GOVERNMENT POLICY AND THE SELECTION OF TECHNOLOGY IN THE INDONESIAN WEAVING INDUSTRY

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I. INTRODUCTION

ECONOMISTS and others have long argued that government policies often have an adverse effect on the choice of technology in developing countries. Governments are alleged to encourage the adoption of excessively capital-intensive techniques through the pricing of foreign exchange, distortions in the labor and capital markets, taxation and other fiscal policies, and a wide range of regulative measures. Myint, for example, has argued that: "scarce inputs such as capital funds, foreign exchange and public economic facilities... are being made available on excessively favourable terms to the larger units in the modern sector...and on excessively unfavourable terms to the small economic units in the traditional sector" [7, pp. 315–16]. However, while much has been written in general terms on the deleterious effects of these policies, less attention has been given to detailed studies which attempt to measure their impact on the choice of technique, on an industry-by-industry basis.[1] Although formidable conceptual and measurement problems do exist, a more fruitful task now is to *calculate*, in approximate terms, the effect of alternative government policies on the selection of industrial technology. The purpose of this article is to illustrate one approach to the issue, using the Indonesian weaving industry as a case study.

This industry has experienced a rapid transformation since the mid-1960s. In contrast to the modest growth of the 1950s and stagnation of the early 1960s, the change of government in 1966 ushered in a period of unprecedented development. Output more than quadrupled from 1968 to 1978, a modern, large-scale

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[1] Notable exceptions include Bhalla [1] and Stewart [16], and research being conducted at the University of Strathclyde [see the special issue of *World Development*, Vol. 5, Nos. 9 and 10 (September/October 1977), edited by James Pickett] and at the Economic Growth Center, Yale University (see Ranis [11]).

factory sector emerged and, more recently, textile exports have begun to expand. There has also been a dramatic change in the technology in use. Automatic looms, virtually nonexistent before 1966, probably accounted for between one-half and two-thirds of total output in 1978. The once dominant handlooms now contribute about 5 per cent of output. The technological transformation has been so rapid that, despite the enormous increase in output, employment growth has been minimal.[2] The poor record of labor absorption raises important questions regarding the choice of weaving technology: are efficient more labor-intensive techniques available which would generate greater employment? To what extent, if at all, have government policies discouraged the adoption of these techniques? This article attempts to answer these questions, focusing in particular upon the effect of three government policies—the exemption of duty on imported machinery, the ban on the import of secondhand textile machinery, and the pricing of foreign exchange.

The Indonesian weaving industry is well suited to a study on the choice of technology. It is an important industry, being the major employer of labor in the Indonesian manufacturing sector. Thus the employment implications of the analysis are significant for manufacturing as a whole. The industry possesses a wide range of techniques, ranging from the improved handlooms to full-automatic mechanized looms. Furthermore, cloth produced by each of the main techniques are relatively close substitutes (although some specialization in the production of different *types* of cloth between techniques is present); indeed, quality differences between techniques are probably less in weaving than in any other major industry. (This has important implications, which will be addressed in the conclusion.) Finally, the task performed by each of the weaving techniques—that is, the conversion into cloth of yarn which has undergone several preparation stages—is substantially the same. Unlike many other industries, the techniques are directly comparable.

This paper is organized as follows. Section II explains the details and origins of the three policies. In Section III our methodology and data sources are presented. Section IV assesses the effect of each of the policies on the economic performance of the four main techniques in the industry. The analysis is conducted using both actual factor prices, that is, wage and interest rates paid by firms using the different techniques, and shadow factor prices, which better reflect the social opportunity cost of these resources. In conclusion, Section V summarizes our results and considers the wider implications for choice of technique studies in developing countries.

II. THE POLICIES

Although ownership in the Indonesian manufacturing sector is predominantly

[2] The evidence on employment trends in the industry is assessed by Hill [4, pp. 83–90]. Employment in the industry may show a significant increase in the future, because further displacement of the handloom sector is unlikely. Few handloom firms now are producing cloth in direct competition with the modern mill sector.

private, government intervention and regulation is pervasive. Many policies have important implications for the selection of technology. Attention in this section is focused on three of these policies.

A. *Prohibition of the Import of Used Machinery*

Like many developing countries, the Indonesian government has an ambivalent attitude toward the import of used machinery. Even during the relatively liberal period of the late 1960s and early 1970s when such imports were permitted, severe restrictions were imposed.[3] In 1974 the government imposed a ban on the import of all secondhand textile machinery. In the following year, firms were no longer permitted to include any used machines in applications to the Investment Coordinating Board (Badan Kordinasi Penanaman Modal, BKPM) for investment incentives.[4] The prohibition was introduced despite theoretical evidence regarding the superiority of used equipment, in terms of savings in costs and foreign exchange, and greater employment creation.[5] Moreover, the ban runs counter to the government's frequently expressed desire to assist the *golongan ekonomi lemah* ("weak economic group") because small mills in Indonesia invariably commence operation with a substantial proportion of used looms. In fact, the government's policies regarding used machinery have adversely affected small, labor-intensive weaving firms in three ways: they are forced to pay a higher price for their looms because the ban has pushed up the domestic price of used looms; they are excluded from the investment incentives offered to the buyers of new looms; and the large firms against which they compete are able to command higher prices when selling their old looms.[6]

There is no evidence that the ban was imposed to protect the domestic capital goods industry, which is very small. Official reasons for the ban are vague, but there appear to be two main factors. First, a widespread feeling that used machinery which has been discarded by industrialized countries is in some sense inferior, and that a country aiming for rapid modernization and development should not permit its import. Government officials were not alone in holding these views, as several reports to the Indonesian government by international

[3] In the case of textiles, for example, the government required that machinery imported be no more than eight years old, that supplies of spare parts be "guaranteed," and that the used price should not be more than half of the current new price.

[4] After our research was completed, the prohibition appears to have been partially lifted, although very tight restrictions and lengthy bureaucratic procedures still apply.

[5] See, for example, Sen [14] and Schwartz [13].

[6] This is not to deny that the theoretical benefits of access to imported used machines may have been overstated in the literature. In one of the few empirical investigations of the international trade in used machinery, Cooper and Kaplinsky [3] argued that the market (for jute machinery) was "highly imperfect" and that there are "good practical reasons for being sceptical" about the possible savings. It should be noted, however, that textiles is a much larger industry, and that the international trade in used textile machinery is well developed. Moreover, there are close links between the Chinese business community in Indonesia and their counterparts in Singapore and Hong Kong, a factor which has facilitated the machinery trade in the past.

agencies had advocated a similar policy. Second, the government wished to reduce under-invoicing on imported machinery. Prior to the ban, firms were able to evade import duties by obtaining false documents stating that their new machinery was in fact secondhand. The prohibition was an administratively convenient method of preventing this practice, even though firms could apply for exemption on the import duty (see next subsection).

B. *Exemption of the Duty on Imported Machinery*

Since 1967 and 1968 the government has offered a wide range of fiscal incentives to foreign and domestic investors, respectively. These include full tax holidays of between two and six years, an investment allowance of up to 20 per cent for projects not eligible for the tax holiday, accelerated depreciation allowances, indefinite carry-forward of losses incurred in the first six-year operation, exemption from import duty on raw materials and equipment for the first two years, and a tax amnesty provision for domestic investors. The incentives apply both to new factories and, where appropriate, to extensions to existing plants (providing *new* machinery is purchased). The effect of several of these incentives is to reduce the price of capital relative to labor, and thus impart a bias toward capital intensity. Despite many official statements regarding the importance of employment creation, in practice little weight has been given to this goal.[7]

Attention here is focused on the effect of the import-duty exemption, for two reasons. First, it can be incorporated into the framework of analysis relatively easily. Second, in the presence of a general import duty, the exemption for capital equipment unambiguously distorts relative factor prices. Other fiscal incentives, such as tax holidays, do not necessarily have this distortionary effect because, in theory at least, they are technique-neutral.

C. *The Exchange Rate*

Advocates of greater liberalization see the pricing of foreign exchange as a crucial issue. Overvalued exchange rates, it is argued, provide a strong stimulus to the selection of excessively capital-intensive techniques. In the case of Indonesia, the issue of the appropriate exchange rate is particularly complex, however, because it belongs to a small group of oil-rich developing countries.[8] From 1971 to 1978 (our data refer to 1977) the Indonesian rupiah was tied to the U.S. dollar, whereas the (Jakarta) consumer price index rose more than twice as fast as that of the United States. As a result, labor-intensive firms in com-

[7] However, there is recognition of the effect of these policies in some official quarters. For example, commenting on instances of "inappropriate technology" in Indonesia, Professor Sadli, a leading economist and the Minister of Manpower for over a decade, observed that "the incentive system ... may have contributed much to the distortions .... [It] distorts factor prices and puts a premium on capital intensity" [12, pp. 366–67].

[8] The four monthly "Survey of Recent Developments" in the *Bulletin of Indonesian Economic Studies* is an authoritative review of developments in Indonesia's balance of payments and the economy as a whole.

petition with capital- and import-intensive operations were adversely affected because the latter's inputs were cheapened owing to the fixed exchange rate. Many economists have argued that the overall effect on the labor-intensive sector in the 1970s was severe.[9]

But it must be emphasized that the exchange rate was fixed over this period *not* because the government deliberately intended to maintain a disequilibrium (overvalued) rate; indeed, before the financial difficulties of the state oil enterprise (Pertamina) in 1975, the free-market rate would almost certainly have been lower, i.e., a devaluation would have occurred [2, p. 5]. Rather, the rate was maintained, in spite of Indonesia's inflation rate exceeding that of its major trading partners, because of the growth of its principal exports, particularly oil. The strengthening of Indonesia's export sector has led to a fundamental change in the country's comparative advantage and, in the process, created problems of structural adjustment. Labor-intensive activities—in weaving, handlooms, and simple power looms—competing with more import-intensive firms in the modern sector have experienced serious difficulties. A good case might be advanced for some form of adjustment assistance to them, on income distribution and employment grounds.

III. METHODOLOGY AND DATA SOURCES

The purpose of this section is to illustrate briefly how the simple neoclassical approach to the choice of technique may be modified to provide a useful analytical framework in which to evaluate the economic performance of the main weaving techniques.[10] Three important modifications to the abstract neoclassical version are required. First, the assumption of a limited range of techniques is unrealistic. In practice, the isoquant consists of a series of segments rather than a smooth curve. This has the effect of generating a *range* of factor price combinations over which a given technique will be economically efficient, rather than a *single* wage-interest ratio. Second, the assumption that different techniques produce homogeneous goods with the same selling price is untenable. In practice, goods produced by different techniques are usually qualitatively different and both their prices, and the prices of inputs used in their production, differ substantially. Consequently, output is measured not in terms of physical units but rather in terms of value added. Finally, the slope of the iso-cost line should be given by the present value of an annual stream of wages. Measuring the slope in terms of the wage-interest ratio is unsatisfactory because it is "timeless": capital is paid for in year 0 and yet wages are paid over the economic life of the machinery.[11]

On the basis of these modifications an isoquant can be constructed for the Indonesian weaving industry, representing combinations of capital and labor

[9] See, for example, Paauw [8].

[10] This section is based on Hill [5]. The exposition is greatly condensed. For a fuller discussion of the issues, see Hill [4, chaps. 8 and 9].

[11] For a proof of this proposition, see Hill [4, pp. 290–91].

TABLE I
ISOQUANT CALCULATIONS

	Technique			
	H	M1	M2	M3
Data per unit:				
Annual output (m)	2,500	9,408	19,404	24,696
Investment costs (Rp.)	61,943	791,157	2,343,451	3,862,578
Labor : Machine	1.06 : 1	0.74 : 1	0.5 : 1	0.28 : 1
Data per 10,000 meters cloth:				
Investment costs (Rp.)	247,772	840,941	1,207,715	1,564,050
Labor (units)	4.24	0.787	0.258	0.113
Value added (Rp.)	353,900	368,800	412,400	431,500
Data per Rp. 3 million value added:				
Investment costs (Rp.)	2,100,356	6,840,624	8,785,515	10,874,044
Labor (units)	35.94	6.40	1.88	0.79

Note: Isoquant slopes: M3—M2=1,916,082; M2—M1=430,286; and M1—H=160,474.

required to produce a given value added for the four main techniques in the industry.[12] A summary of the procedure for constructing the isoquant, and the results, are presented in Table I. The data refer to medium quality combric, a major type of cloth produced. (Similar calculations were made for *sarung,* and the results found to be broadly similar.) The first section of the table presents data on investment costs and labor-to-machine ratios for each technique. The data are then converted to investment costs and labor units for the same physical unit in the second section. Finally, the data are standardized for a given value added. (10,000 meters and 3 million rupiah are chosen purely for convenience; any figures would suffice.)

Table I indicates that all techniques are *technically* efficient, in that no technique uses more of both factors of production to produce a given value added. To assess their *economic* efficiency, factor prices must be introduced. Two sets of wage and interest rates are used. First, actual factor prices, which approximate average wage and interest rates firms using each of the techniques were observed to pay. These prices enable us to determine whether or not the techniques are economically efficient given actual market conditions, and whether investors are economically rational in selecting these techniques. Second, a set of shadow prices, which better reflect the social opportunity cost of labor and capital to firms in the industry. These prices enable us to ascertain which is

[12] The four techniques are: fully-automatic, imported power looms (labelled here as M3); semi-automatic, mechanized power looms (M2); non-automatic, locally-produced power looms (M1); and locally-produced improved handlooms (H). For a description of the four techniques and the derivation of the data in Table I, see Hill [5, sec. III]. Our financial and technical data were obtained from detailed interviews with the owners of a representative sample of eighty-one firms in the industry (ten M3 firms, twenty-three M2 firms, nine M1 firms, and thirty-nine H firms) based on sixteen-month research in Indonesia. All financial data have been standardized at August 1977.

TABLE II

TYPICAL ACTUAL AND SHADOW FACTOR PRICES BY TECHNIQUE

Technique	Wage Rate[a] (Rp./Year)		Interest Rate[b] (%)	
	Actual	Shadow	Actual	Shadow
M3	240,000	216,000	6	12
M2	150,000	142,500	9	14
M1	105,000	105,000	15	16
H	52,000	52,000	24	18

Sources: [4] [5].

[a] Refers to production worker.

[b] These are *real* interest rates. Discounting annual wages by the nominal interest rate to obtain the present value figure effectively understates the real wage cost because of the effect of inflation.

the preferred technique from the social point of view. Actual and shadow factor prices for each of the techniques are presented in Table II.[13]

Having specified these factor prices, it is possible to determine the economic efficiency of the techniques by graphing the isoquant and the iso-cost lines. There are two lines for each technique, representing actual and shadow factor prices. If the relevant iso-cost line intersects the isoquant at the point representing the technique, it can be concluded that the technique is not economically efficient at the given wage and interest rate. The slope of the iso-cost line, being equivalent to the present value of a stream of annual wages, is calculated as follows:

$$W+\frac{W}{1+r}+\frac{W}{(1+r)^2}+\cdots+\frac{W}{(1+r)^n}=W\left\{\frac{1}{r}\left[1-\frac{1}{(1+r)^n}\right]\right\},$$

where W = annual wages, r = rate of interest (and discount rate), n = working life of the machinery (years).

A more convenient form of data presentation, however, is through the calculation of "boundary prices" for each technique. These are combinations of factor prices within which a given technique is economically efficient. They are calculated from the annuity formula above, using the slope of each segment of the isoquant (given in the note to Table I). These segments represent the maximum and minimum slopes of the iso-cost line for which a given technique is economically efficient (that is, for which the iso-cost line does not intersect the isoquant). In effect, therefore, the slope of each segment of the isoquant is equivalent to the maximum and minimum present value of the stream of annual wages. By specifying a given annual wage (interest rate) and discount period, the maximum

[13] Actual factor prices refer to average wage and interest rates paid by firms in our sample. The shadow prices are an approximate attempt to correct for the effect of distortions in the factor markets. (Unfortunately, a full set of accounting prices is not available for Indonesia.) Both sets of prices should be taken only as a general guide; in practice there exist considerable *intra*-technique factor price variations. For a brief explanation of the derivation of these prices, see Hill [5]. A fuller exposition is given in Hill [4, chap. 6 (interest rates), chap. 7 (wage rates), and pp. 327–34 (shadow prices)].

TABLE III

BOUNDARY WAGE AND INTEREST RATES: ACTUAL AND SHADOW FACTOR PRICES

Technique	Annual Wage for Given r (Rp.)				r for Given Wage (%)		
	max/min	12%	24%	36%	max/min	Actual	Shadow
Case I: Existing policies							
M3	min	237,869	460,585	689,858	max	12.1	10.8
M2	max	237,869	460,585	689,858	max	34.9	33.1
	min	53,417	103,432	154,918	min	6.7	6.2
M1	max	53,417	103,432	154,918	max	65.4	65.4
	min	19,922	38,575	57,776	min	24.4	24.4
H	max	20,460	38,692	57,797	min	32.4	32.4
Case II: Import of used machinery permitted							
M3	min	276,913	523,666	782,230	max	10.0	8.7
M2	max	276,913	523,666	782,230	max	36.3	34.4
	min	52,729	99,716	148,951	min	4.7	4.2
M1	max	52,729	99,716	148,951	max	82.7	82.7
	min	16,188	30,613	45,728	min	25.3	25.3
H	max	16,188	30,613	45,728	min	41.0	41.0
Case III: A duty on imported machinery							
M3	min	259,475	502,420	752,517	max	11.0	9.7
M2	max	259,475	502,420	752,517	max	27.8	26.4
	min	66,944	129,623	194,147	min	5.9	5.4
M1	max	66,944	129,623	194,147	max	60.7	60.7
	min	21,491	41,613	62,327	min	19.4	19.4
H	max	22,072	41,740	62,350	min	30.0	30.0
Case IV: Devaluation							
M3	min	293,858	568,996	852,234	max	9.5	8.3
M2	max	293,858	568,996	852,234	max	21.0	19.9
	min	88,456	171,276	256,534	min	4.8	4.3
M1	max	88,456	171,276	256,534	max	54.3	54.3
	min	23,988	46,447	69,568	min	14.5	14.5
H	max	24,636	46,589	69,593	min	26.8	26.8

Notes:

1. The boundary price data are calculated by using the annuity formula in reverse. For example, in case I, technique M3, the slope of the isoquant between M3 and M2 is 1,916,082 rupiah (from Table I). Thus, at an interest rate of 12 per cent and an operating life of thirty years, the minimum wage rate for which M3 is economically efficient is obtained as follows:

$$1{,}916{,}082 = W\left[\frac{1}{0.12}\left(1-\frac{1}{1.12^{30}}\right)\right].$$

2. Since M3 and H are at either end of the isoquant, only a single value (maximum or minimum) can be calculated.
3. Unlike the other techniques, the maximum wage for H and the minimum wage for M1 are not the same. This is because (realistically) handlooms are assumed to be purchased secondhand and thus have a shorter working life (twenty-five years, as compared with thirty years). The exception is case II where all looms are purchased secondhand.

and minimum interest rates (wages) consistent with economic efficiency can be determined. The results are presented in Table III (case I).

IV. THE EFFECT OF ALTERNATIVE GOVERNMENT POLICIES

Table III (case I) indicates that at the actual factor prices given in Table II, techniques M3 and M2 are economically efficient, and thus economically rational from the point of view of profit-maximizing investors. However, interest rates would have to be considerably higher, or wages lower, for the two labor-intensive techniques (M1 and H) to be economically efficient. In the case of shadow prices, if the price signals were "correct," M2 emerges as the desired technique. For all others, the combination of shadow factor prices in Table II lies outside the boundary prices in Table III (case I). Clearly, the widespread use of fully-automatic machinery has been encouraged in part by factor-market distortions.

Two sets of factors determine the economic performance of the four techniques. First, those which affect the shape of the isoquant, that is, the capital and labor requirements to produce a given value added. Second, relative factor prices, which determine the slope of the iso-cost line. In this section we return to the main topic of the article and examine the first set of factors. In particular, our aim is to analyze the effect of the three government policies (discussed in Section II) on the selection of technology in the industry. The approach will be to calculate, in effect, a separate isoquant to capture the effect of each policy. Boundary prices are then obtained, using both actual and shadow factor prices.[14]

A. *The Prohibition on Imported Used Machinery*

The prohibition adversely affects the more labor-intensive techniques because these looms become economically obsolete more rapidly in industrialized and semi-industrialized countries. Thus the secondhand price (expressed as a percentage of the new price) is generally lower the more labor-intensive the technique is. It is difficult to determine precisely the effect of the removal of the ban because, unlike new looms, there are no ruling secondhand prices. As Cooper and Kaplinsky [3] demonstrate, much depends on the contacts and business acumen of the buyer. One solution to the problem would be to follow the approach of Pack [9] and introduce as an additional variable in our boundary price calculations the price of secondhand looms as a percentage of the new price. This has the disadvantage, however, of making the data presentation more cumbersome, because three sets of boundary price data would be required instead of one. A simpler approximation is to make an estimate of the likely price, based on discussions with local and foreign weavers in Indonesia, and correspondence with firms in developed countries which specialize in the export of secondhand textile machinery. It needs to be emphasized that only the price of the loom itself is less; other costs (transport, docking, installation, and provision of a set of spare parts) remain unaffected. This point is frequently over-

[14] Much of the detailed calculations are omitted. Interested readers are referred to Hill [4, chap. 10 and app. 10.1], copies of which are obtainable from the author.

looked by those advocating the adoption of used machinery in developing countries.[15]

Boundary prices in the case of free entry of secondhand machinery are presented in Table III (case II). The two more capital-intensive techniques remain economically efficient given actual factor prices, although M3 is rendered less competitive. At typical wages in the "existing policies" case this technique is economically efficient up to an interest rate of 12 per cent, whereas the maximum after the policy change is 10 per cent. Another way of looking at the effect is through the change in boundary wage rates. At an interest rate of 12 per cent, wages would have to be over 276,000 rupiah (more than 15 per cent higher than case I) for M3 to be economically efficient. There is little effect on technique M1, it becoming marginally less competitive after the change. But handlooms are adversely affected. Interest rates would have to be considerably higher (41 per cent as compared to 32 per cent) or the low wages even lower still for them to be economically efficient. Using shadow prices, M2 is the only technique which is economically efficient. For all other techniques, the combinations of shadow prices assumed in Table II are outside the boundary prices in Table III (case II), that is, the iso-cost lines would intersect the relevant point on the isoquant. This illustrates the importance of capital market reform to encourage the adoption of appropriate technology. Even if the import of used machinery were permitted, investors with access to credit at very low real interest rates would most likely continue to adopt the most capital-intensive technique.

At first sight, the results in Table III (case II) may appear surprising. Why does technique M2 become more competitive, even though the effect of the policy change is to reduce the amount of capital required to produce a given value added for *all three* mechanized techniques? In the case of handlooms the answer is obvious: the technique with which they are competing (M1) becomes more efficient. Ironically, in spite of government statements emphasizing how primitive handlooms are, the effect of the prohibition has been to render them *more* competitive by penalizing technique M1. Technique M3 becomes less competitive with M2 owing to the fact that the former's economic obsolescence is not as rapid and thus the price falls less sharply. M1 is less competitive with M2 presumably because, even though these looms can be obtained very cheaply overseas, the other costs remain substantially the same and they "swamp" the effect of the loom price reduction. In passing, it should be noted that secondhand looms are competitive with new looms for all the mechanized techniques (calculations are not presented here). For M3 the improvement is only marginal, indicating that firms using these looms are not greatly affected by the prohibition.

[15] In our calculations, secondhand M3 looms are two-thirds the new price and M2 looms one-half. M1 looms are domestically manufactured, hence it is necessary to estimate the secondhand price of such looms produced overseas (mainly in China and India). A figure of U.S.$400 is used. No great reliance can be placed on the precision of these estimates, but we are confident that they are reasonably accurate. These prices refer to looms in good condition and about five years old.

B. *A Duty on Imported Equipment*

There is no economic justification for the exemption of duty on imported machinery in the presence of a general import duty, and this modification can easily be incorporated into the analysis. A 20 per cent duty is assumed in our calculations. This is applied to the price of the loom itself for techniques M3 and M2. In the case of M1, being domestically manufactured, we need to know the composition of tradable components in its manufacture. This is estimated to be approximately 60 per cent, in which case a similar proportion of the duty is passed on.

The effect of the duty, as shown in Table III (case III), is broadly similar to removing the import prohibition on used machines. Techniques M3 and M2 are economically efficient at the actual factor prices assumed in Table II. However, at the shadow prices, only M2 would be adopted by profit-maximizing investors. Even assuming the "inflated" actual wages (240,000 rupiah)—let alone shadow wages—M3 is not economically efficient at the shadow interest rate of 12 per cent. The imposition of a duty also improves the competitiveness of the two labor-intensive techniques, M1 and H, but neither would be adopted at the factor prices given. For example, at the annual wage rates in Table II, the minimum interest rate consistent with economic efficiency for M1 is 19.4 per cent, while that for H is 30 per cent.

C. *The Pricing of Foreign Exchange*

In Section II it was argued that large capital-intensive firms benefited from the export boom of the 1970s because the domestic price (rupiah) of imported machinery was lower than would have otherwise been the case. But this is not to argue that the currency should have been devalued. Rather an alternative exchange rate is introduced to demonstrate the adverse effects on labor-intensive techniques of structural changes associated with the dramatic rise in oil revenue. Moreover, it should be emphasized that we are not attempting to predict the effect of the devaluation of November 1978. The basic calculations were completed before this date, the alternative rate introduced here (Rp.630 = U.S.$1) being computed on the basis of annual average price changes in Indonesia's major trading partners, weighted according to their share of the trade. Coincidentally, this rate is almost identical to the actual post-devaluation rate (which was reduced from Rp.415 to Rp.625 = U.S.$1).

Estimating the effect of the devaluation on machine prices is relatively straightforward, but the effect on the economic performance of the techniques is more difficult to predict. Our approach is necessarily partial. In practice, a devaluation sets in train a whole series of price rises, in addition to imported machinery. By assuming no change in all but the latter, we are in fact considering only the case of a "fully effective" devaluation, that is, of no increase in the price of non-traded goods. This might be regarded as the border case, the actual outcome being closer to the "no devaluation" case the more the prices of non-traded goods rise and erode the effects of the devaluation. Much depends on the time

period to which the analysis relates, because the effect of a devaluation on the ratio of the price of traded to non-traded goods is usually greatest immediately after the devaluation. Note, however, that our analysis does not assume *prices* remain constant but only that *value added* (per unit of output) does not change.

At actual factor prices, the main effect of the devaluation is that, owing to the fragmented nature of factor markets, all three mechanized techniques are now economically efficient (that is, the combinations of actual factor prices specified in Table II lie within the boundary prices), whereas previously just M3 and M2 were. The devaluation improves the economic performance of the two labor-intensive techniques. This is because the price of M1 looms does not increase by the full extent of the devaluation. Given typical wage rates, it is competitive at interest rates above 14.5 per cent. Handlooms also become more competitive. This follows from our assumption that, because existing supplies of used handlooms are virtually unlimited (such has been the decline of this sector over the past fifteen years), the devaluation is unlikely to lead to an increase in their price. As Table III (case IV) shows, the minimum interest rate is now only a little above the typical rate which these firms face (26.8 per cent as against 24 per cent). Alternatively, the boundary wage at a 24 per cent interest rate is only about 10 per cent less than the actual wage. Clearly, the two labor-intensive techniques—and employment generation in the industry—have been seriously affected by the export boom and the associated structural changes in the economy.

In the case of shadow prices, the results are surprisingly similar to the other policy reforms. M3 is not economically efficient if factors of production are shadow-priced, and it would not be adopted by economically rational investors. The maximum interest rate consistent with a tangency solution is less than the shadow rate (12 per cent) at both actual and shadow wage rates. Real wages would have to increase substantially for this technique to be adopted. Although handlooms become more competitive at actual prices, the compression of interest rate differentials in the case of shadow prices means that investors would be unlikely to adopt this technique. The main effect of the devaluation at shadow prices is that both M2 and M1 are economically efficient, whereas previously M2 was the only technique to meet this condition. Thus a devaluation could be expected to promote the development of a more labor-intensive weaving industry.

V. CONCLUSION

Our results indicate clearly that government policies have encouraged the use of excessively capital-intensive techniques in the Indonesian weaving industry. Efficient labor-intensive techniques are available. The existing "technology shelf," to use Ranis's term [10], is satisfactory because it contains a range of technically efficient technologies. A policy of getting prices and policies "right"—despite reservations of some writers in the field of choice of technology—is likely to result in a shift toward more labor-intensive techniques in the industry and a

substantial increase in employment generation. Handlooms are unlikely to be competitive under most feasible policy reforms, except at significantly higher interest rates and lower wage rates. An "intermediate," mechanized loom (M2) emerges as the most desirable technique for the factory weaving sector.

Nevertheless, there are two important qualifications to the argument that government policies, especially fiscal and other taxation incentives, bias the selection of industrial technology. First, the nominal value (and therefore the distortionary effect) of these incentives is usually overstated. Firms exempted from taxation and other levies would not normally have to pay the full amount in any case because enforcement is weak and erratic, and widespread evasion occurs. In fact, several firms in our sample did not even apply for the incentives, arguing that the benefits barely exceeded the cost, taking account of the onerous bureaucratic requirements and increased surveillance by government departments after the concessions were granted. A distinction here should be drawn between foreign and domestic firms. The concessions are more important for foreign firms, which are less willing or able to practice wide-scale evasion. Second, government promotion of the modern sector and neglect of the traditional sector can be a double-edged sword. In fostering the development of large firms, governments may expect to derive political and economic benefits from their patronage. Bureaucracies in most developing countries are weak. Large urban-based firms have more difficulty evading government regulations than small rural firms. In the case of the former, for example, taxation and other official (and unofficial) exactions may be relatively heavier and regulations regarding minimum wages less easily avoided.

What are some of the wider implications of our study for research on the choice of technology in developing countries? Despite its size and importance, weaving may be something of a special case in the manufacturing sector of developing countries. It is an old long-established industry exhibiting a wide range of techniques.[16] Textile machinery is manufactured not only in industrialized countries but also in several developing countries (in Asia alone China, India, Indonesia, South Korea, and Taiwan). Few other manufacturing activities are as technologically diverse as weaving. Moreover, as was pointed out above, quality differences between the products produced by different techniques are less than in almost any other major industry in developing countries. And in the Indonesian industry, owing mainly to historical factors, there has been less product specialization among the techniques than in most other developing countries. This is an important consideration. As Stewart [15, p. 114] argues, quality differences in some industries are such that if product requirements are sufficiently finely specified the relevant issue may well become choice of *product* rather than choice of *technique*.

Finally, the structure of the industry is very relevant to our conclusions. There is considerable evidence of the relationship between the choice of technology

[16] The useful distinction between "old" and "new" industries and its implication for the choice of technology is discussed by Stewart [16, p. 197].

and market structure in developing countries. When competitive pressures are intensive (as they are in Indonesia, albeit within the protected domestic market), firms are more likely to be sensitive to changes in the wage-interest ratio because they are forced to seek out and adopt the least-cost technique. Consequently, there is less scope for the pursuit of "noneconomic" goals—the desire for a "quiet life" (a smaller labor force with a more capital-intensive technique), the use of the most modern machinery available (prestige), or the production of goods whose quality is excessively high for the need or effective demand of consumers (engineering man). Wells's conclusion on the basis of his study of Indonesian manufacturing supports our argument: "The choice of technique appears to be most closely related to the competitive position of the firm.... Where price was the basis of competition, the pressures to reduce costs to a minimum drove the firm to a more labour-intensive technology" [17, p. 65]. Empirical support for the proposition that competitive pressures compel weaving firms to be cost minimizers is documented in a nine-industry case study of Indonesian manufacturing conducted by Keddie [6].

Ultimately, then, many of the complex issues surrounding the selection of technology in developing countries must be examined by adopting a disaggregated approach, through industry and country-specific case studies. Our article is intended as a contribution to this time-consuming, laborious but much-needed field of research.

REFERENCES

1. BHALLA, A. S., ed. *Technology and Employment in Industry: A Case Study Approach* (Geneva: ILO, 1975).
2. BOOTH, A., and GLASSBURNER, B. "Survey of Recent Developments," *Bulletin of Indonesian Economic Studies,* Vol. 11, No. 1 (March 1975).
3. COOPER, C., and KAPLINSKY, R. *Second-Hand Equipment in a Developing Country: A Study of Jute-Processing in Kenya* (Geneva: ILO, 1974).
4. HILL, H. "Choice of Technique in the Indonesian Weaving Industry" (Ph.D. diss., Australian National University, 1979).
5. ————. "Choice of Technique in the Indonesian Weaving Industry," *Economic Development and Cultural Change,* Vol. 31, No. 2 (January 1983).
6. KEDDIE, G. J. "Adoption of Production Technique by Industrial Firms in Indonesia" (Ph.D. diss., Harvard University, 1975).
7. MYINT, H. *Economic Theory and the Underdeveloped Countries* (New York: Oxford University Press, 1971).
8. PAAUW, D. S. "The Indonesian Economy in the 1980s," paper prepared for project on Regional Development Strategy for the 1980s by ESCAP, 1979.
9. PACK, H. "The Optimality of Used Equipment: Calculations for the Cotton Textile Industry," *Economic Development and Cultural Change,* Vol. 26, No. 2 (January 1978).
10. RANIS, G. "Industrial Sector Labor Absorption," *Economic Development and Cultural Change,* Vol. 21, No. 3 (April 1973).
11. ————. *Technology Choice and Employment in Developing Countries: A Synthesis of Economic Growth Center Research,* Economic Growth Center Discussion Paper No. 276 (New Haven, Conn.: Yale University, 1978).
12. SADLI, M. "Application of Technology and Its Employment Effects: The Experience of

Indonesia," in *Employment in Developing Nations: Report on a Ford Foundation Study*, ed. E. O. Edwards (New York: Columbia University Press, 1974).

13. SCHWARTZ, S. "Second-hand Machinery in Development, or How to Recognize a Bargain," *Journal of Development Studies,* Vol. 9, No. 4 (July 1973).
14. SEN, A. K. "On the Usefulness of Used Machines," *Review of Economics and Statistics,* Vol. 44, No. 3 (August 1962).
15. STEWART, F. "Choice of Technique in Developing Countries," *Journal of Development Studies,* Vol. 9, No. 1 (October 1972).
16. ————. *Technology and Underdevelopment* (London: Macmillan Press, 1977).
17. WELLS, L. T., Jr. "Men and Machines in Indonesia's Light Manufacturing Industries," *Bulletin of Indonesian Economic Studies,* Vol. 9, No. 3 (November 1973).