 (.08)	- .03* (.14)	.95
Chile (1963-66)	.60 (.05)	- .23 (.03)	-1.02 (.20)	.74
Colombia (1953-66)	.94 (.05)	- .94 (.11)	-3.45 (.45)	.97
Dom. Republic (1953-65)	.88 (.19)	- .33* (.18)	- .16* (.10)	.69
Greece (1958-64)	.39 (.14)	- .98 (.09)	-1.44 (.41)	.87
India (1959-66)	1.07 (.05)	-1.31 (.14)	-1.29 (.12)	.98
Iran (1963-66)	.78 (.03)	- .81 (.06)	-3.03 (.19)	.94
Israel (1958-66)	.88 (.06)	- .84 (.09)	- .72 (.10)	.97
Korea (1958-66)	.87 (.03)	- .79 (.07)	-1.57 (.16)	.91
Malaysia (1961-65)	.67 (.06)	- .94 (.12)	- .44 (.12)	.80
Panama (1961-67)	.89 (.03)	- .83 (.04)	- .83 (.06)	.99
Peru (1963-66)	.58 (.11)	- .08* (.06)	- .25* (.53)	.55

TABLE 1 (cont.)

Country	Coefficient of Rate of Growth of Output	Wage Rate	Capital's Share	$\bar{R}^2$
Philippines (1958-66)	.96 (.03)	- .95 (.03)	-1.54 (.22)	.99
Southern Rhodesia (1959-65)	.77 (.10)	- .52 (.12)	- .65 (.13)	.52

Note: Coefficients computed from regression equations, $r_L = br_Q + cr_W + dr_{KS}$, were fit by ordinary least squares to observations of two digit industries of each country. Rates of growth computed from terminal year values. All data were taken from the editions of 1967 and 1968, The Growth of World Industry, United Nations, New York, 1969 and 1970.

* The asterisks identify those coefficients that are less than twice their standard error.

rates in terms of reduced employment growth is generally very marked. The extreme case is India. The average annual increase in wage rates (deflated by product price changes of course) of the 16 sectors included in the regression was 3.24 per cent per year. With a wage coefficient of 1.31, a rate of growth of employment of 4.24 was forgone. On the other hand, where the average r_W was negative over the period covered, as in the Philippines, employment growth was greatly encouraged. For the Philippines the average r_W for the 17 sectors was -2.42 per cent per year, and the average of r_L 6.36 per cent compared to 4.69 per cent for r_Q. Even if one assumed that changes in capital's share were, in some sense, beyond the influence of policy, a wage policy directed toward keeping wage rates constant would yield great returns for employment growth.

f. The simple correlation between the rate of growth of wage rates and that of capital's share of value added was rarely significantly different from zero, but it was negative in 12 of the 15 cases. In all but three of countries (Chile, Israel, and Southern Rhodesia), average r_{KS} is positive. If the change in capital share is in fact due to a bias in productivity growth, the absence of a significant relationship between r_{KS} and r_W indicates that rising wage rates do not induce such bias. On the other hand, one may assume that the preponderance of negative correlation coefficients means only that the elasticity of substitution is less than unity.[8]

Before discussing what these results tell us about the

relationship between the rates of growth of employment and productivity growth, it is useful to consider another set of regressions.

2. Instead of using the various two digit manufacturing sectors of a given country to obtain a country regression, it is possible to employ data from a given sector across countries to obtain a regression for each sector. These regressions are shown in Table 2.

The results shown in Table 2 tell a story very similar to that of Table 1. Except for Sector 32, all signs are consistent with the arguments of Part I. With only isolated exceptions all coefficients are at least twice their standard error. The oddest result is the insignificant coefficient of r_Q for Sector 22. This result is of course difficult to accept. Wage coefficients are usually somewhat lower than the country regressions, while those for r_{KS} are frequently higher. These differences, though evident, are small and not generally significant.

The simple correlation coefficient between r_W and r_{KS} was negative, but usually insignificant, in all but three sectors. As already noted this negative relationship is consistent with an elasticity of substitution of less than unity. More confidently, one can say that this relationship suggests that rising wage rates do not induce a bias in productivity growth that raises capital's share.

The results shown in Tables 1 and 2 surely justify the

TABLE 2

Regression Coefficients of Rates of Growth of Employment on Output, Wages, and Capital Share by Sector

Sector	Coefficients of Rate of Growth of Output	Wage Rate	Capital's Share	$\bar{R}^2$
20 Food	.69 (.06)	-.77 (.08)	-.91 (.15)	.81
21 Beverages	.30 (.07)	-.14 (.06)	-.40 (.16)	.23
22 Tobacco	.13* (.14)	-.26 (.05)	-.62 (.21)	.23
23 Textiles	.75 (.07)	-.47 (.12)	-1.11 (.16)	.87
24 Footwear	.80 (.09)	-.59 (.08)	-1.33 (.30)	.74
25 Wood	.70 (.05)	-.66 (.06)	-.31 (.08)	.91
26 Furniture	.87 (.06)	-1.01 (.06)	-1.77 (.19)	.97
27 Paper	.78 (.03)	-.47 (.07)	-.07* (.04)	.96
28 Printing	.69 (.08)	-.70 (.13)	-1.05 (.24)	.76
29 Leather	.90 (.20)	-.43 (.06)	-.55 (.16)	.35
30 Rubber	.84 (.05)	-.47 (.04)	-1.03 (.13)	.85
31 Chemicals	.62 (.07)	-.14* (.08)	-.55 (.23)	.63
32 Petroleum	.49 (.08)	.05* (.09)	.53* (.47)	.27

TABLE 2 (cont.)

Coefficients of Rate of Growth of

Sector	Output	Wage Rate	Capital's Share	$\bar{R}^2$
33 Non-Metallic Minerals	.76 (.06)	- .33 (.10)	- .77 (.35)	.78
34 Basic Metals	.69 (.08)	- .73 (.10)	- .49 (.16)	.85
35 Metal Products	.68 (.06)	- .28 (.05)	-1.96 (.32)	.77
36 Non-electric Machinery	.80 (.06)	- .28 (.11)	- .32 (.13)	.87
37 Electric Machinery	.86 (.03)	- .79 (.09)	-1.15 (.22)	.98
38 Transport Equipment	.77 (.04)	- .65 (.08)	- .39 (.12)	.97
39 Misc. Manufacture	.78 (.04)	- .99 (.06)	-2.63 (.26)	.97

Note: Coefficients computed from regression equations, $r_L = br_Q + cr_w + dr_{KS}$, by ordinary least squares to observations for a given two digit sector across countries. Growth rates were computed from terminal year values. The interval of time for which data are available is not the same for all countries, but this should not impose any bias on the results. All data were taken from the 1967 and 1968 editions of The Growth of World Industry, United Nations, New York, 1969 and 1970.

* The asterisks identify the coefficients that are less than twice their standard error.

conclusion that rising wage rates have a negative effect on employment growth, and this effect is large enough to justify policy measures.

Do these results indicate anything about the relationship between productivity growth and employment growth? Expression 7 in Part I is

$$7) \quad r_L = r_Q - r_P + \sigma (r_P - r_W)$$

From this expression it is evident that an r_W matched by an equal r_P would have no effect on employment growth. Thus the effect of r_W on employment shown in Tables 1 and 2 is an effect due to the difference between r_P and r_W. Since the coefficient of r_W is always negative as 7) says it should be, we are entitled to conclude that the coefficient of r_P (were it measurable) would be positive. Thus the empirical results of the regressions shown in Tables 1 and 2 are consistent with the arguments of Part I that the greater is productivity growth, given the growth rate of wages, the greater will be employment growth.

III.

In Parts I and II the elasticity of substitution, productivity growth, and growth of wage rates have been shown to be strategic in the explanation of employment growth in developing countries. Evidently policies that result in increasing either productivity growth or the elasticity of substitution on the

one hand, and that prevent market wage rates from rising on the other will contribute to employment growth. In particular, the results support the view that a wage subsidy will have significant effects on employment.

A substantial number of the studies of the nature of the import substitution strategy in this series have shown that that strategy contributes to the creation of an economic environment that dampens productivity growth and facilitates rising wage rates. In addition, import substitution, as generally practiced, has tended to result in the evolution of a rather rigid, inflexible manufacturing sector. In such a sector the capacity to respond to changing factor prices is reduced.[9]

More generally, the import substitution strategy, as described in previous memoranda, has affected those variables strategic to employment growth in such a manner that employment growth was severely dampened. To put the matter positively, employment growth in the manufacturing sectors of the developing countries has often been penalized more by the policies followed than by matters beyond the control of the policymaker. This conclusion does not mean, of course, that the employment problem in the economy can be easily resolved. In particular, employment growth in agriculture has not been included here and is evidently of great importance in the overall employment problem.

Footnotes

1. Write k for the capital labor ratio ($\frac{K}{L}$), w (wage rate) and r (rate of return) for the productivity of labor and capital respectively, $v = \frac{dw}{w}\frac{k}{dk}$, and $u = \frac{dr}{r}\frac{k}{dk}$. Evidently the proportionate increase in labor productivity due to a rising capital labor ratio is vk. Also $r = f'(k)$, $\frac{dr}{dk} = f''(k)$, and $\frac{dw}{dk} = -k \cdot f''(k)$, where $f''(k)$ is negative by assumption as to the nature of production function. Then $u = -f''(k)\frac{k}{r}$ and $f''(k) \cdot k = -u \cdot r$. So

$$\frac{dw}{w} \cdot \frac{k}{dk} = u \cdot k \cdot \frac{r}{w}$$

$$= u \cdot \frac{rK}{WL}$$

$$\frac{dw}{w} = u \cdot \frac{rK}{WL} \cdot \frac{dk}{k}$$

From Equation 2 in the text $a = \frac{rK}{Q}$ and $1 - a = \frac{WL}{Q}$, so that $\frac{rK}{WL} = \frac{a}{1 - a}$ and then

$$v = \frac{dw}{w}\frac{k}{dk} = u\frac{a}{1 - a}$$

and

$$\frac{v}{u} = \frac{a}{1 - a}$$

The elasticity of substitution may be defined as $\frac{1}{\sigma} = \frac{d(\frac{w}{r}) \cdot \frac{r}{w}}{dk/k}$. Since we can write

$$d\left(\frac{w}{r}\right) \cdot \frac{r}{w} = \frac{dw}{w} - \frac{dr}{r}$$

then $$\frac{1}{\sigma} = \frac{dw}{w}\frac{k}{dk} - \frac{dr}{r}\frac{k}{dk}$$

$$= v + u$$

$$\sigma = \frac{1}{v + u}$$

Using $\frac{v}{u} = \frac{a}{1 - a}$, we finally get $v = \frac{a}{\sigma}$ as used in Expression 3). This derivation follows that given in Philip A. Neher, Economic Growth and Development: A Mathematical Introduction. New York: John Wiley and Sons, Inc. 1971 Chapters 5 and 6.

2. The sources of growth of productivity may also matter, but all that can be done here is to note a few questions.

a. Does productivity growth due to embodied technical change modify the argument? In this case there is both capital formation and productivity growth. Does this mean that we get employment growth from both the new capital and from the productivity growth -- if other conditions (constant wages, demand, etc.) are met?

b. Similar questions may be asked about learning-by-doing. The chief complication of this source of productivity growth is that new entrants, by definition, are not as productive as old workers until the elapse of some time. In this case, the productivity curve of new workers remains fixed, while that of existing workers shifts rightward. Will there then be any employment effect, even if wage rates are constant and other conditions for expansion met?

c. Productivity growth due to the fact that new

entrants to the labor force have more and better education creates the opposite kind of problem. In this case, new workers and more productive than existing ones, so what then will happen to employment?

d. If there are increasing returns to scale, some additional problems may emerge.

To measure empirically the various sources of productivity growth is generally not possible, and nothing further will be attempted in this report.

3. Define profits as $\Pi = PQ - wL - aK$ where P is the price of the product and w and r returns to labor and capital respectively. In equilibrium profits are zero, so cost = $P = w\frac{L}{Q} + r\frac{K}{Q}$. As $\frac{L}{Q}$ and $\frac{K}{Q}$ fall at rate r_P, wage and profit rates rise at the same rate, so that cost per unit does not change.

4. If the price of the product is introduced into Equation 4, it becomes

$$r_L = r_K + \frac{\sigma}{a}(r_P - r_W + r_i)$$

where r_i is the proportional rate of growth of the price of the product. If r_i is negative but equal in absolute value to r_P (and r_W is zero), employment growth is limited to that due to capital formation. In this event, the shift in the physical productivity curve of labor is countered by the fall in product price, so that the marginal revenue curve of labor (the curve determining employment) has, in effect, remained unchanged.

What happens to capital formation (and output) and, hence employment then depends on the change in the quantity demanded subsequent to the price decline.

With a product price introduced Equation 7 becomes

$$r_L = r_Q - r_P + \sigma(r_P - r_W + \ _i)$$

Now if r_i in absolute terms equals r_P, and r_W is zero, $r_L = r_Q - r_P$ again. If the demand curve has an elasticity of unity, the quantity demanded (and output) will grow at a rate equal to r_P. So employment will remain constant. If the elasticity exceeds (is less than) unity, demand and output will grow at a rate greater (less) than that of productivity, and employment will rise (fall) in the sector. As noted in the text however, if the fall in price opens new export markets, the elasticity concept does not tell us all we need to know.

5. Gordon C. Winston, "Capital Utilization and Employment: A Neoclassical Model of Optimal Shift Work." mimeographed, May, 1971.

6. Regressions were also fitted without suppressing the a, and in most instances (not all) it was not significantly different from zero at conventional levels of significance.

7. Jeffrey G. Williamson, "Capital Accumulation, Labor Saving, and Labor Absorption Once More," Quarterly Journal of Economics, 85 (February 1971), 41-65, provides an excellent analysis of labor demand functions derived from production

functions. He then uses Philippine data in the various models to derive estimates of elasticity of substitution, returns to scale, and lags. Data availability prevent such a complete analysis for many developing countries. This Williamson paper is perhaps the best study available of labor demand functions for a single country.

8. If this latter interpretation is accepted, the economic rationale of the significant relationship between r_L and r_{KS} is less clear.

9. On these points see Henry J. Bruton, "The Import Substitution Strategy of Economic Development: A Survey," The Pakistan Development Review, Summer 1970. This article reviews the findings of the first 24 Research Memoranda in the AID-Williams College contract. Later Research Memoranda that are pertinent to the present argument are RM-28, John B. Sheahan, "Import Substitution and the Terms of Trade;" RM-33, John B. Sheahan, "Criteria for Investment Allocation in Colombia;" RM-34, Stephen R. Lewis, Jr., "Domestic Savings and Foreign Assistance When Foreign Exchange is Undervalued;" RM-36, John R. Eriksson, "Wage Change and Employment Growth in Latin American Industry;" and RM-40, Gene M. Tidrick, "Wages, Output, and the Employment Lag in Jamaica."