Private Sector Development Department
Occasional Paper No. 9

Enterprise Training in Developing Countries:

Overview of Incidence, Determinants, and Productivity Outcomes

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September 1995

This paper has been cleared for inclusion in the occasional paper series by R. Shyam Khemani. It was funded, in part, by a grant from the World Bank Research Committee. The views expressed are those of the authors and should not be attributed to the World Bank. This paper forms a chapter in the forthcoming book, titled Enterprise Training in Developing Countries, edited by Hong W. Tan .

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Abstract

Unique firm-level data from five developing countries -- Colombia, Indonesia, Malaysia, Mexico, and Taiwan, China -- were assembled to provide a first look at the incidence, determinants, and productivity outcomes of enterprise training in developing countries. Several common training determinants were identified in our cross-national analysis. Firms are more likely to train when they are large, employ an educated and skilled workforce, invest in R&D and technology licenses, emphasize quality control methods, have foreign capital participation, and export to foreign markets. The production function analyses provided strong evidence of the productivity enhancing effects of training. A large and significant impact of training on productivity was found for skilled workers but not unskilled workers, and for inhouse formal training as compared with external sources of training.

1

Introduction

1.1 There is broad agreement that human capital, defined to include both education and postschool training, contributes to economic growth through raising the productivity of workers and facilitating the adoption and use of new technologies. Support for this view is found in three lines of research--on human capital and productivity, on technology and innovation, and on models of endogenous growth. In theory, both education and training are thought to be important; in practice, however, studies in these three research traditions have tended to focus on the role of educational attainment, which is more readily measured than training.

1.2 The evidence on the links between education, technology, and productivity is strong. In the technology literature, microeconomic case studies have identified the critical role of educated workers in the innovative process (Setzer, 1974; Carnoy, 1990; Pack, 1992), and industry-level studies have found more recent vintages of capital (or technology) to be complementary with the education of the workforce (Bartel and Lichtenberg, 1987). A large body of human capital studies, principally using developed country data, have also shown that educated farmers and workers are more productive in a rapidly changing environment, and thus earn higher incomes (Welch, 1970; Tan, 1980; Mincer, 1989). Finally, studies of endogenous growth, which stress the importance of purposive human capital investments as the driver of economic growth (Lucas, 1988; Romer, 1989), show that schooling enrollment rates are important explanators of aggregate differences in growth across countries.

1.3 Much less is known about training and its effects on productivity. There is a body of training research based on individual responses to training questions in worker-level surveys; they show that the likelihood of training, and their returns as reflected in wages, are higher in industries characterized by rapid technological change, especially for the most educated workers (Lillard and Tan, 1992; Tan et al, 1992). However, since firm size and industry are often the only information available on firms, little is known about the employer's role in training, or training's effects on firm-level productivity, which must be inferred indirectly from wages. Training research using firm data is more limited. Exceptions are two studies by Bartel (1991, 1992), one using a sample of publicly traded U.S. firms to investigate the impact of training on a simple measure of output, the other using employee data from one American company. They indicate that training has a positive impact on output, wage growth and job performance.

1.4 Thus, large gaps exist in our knowledge about training--its incidence among firms and in the workforce, its determinants, and its consequences for firm-level productivity and economic growth. Recognizing this, a number of industrialized countries within the OECD have

begun to systematically assemble existing employee and firm-level surveys with training information, and design survey instruments to collect data on training and workplace practices. No comparable effort is underway in developing countries, where the paucity of training information is perhaps most acute and the need for such data is greatest.

1.5 In many developing countries, policymakers make critical resource allocation decisions and design education and training policies in the absence of reliable training data. Often, the only data available to them are on the supply of graduates from public vocational-technical institutes and government training centers. As such, training policies developed in these countries tend to be very supply oriented--a policy response to perceived skill shortfalls is often to expand supply capacity of vocational-technical institutions; manpower planning is often also based on simple extrapolations of past trends in skill supply. By failing to recognize that skill requirements can change with shifts in demand, evolving patterns of international competition, and new technology, these supply oriented policies often result in mismatches between skills supplied by public training institutions and those needed by industry.

1.6 When training is provided or sponsored by employers, the issue of matching training supply and demand does not arise. Firms train only for needed skills. And because most new technologies enter developing countries through enterprises, employers have the equipment and technical information needed to determine what skills are needed. Furthermore, in most countries, the largest share of training is provided by employers during employment, either inhouse or from external training institutions, equipment suppliers and buyers, industry groups, and joint-venture partners. To the extent that enterprises can be encouraged to train, they offer an important means to expand the resources available for skills development in the country

1.7 In this paper, we assemble a unique set of firm-level data from Colombia, Indonesia, Malaysia, Mexico and Taiwan, China to provide a first look at the incidence, determinants, and productivity outcomes of enterprise training in developing countries. These firm-level surveys are unique in providing not only a wealth of production data, but also detailed information about employers, their workers, technology used, and most importantly, investments in training. For all countries, except Taiwan which only reported training expenditures, firms provided information on both informal and formal training, and numbers trained by source and by broad occupational groups. Firms in all countries also reported expenditures on R&D and technology licenses, which allows us to address the question of how skills and training requirements are affected by the use of new technology. Finally, the production data enables us to estimate the effects of training on firm-level productivity within a production function framework.

1.8 In Section II, we describe the firm-level surveys and use them to provide a broad overview of enterprise training in the five developing countries. We also describe key variables contained in the surveys, and how they might shape employers' incentives to train. These potentially important training determinants are analyzed in Section III. This is followed, in Section IV, by production function analyses of the impact of training on firm-level productivity in which a variety of training measures are used. Section V summarizes the cross-country results and draws out their policy implications.

2

Data and Overview

2.1 We have assembled a unique set of firm-level data to look at training in five developing countries--Colombia, Indonesia, Malaysia, Mexico, and Taiwan, China.[1,2] These datasets were developed as part of a World Bank study on "Enterprise Training Strategies and Productivity". Three countries--Colombia, Indonesia, and Malaysia--fielded surveys of manufacturing firms using a survey instrument designed by the World Bank project team. A fourth country, Mexico, used a survey instrument developed jointly by the Secretariat of Labor and Social Welfare and the ILO, with input from the World Bank team to ensure comparability with the other country surveys. Taiwan, China was included in this sample because key training, technology, and production data were elicited in the 1986 Census of Manufacturing. It was also attractive both for its large sample size and to serve as a benchmark for the other developing countries.

2.2 Each country's survey of manufacturing firms has unique features. The Colombia survey, conducted in 1993 by SENA (the national training agency), includes 500 firms drawn from the five principal cities in the country. It is a random sample stratified by firm size, with larger firms over-sampled relative to the population. The Indonesia survey of 300 firms was fielded in 1993 as part of a World Bank project, and it surveyed primarily larger firms in three provinces. The Malaysia survey of 2,200 firms was fielded in 1995 as part of a World Bank-UNDP funded study for the Government of Malaysia. Though nationally representative, the survey over-sampled larger firms. The Mexico survey is a nationally representative, stratified (by size) random sample of 5,072 firms, and it was surveyed in 1993 under the direction of the Secretariat of Labor and Social Welfare. The Taiwan sample of 56,047 firms is drawn from the 1986 Manufacturing Census, and it includes the universe of firms in nine two-digit industries.

Enterprise Training Information

[1] We acknowledge Amy Hwang (Academia Sinica) for providing the Taiwan data; the Secretariat of Labor and Social Security (Mexico) for providing the Mexican data; the Economic Planning Unit, Government of Malaysia, for providing the Malaysia data; SENA, the National Training Agency, for the Colombia data; and the Indonesia department of the World Bank for providing the Indonesia data.

[2] The data on Taiwan includes nine industries--textiles, clothing, paper/publishing, chemicals, plastics, iron & steel, machinery, electric/electronics and transport equipment. In 1986, these nine industries accounted for 63 percent of total manufacturing output, 66 percent of total employment in manufacturing, 71 percent of total exports, and 71 percent of total expenditures on R&D, knowhow purchases, and training.

2.3 The five surveys contain a wealth of information about employer provided or sponsored training.[3] We first describe the training data, highlighting similarities and differences in the kinds of training information elicited in each country, and then use these data to provide an overview of the broad patterns of enterprise training in the five economies.

2.4 All country surveys, with the exception of Taiwan, elicited information on informal training, formal structured training, the sources and types of training provided, and the number of workers trained. In Taiwan, firms were only asked to report their training expenditures; our assumption is that these expenditures cover primarily formal structured training. In the other country surveys, respondents were either asked about whether informal on-the-job training was provided by co-workers and supervisors (Colombia and Malaysia), or how many workers received informal training (Mexico and Indonesia). Substantially more information was obtained on formal structured training. Typically, respondents were asked to report the number of workers getting formal training over the past year, by broad occupational group and by source of training.

2.5 The occupational breakdowns permit two kinds of skill distinctions. The first is one based on "white-collar" occupations versus "blue-collar" occupations, for short, non-production versus production workers. Most studies use the proportion of non-production workers as a crude proxy variable for skills. The second is based on a distinction between occupations that might be thought of as being "skilled"--such as managers and directors, professionals, engineers, technicians, craftsmen, and skilled production workers--and those that are "unskilled"--such as "other" administrative and unskilled production workers. The latter definition of skills is used in Colombia, Indonesia, and Mexico; in Taiwan and Malaysia, we rely on the crude definition of skills.[4]

2.6 Information on various sources of formal training was elicited in four countries, except Taiwan. First, all four surveys distinguished between formal training provided inhouse by the employer, and formal training obtained in external training institutions. Second, the surveys for Colombia, Indonesia, and Malaysia elicited information on the numbers trained in a wide range of external providers. While there are obvious variations in these external sources across countries--for example, Colombia's public training agency SENA, which is funded by a payroll levy, or Malaysia's public industrial training institutes (ITIs)--they can be broadly grouped into five external training sources: (1) universities and colleges, (2) government-run training centers, (3) industry associations, (4) equipment suppliers and buyers, and (5) private training institutes

[3] In this paper, we focus on a relatively small (but key) sub-set of the training information elicited. Other variables include presence of a company training school, numbers of instructors, hours of training, estimates of training expenditures, respondent's perceptions of training deficiencies, and use of different training incentives. These variables will be investigated further in future work.

[4] In Malaysia, this was necessary because external training was only reported by non-production and production occupations.

and other unspecified sources. In Mexico, firms reported the total numbers trained externally but did not provide details on where they were trained.[5]

2.7 Table 1 summarizes the main training variables and countries to which they are applicable. First, for all countries except Taiwan, we can define an indicator variable for informal on-the-job training. We will note its incidence, but will not include informal training in the analyses. Second, for all countries, we can construct an indicator variable for whether the employer provides any formal training, either inhouse or from external sources. We will refer to this as "any training". Third, for four countries, we can distinguish between whether formal training is provided by the employer within the firm's premises (termed "inhouse training") or whether training is provided by external training institutions (termed "external training").[6] Fourth, for these same four countries, we can construct measures of training intensity by skill group and by inhouse versus external training. Here, in place of the simple indicator variable, training is measured by the number of workers trained as a proportion of the relevant worker group. Finally, for three countries, we can define these training intensity measures for five external sources of training.

Table 1: Training Variables in the Five Surveys

Country Surveys	*Training Variables*
COL, IND, MAL, MEX	Any informal training by coworkers & supervisors
COL, IND, MAL, MEX, TAI[a]	Any formal structured training, provided by inhouse trainers or by external trainers
COL[b], IND, MAL, MEX[c]	Any inhouse formal training versus any external formal training
COL[b], IND, MAL, MEX[c]	Any formal training for skilled workers versus unskilled workers
COL[b], IND, MAL, MEX[c]	Training intensity[d] by skilled vs unskilled groups and by inhouse vs external training
COL, IND, MAL	Any external training by source of training

Notes:

COL = Colombia, IND = Indonesia, MAL = Malaysia, MEX = Mexico, TAI = Taiwan, China.

[a]: Only expenditures on (presumably) formal training reported.

[b]: Combines training provided by external trainers on the premises or in external institutions.

[c]: External training sources not identified, except in a separate questionnaire where respondents could identify one principal external source of training, if used at all.

[d]: Number trained by skill group or source as a proportion of relevant occupational group.

[5] Qualitative information on external training was elicited in a separate questionnaire. Firms were asked whether they used any external training providers, and if so, they were asked to identify the one principal source.

[6] In Colombia, a distinction was made between training provided within the firm's premises by external trainers, and training outside the firm in external training institutions. In the paper, we combine both of these sources into one external training category.

Overview of Enterprise Training

2.8 Cross-national comparisons of training are fraught with problems, and this paper is no exception. A strong word of caution. In our description of the country surveys, we noted that, with the exception of Taiwan (which is a census), all other surveys over-sampled larger firms relative to their true weight in the population. As such, the data for the other countries must be appropriately weighted to provide nationally representative estimates of training. This was done in Mexico. In Colombia, Indonesia, and Malaysia, definitive figures on the number of micro and small enterprises were not available to us.[7] Consequently, the sampling weights that we use understate the true importance of micro and small firms in the manufacturing sectors of these three countries. To the extent that micro and small enterprises do little training, our weighting scheme tends to overstate overall training incidence in the three countries relative to Mexico and Taiwan.

2.9 Our inclination is to treat the aggregate training estimates as being illustrative of broad patterns of training in the different countries, and to rely on comparisons by employer size--where the problem with sampling weights is less an issue--to verify statements based on the overall figures. To this end, we define four firm size categories: micro firms with 15 or fewer employees, small firms with 16-100 workers, medium firms with 101-250 employees, and large firms with over 250 employees.

2.10 With this caveat, we now turn to the broad patterns of enterprise training suggested by the data. These are reported in Table 2A for the manufacturing sector as a whole, and in Table 2B by four firm sizes. Four points are noteworthy.

Table 2A: Incidence of Training by Country, Type of Training, and Source of Training

Type and Source of Training	*Colombia* (*1992*)	*Indonesia* (*1992*)	*Malaysia* (*1994*)	*Mexico* (*1992*)	*Taiwan* (*1986*)
Sample Size	500	300	2,200	5,072	56,047
% informal training	75.9	18.5	83.1	11.3	n.a.
% formal training from any source	49.6	18.9	34.7	10.8	9.29
% internal formal training	3.7	9.7	25.2	5.8	n.a.
% external formal training	48.7	14.2	20.4	7.9	n.a.
External sources					
% universities & colleges	13.01	0.24	5.56	n.a.	n.a.
% government training centers	9.07	6.40	7.32	n.a.	n.a.
% industry associations	19.96	1.93	3.88	n.a.	n.a.
% private training institutes	n.a.	8.56	9.38	n.a.	n.a.
% buyers & suppliers	11.84	3.38	7.86	n.a.	n.a.

[7] Malaysia is conducting a census of micro and small enterprises and, as figures become available, we will work with statistical agencies to devise more appropriate weights.

Table 2B: Incidence of Training by Source of Training and Firm Size

	Colombia				*Indonesia*[a]			*Malaysia*				*Mexico*			
Characteristics	*Micro*	*Small*	*Medium*	*Large*	*Small*	*Medium*	*Large*	*Micro*	*Small*	*Medium*	*Large*	*Micro*	*Small*	*Medium*	*Large*
Number of firms	46	143	139	62	62	58	185	153	638	932	453	661	1060	1546	1789
% Firms training informally	67.6	77.8	88.6	87.2	15.7	32.6	16.1	56.5	80.5	88.8	92.4	7.4	36.1	44.7	30.4
% Firms training formally	32.9	52.1	79.3	81.3	16.6	19.9	30.9	9.4	19.3	43.7	69.5	5.50	41.8	59.0	49.0
% Firms training internally formally	3.1	2.4	9.6	12.8	11.3	2.2	9.8	5.9	14.2	31.2	52.1	2.5	22.5	39.4	39.9
% Firms training externally	32.9	50.9	76.8	81.3	10.9	17.7	28.8	5.0	8.1	25.6	50.8	3.9	30.6	45.7	40.2

Notes:

Micro firms are those with 15 or fewer workers
Small firms are those with 16-100 workers
Medium firms are those with 101-250 workers
Large firms are those with more than 250 workers
[a.]: There are no microenterprises in the Indonesia sample.

2.11 First, there are implausibly wide variations in the incidence of informal training reported by employers--75 to over 80 percent in Colombia and Malaysia, and under 20 percent in Indonesia and Mexico. Some part of this difference is due to weighting. In Mexico, informal training rises with size--to about 45 percent of medium size firms--and the low overall level of 11 percent may be driven in part by greater weight assigned to micro firms, who do little informal training (7 percent). More likely, the problem is related to non-response: most employers are familiar with whether they provide informal training (Colombia and Malaysia), but few can accurately recall and report the numbers receiving informal instruction, as they were required to do in Mexico and Indonesia.

2.12 Second, a sizable proportion of firms in all five developing countries report providing no worker training, either informal on-the-job training or structured formal training (see Table 2B). In Colombia and Malaysia, where we have relatively more confidence in the informal on-the-job training data, over 20 percent of small enterprises in both countries do not provide any basic informal instruction from co-workers and supervisors; even among the largest firms, as many as 8 to 12 percent of employers provide no informal training. For formal training, the proportion of employers that do not train is even higher--between 50 and 80 percent of small firms, and between 20 and 70 percent of large firms in the four developing countries. The presence of large numbers of firms without any system of worker training is worrisome, given the critical role that skills play in technology development and the presumed beneficial effects of training on productivity growth (these links are quantified and demonstrated in subsequent sections of the paper).

2.13 Third, putting aside level differences in formal training attributable to weighting, there are striking cross-country differences in the relative importance of employer-provided inhouse training versus external training. In Colombia, a relatively high proportion of firms (50 percent) are classified as providing formal training, primarily because of their heavy reliance on training done by external providers. To see this, note that only 4 percent of employers train inhouse, as compared to 49 percent that use outside providers. In contrast, about 35 percent of firms in Malaysia report providing formal training, but a higher proportion train inhouse (25 percent) rather than sending workers to external institutions (20 percent). Indonesia and Mexico fall in between, with a higher proportion of firms sponsoring external training rather than training inhouse. These cross-country patterns--of inhouse versus external training--are repeated by firm size, as is apparent in Table 2B. Clearly, there are cross-country differences in the inhouse training capabilities of employers, with those in Colombia being particularly weak.

2.14 Finally, the data reveal that employers use a wide range of external training providers, and some of these are as important, if not more important, than government-run centers as sources of industrial training. In Colombia, a higher proportion of employers report worker training from industry associations (20 percent), universities (13 percent), and supplier-buyers (12 percent) than from SENA training centers (9 percent), which firms are required to

support through training payroll levies.[8] In Indonesia, industry associations play a relatively small training role (2 percent), and most external training is provided by private training institutes (9 percent) and by government training centers (6 percent). In Malaysia, private training institutes dominate (9 percent), with suppliers-buyers (8 percent) being as important a source of training as all public training centers combined (7 percent).

Key Variables and Some Hypotheses

2.15 In addition to the training data, respondents in these five countries provided a broadly comparable set of firm-level variables. In general, these include (1) attributes of the establishment, including year established, single-plant or multi-plant status, two-digit industry classification, and foreign ownership; (2) data on production and inputs, including capital assets, employment, intermediate inputs, and energy use; (3) characteristics of the workforce, including the mean educational attainment of the workforce, number of employees by broad occupational groups, proportion of female workers, wages, and union status; (4) information on exports, expenses on R&D and foreign technology licenses; and for several countries, (5) information on the degree of automation and use of quality control methods. Table 3 provides summary statistics on some of these key variables.

Table 3: Mean Characteristics Of Enterprises by Country

	Characteristics							
Country	*Sample Size*	*Firm Size*	*% Firms Training*[a]	*% R&D Firms*[b]	*% Firms Exporting*[d]	*% Foreign Firms*[e]	*% Skilled Labor*[f]	*Mean Education*[g]
Colombia	500	56.00	49.60	62.41	20.68	n.a.	0.28	7.91
Indonesia	300	167.99	18.88	14.42	21.92	4.80	0.13	8.09
Malaysia	2,200	161.88	34.71	17.24	52.33	29.93	0.14	8.59
Mexico	5,072	21.69	10.77	14.21	5.23	1.76	0.36	7.23
Taiwan	56,047	90.56	9.29	9.46	16.84	6.67	0.24	n.a.

Notes:

[a]: For Colombia, Indonesia, Malaysia and Mexico, it includes firms that report internal formal or external training. For Taiwan, it includes firms that report positive training expenditures.
[b]: For all countries, it includes firms that report positive expenditures on Research and Development.
[d]: In all countries it includes firms with positive export-sales ratios.
[e]: In Indonesia, Malaysia, Mexico, Taiwan, it includes all firms with any foreign financial capital.
[f]: In Malaysia and Taiwan, this is calculated as the ratio of non-production to production labor; in all other countries it is defined as the ratio of skilled to unskilled labor.
[g]: It is calculated as the average educational level of the workers employed.

2.16 We will use this wealth of firm-level information to provide insights into the reasons for these cross-country patterns of enterprise training, and to estimate the relationships between training and firm-level productivity. In these analyses, we are informed by the extant

[8] We note that the incidence figures do not reflect numbers of trainees, and more workers may be trained by SENA than by the other sources.

literature on training and technology. The melding of elements from each of these research traditions yields a rich set of hypotheses to be investigated. Three of these hypotheses are discussed below.

2.17 First, we know that the productivity advantage of new technology is only attained through an intensive learning process. There is evidence from the technology literature that much of the productivity gains from introducing a new innovation comes from making cumulative small modifications in it, essentially through an intensive learning-by-doing process (Bell and Pavitt, 1992). For the petroleum refining industry, Enos (1962) finds that new technologies may even be less productive than older ones, at least initially, until the technology is adapted to and modified for the specific conditions in the firm. To effectively use the new technology, firms have to adjust management, reorganize production lines, introduce quality control methods, upgrade skills, and motivate workers to learn about the new technology. As such, we hypothesize that innovating firms will have greater incentives to provide training opportunities, or to motivate learning about new product and process technologies, as compared to firms using older, more established technologies.

2.18 Second, there is evidence that innovative firms are also more likely to use highly educated and skilled workers. This follows from the "allocative efficiency of education" hypothesis of Welch (1970). According to Welch, education has two effects: it increases the productivity of individuals, the "productive" effect, and their ability to make sense out of new information, the "allocative" effect. If better-educated workers are more adept at critically evaluating new information, and therefore learn more when exposed to new information, we should expect a firm's use of new technology to be positively correlated with the educational and technical skills of its workforce. Conditional upon adoption, we hypothesize that the productivity gains from using new technology are enhanced by a continuing process of worker training and skills upgrading, and by complementary investments in knowledge-generating activities such as R&D, and investments in new machinery and equipment (Tan, 1980).

2.19 There is a large body of substantiating evidence for this hypothesis. Setzer (1974) reports that the skill composition of the workforce is typically high in the early stages of the product cycle when many characteristics of the new technology are unknown, but subsequently declines as the technology becomes well-established. There is also evidence from the training literature. Using industry estimates of total factor productivity (TFP) growth as a proxy measure for the degree of innovativeness, Lillard and Tan (1992) find that workers are more likely to get employer training (and more of it) in industries with high rates of TFP growth, especially the more educated workers. Furthermore, they find that the returns to education are higher in the technologically progressive industries as compared to the low-tech industries. Similar results have been found in other industrialized economies and developing countries (see Tan, et al 1992; Carnoy, 1990).

2.20 Third, employers must make decisions not only about whether to train, but also what kinds of training to provide. They may choose to provide training inhouse, or rely on outside training providers. In part, this will depend upon the vocational and technical education

(VTE) system in the country--its ability to meet the skill requirements of enterprises, the quality of technical training provided, and the job relevance of skills which its graduates bring to the employer. These factors determine how cost effective it would be for enterprises to rely on outside training institutions rather than providing these skills inhouse. The technology discussion suggests another set of determining factors. If the productivity advantage of technology is revealed only through learning by doing, innovative firms have an incentive to train inhouse to embody the new technology in its workers skills. Outside providers are typically not well-prepared to impart skills associated with the most recent, and still evolving, technologies. They play an increasingly important role (and their training services are utilized more intensively by firms) when technologies become standardized and their productive characteristics become well-understood. Research by Lillard and Tan (1992) and Tan et al (1992) on the determinants of worker training by source provides evidence consistent with this hypothesis.

3

Determinants of Enterprise Training

3.1 We have provided a broad overview of enterprise training and discussed the factors that may shape employer incentives to train. With this as background, we turn to an empirical analysis of the determinants of enterprise training in the five countries. We are interested in identifying what key factors shape employer decisions to provide training, whether the determinants of training differ by skill group and by training source, and how these economic forces might vary across the five developing countries. To address these questions, we estimate separate probit models for any formal training, training by skill group (skilled and unskilled workers), and training by source (inhouse and external training).[9] The first model can be estimated for all five countries; the more disaggregated training model specifications are limited to the four developing countries (excluding Taiwan) which elicited detailed information on training by occupation and by training provider.

3.2 The likelihood of employers providing each type of training is hypothesized to depend on the relative costs and benefits of investing in training. It equals one if the present value of training exceeds its costs, and equals zero otherwise. The net benefits of training (benefits minus costs) are not directly observed, but are thought to be related to a set of observable attributes of the employer. These attributes include firm size; worker characteristics such as education and skill mix; its level of technology, as reflected in its R&D expenditures and purchases of know-how, exporting, and foreign ownership; organizational factors such as the degree of automation, use of quality control methods, employment of female labor, and unionization; and two-digit industry dummy variables to control for other industry differences. With a few exceptions, information on these firm and worker attributes are available for all five countries in our sample.

3.3 In the discussion that follows, we summarize the effects of the most important regressors on the likelihood of the employer providing any formal training, by skill group, and by training source. For each set of regressors, the results for all countries are presented together so as to facilitate cross-national comparisons. The training probit estimates on which these tables are based are reported in full for each country in Annex Tables A1 through A5.

[9] A set of probit estimates was also developed for training by skill group and by training source combined. These estimates are not reported here, but are available from the authors.

Firm Size

3.4 Table 4 reports the effects of firm size on the probability of enterprise training. Relative to the smallest firms (micro firms are the omitted size category except in Indonesia), larger firm sizes are associated with monotonically higher likelihoods of formal training; in Taiwan and Colombia, the probability of training tapers off at the largest size category. The importance of size, controlling for other correlates of training, may reflect scale economies in training provision and unobserved employer attributes associated with improved management and training capabilities.

Table 4: Effects of Firm Size on the Probability of Any Training and Training by Skill Group and Training Source

Country	*Any Formal Training*	*Skilled Worker Training*	*Unskilled Worker Training*	*Internal Formal Training*	*External Training*
COLOMBIA					
16-100 workers	0.499[b]	0.678[a]	0.569[a]	-0.550	0.474[b]
101-250 workers	1.178[a]	1.378[a]	1.088[a]	0.189	1.079[a]
250+ workers	0.839[a]	1.226[a]	1.064[a]	0.129	0.824[a]
MEXICO					
16-100 workers	0.802[a]	0.915	0.692[a]	0.569[a]	0.856[a]
101-250 workers	1.116[a]	1.256[a]	1.081[a]	0.971[a]	1.112[a]
250+ workers	1.261[a]	1.408[a]	1.279[a]	1.251[a]	1.281[a]
INDONESIA					
250+ workers	0.416	0.557[b]	0.295	0.069	0.575[a]
MALAYSIA					
16-100 workers	0.362[b]	0.518[c]	0.246	0.385[b]	0.221
101-250 workers	0.939[a]	1.265[a]	0.657[a]	0.801[a]	0.924[a]
250+ workers	1.446[a]	1.748[a]	1.172[a]	1.182[a]	1.477[a]
TAIWAN					
16-100 workers	0.495[a]	n.a.	n.a.	n.a.	n.a.
101-250 workers	0.687[a]	n.a.	n.a.	n.a.	n.a.
250+ workers	0.682[a]	n.a.	n.a.	n.a.	n.a.

Notes:

[a]: Significant at 1%
[b]: Significant at 5%
[c]: Significant at 10%
Source: Annex Tables A1-A5.

3.5 The effects of firm size on training differ by skill group and by source of training. In all four countries (these data are not available for Taiwan), increasingly larger firm sizes are associated with a higher likelihood of training for skilled workers than for unskilled workers, and, with the exception of small firms in Malaysia, for external training as compared to inhouse training. In Colombia and Indonesia, firm size has a strong positive impact on the likelihood of external training but not inhouse training; this may be indicative of relatively weak inhouse training capabilities among Colombian and Indonesian employers.

3.6 Another size-related variable--whether the firm has multiple plants--was included in the training probits but was not reported in Table 4. Controlling for size, being a multi-plant firm is typically associated with a higher probability of employer provided or sponsored training. These effects vary by skill group and source--in Colombia, multi-plant status is associated with a greater likelihood of inhouse training and training for unskilled workers; in Mexico, with greater inhouse training and training for both skilled and unskilled workers; and in Malaysia, with training for skilled workers. Having multiple plants may make it more economical (because of economies of scale) for employers to provide inhouse training; alternatively, multi-plant employers may train to ensure greater uniformity in product standards and skills across plants.

Education and Skill Mix

3.7 Table 5 reports the effects of two workforce characteristics--mean years of education and the proportion of the workforce that is skilled--on the likelihood of employer training, by skill group and by training source.

3.8 The training effects of education stand out. A more highly educated workforce is associated with a greater likelihood of any formal training in three of the four countries for which we have education data. In these three countries, education has a statistically significant positive impact on training for all skill groups and for all training sources. For Indonesia, the effects of education on training are negative, possibly reflecting the variable's high correlation with other included worker attributes. In other words, with the exception of Indonesia, this result provides strong evidence that investments in the two forms of human capital--education and training--are highly complementary.

3.9 Controlling for mean education, a workforce with a higher skill mix is associated with a greater probability of any training in Taiwan and Malaysia. In Malaysia and Mexico, skill mix is a more important determinant of external training than inhouse training. To the extent that training for skilled workers tends to be highly technical or specialized, employers may find it more economical to send skilled workers to external training providers than to develop these programs themselves. In Malaysia, there is also evidence that a more highly skilled workforce is associated with a higher probability of training for **both** skilled workers **and** unskilled workers. Thus, at least for Malaysia, unskilled workers enjoy an externality in training by working in a workplace with a high proportion of skilled workers.

Table 5: Effects of Education and Skill Mix of Workers on Probability of Any Training and Training by Skill Group and Training Source

Country	*Any Formal Training*	*Skilled Worker Training*	*Unskilled Worker Training*	*Internal Formal Training*	*External Training*
COLOMBIA					
Mean education	0.070[a]	0.060[a]	0.065[a]	0.064[b]	0.063[a]
Proportion skilled workers	0.245	0.58	-0.301	-0.028	0.026
MEXICO					
Mean education	0.034[a]	0.039[a]	0.045[a]	0.029[a]	0.035[a]
Proportion skilled workers	0.137	0.393[a]	0.098	0.240	0.354[b]
INDONESIA					
Mean education	-0.137[b]	-0.125[b]	-0.081	-0.058	-0.136[b]
Proportion skilled workers	-0.070	0.010	-1.703	-1.029	-0.176
MALAYSIA					
Mean education	0.064[a]	0.081[a]	0.076[a]	0.088[a]	0.062[a]
Proportion skilled workers	1.742[b]	1.096[a]	1.668[a]	0.635[a]	1.938[a]
TAIWAN					
Mean education	n.a.	n.a.	n.a	n.a.	n.a.
Proportion skilled workers	0.371[a]	n.a.	n.a	n.a.	n.a.

Notes:

[a]: Significant at 1%
[b]: Significant at 5%
Source: Annex Tables A1-A5.

The Firm's Technology

3.10 Table 6 shows the relationship between training and employer investments in R&D and know-how (henceforth termed "R&D"). In three of the five countries--Malaysia, Mexico and Taiwan--R&D is associated with a significantly higher likelihood of enterprise training. In Colombia and Indonesia, it is not, possibly reflecting the lower average level of employers' technological capabilities in these two less developed countries. Consistent with this

interpretation, the R&D-training link is stronger the higher is the income level of the country--note that the coefficient of R&D rises from 0.209 for Mexico, to 0.365 for Malaysia, and 1.689 for Taiwan.

3.11 The results, by skill group, suggests that while R&D firms are more likely to train both skilled and unskilled workers than firms not doing R&D, the likelihood of their training unskilled workers is actually higher. Plausibly, unskilled workers require little instruction, beyond some informal on-the-job training by co-workers, to operate older, well-established technologies. When new technologies are being introduced, however, production is no longer routinized; under these circumstances, training for all workers--skilled and unskilled--becomes critical if unanticipated problems are to be detected and fixed, and the productivity advantage of using new technologies are to be realized (Enos, 1962).

Table 6: Effects of Investing in Research and Development (R&D) on Probability of Any Training and Training by Skill Group and Training Source

Country	*Any Formal Training*	*Skilled Worker Training*	*Unskilled Worker Training*	*Internal Formal Training*	*External Training*
COLOMBIA					
Invest in R&D	0.103	0.073	0.157	0.595[c]	0.104
MEXICO					
Invest in R&D	0.209[a]	0.195[a]	0.213[a]	0.186[a]	0.183[a]
INDONESIA					
Invest in R&D	0.074	0.077	0.118	0.382	-0.101
MALAYSIA					
Invest in R&D	0.365[a]	0.344[a]	0.424[a]	0.395[a]	0.334[a]
TAIWAN					
Invest in R&D	1.689[a]	n.a.	n.a.	n.a.	n.a.

Notes:

[a]: Significant at 1%
[b]: Significant at 5%
[c]: Significant at 10%
Source: Annex Tables A1-A5.

3.12 When training by source is considered, R&D is positively and significantly related to the probability of inhouse training in Mexico, Malaysia, and Colombia. In these three

countries, the estimated coefficients for inhouse training are usually larger than those for external training; these differences are even more marked in probit training models disaggregated further by both skill and training source (not reported here). These results--that R&D firms are more likely to train their workers inhouse--are consistent with Tan's hypothesis (1980) that the use of advanced technologies is associated with a greater reliance on inhouse training than on external training, in part because external training providers are not well equipped to train in new technologies, in part because inhouse training is best suited to the innovation process.

Exports and Foreign Ownership

3.13 Table 7 shows the effects on training of two other firm characteristics--exports and foreign ownership. The export variable is positive and significant in four of the five countries (exception is Malaysia) when we include all the training results by skill group or by source. The importance of a firm's export-orientation suggests that international competition can have a salutary impact on training, perhaps because greater exposure to new production techniques or to competitive forces increases employer incentives to train. In Colombia, Mexico and Indonesia, exports are associated with a greater likelihood of inhouse training than external training, a result resembling the R&D link with training.

Table 7: Effects of Exporting and Foreign Ownership on Probability of Any Training and Training by Skill Group and Training Source

Country	*Any Formal Training*	*Skilled Worker Training*	*Unskilled Worker Training*	*Internal Formal Training*	*External Training*
COLOMBIA					
Exporting	0.368[b]	0.334[b]	0.092	0.631[a]	0.311[b]
Foreign Ownership	n.a.	n.a.	n.a.	n.a.	n.a.
MEXICO					
Exporting	0.131[a]	0.127[a]	0.152[a]	0.118[b]	0.113[b]
Foreign Ownership	0.045	0.053	0.057	0.064	0.078
INDONESIA					
Exporting	0.055	0.057	0.141[b]	0.099[c]	0.059
Foreign Ownership	0.469	0.414	0.538	0.371	0.587[c]
MALAYSIA					
Exporting	0.027	0.101	0.002	-0.012	0.030

Foreign Ownership	0.188[a]	0.064	0.233[a]	0.243[a]	-0.029[a]
TAIWAN					
Exporting	0.257[a]	n.a.	n.a.	n.a.	n.a.
Foreign Ownership	0.347[a]	n.a.	n.a.	n.a.	n.a.

Notes:

[a]: Significant at 1%
[b]: Significant at 5%
[c]: Significant at 10%
Source: Annex Tables A1-A5.

3.14 Firms with foreign capital are also more likely to train. Controlling for other factors, many being characteristics of multinationals (such as R&D, exports, and firm size), foreign firms are significantly more likely to train only in Taiwan and Malaysia (foreign ownership is not known in the Colombia sample). The weak training result in Mexico may be attributable, in large part, to the presence of *maquiladora* firms; many *maquiladora* firms are simple assembly operations, using predominantly unskilled female labor who require little formal training. In Malaysia, on the other hand, foreign firms are more likely to train production workers and to provide this training inhouse as compared to domestic firms. This may reflect the well-developed inhouse training capabilities of foreign firms, many of which are large multinationals involved in high-tech semiconductor and electronics production and assembly.

Table 8: Effects of Degree of Automation and Quality Control on Probability of Any Training and Training by Skill Group and Training Source

Country	*Any Formal Training*	*Skilled Worker Training*	*Unskilled Worker Training*	*Internal Formal Training*	*External Training*
COLOMBIA					
Automation	0.001	0.001	-0.001	0.001	0.002
Quality Control	0.301	0.208	0.459[a]	0.187	0.305
MEXICO					
Automation	0.001	0.001	0.001	0.001	0.001
Quality Control	0.231[b]	0.318[a]	0.201[b]	0.242[b]	0.215[b]
INDONESIA					
Automation	0.002	0.002	0.013[b]	0.006	0.002
Quality Control	0.148	0.001	0.331	0.147	-0.005
MALAYSIA					
Automation	0.002	0.004[a]	0.001	0.001	0.004[a]
Quality Control	0.272[a]	0.403[a]	0.245[a]	0.309[a]	0.160[b]

TAIWAN					
Automation	0.344[a]	n.a.	n.a.	n.a.	n.a.
Quality Control	n.a.	n.a.	n.a.	n.a.	n.a.

Notes:

[a]: Significant at 1%
[b]: Significant at 5%
[c]: Significant at 10%
Source: Annex Tables A1-A5.

Automation and Quality Control

3.15 Table 8 shows the effects of two organizational variables, proxied by the degree of equipment automation and use of quality control methods, on the probability of training by skill group and by source. Automation can either lead to the "dumbing down" of skills, as some have argued, or to increased skill requirements to operate and maintain increasingly sophisticated equipment. The results, while not overwhelming, suggest that the probability of training is higher the greater is the share of equipment that is semi- or fully automatic. This relationship was statistically significant in Taiwan for any formal training; in Malaysia, employers were more likely to train skilled workers and send them for external training; in Indonesia, automation had a significant impact on the training provided to unskilled workers.

3.16 Employers that emphasize quality control are more likely to train. This result is significant in Mexico and Malaysia for training provided to both skilled and unskilled workers, and for training from internal and external sources; in Colombia, it is important only for unskilled worker training. A second result is suggested by comparing the relative size of the training coefficients of quality control estimated for each skill group and for each training source. For Mexico and Malaysia, these comparisons indicate that employers using quality control methods are more likely to train skilled workers than unskilled workers, and are more likely to train them inhouse as opposed to sending them offsite for training.

Female Labor and Unionization

3.17 Table 9 summarizes the training effects of two other variables which characterize work organization in the firm--the use of female labor, and unions. Use of large numbers of female workers may reflect forms of organization built around simple assembly, manual dexterity, seasonal work, and relatively low skills. Controlling for mean education and skill composition, the training effects of having a higher proportion of female workers are mixed--statistically insignificant in Mexico, Malaysia and Taiwan, and significantly negative in Colombia and Indonesia. In Indonesia, firms that employ a high proportion of female workers are less likely to provide training for all groups and for all training sources.

3.18 In theory, unions are thought to reduce the likelihood of training by negotiating higher levels of wages and reducing the ability of employers to lower wages to finance firm-

specific training through a training wage. However, when statistically significant union effects on training are found, they are invariably positive as in Colombia, Mexico, Malaysia, and Taiwan. Similar results have been reported in several industrialized countries (see Lillard and Tan, 1992, Tan et al, 1992). The Taiwan union variable is different in referring to employer membership in guilds and industry associations; its effects on training, however, are also positive. In Colombia and Malaysia, the union effect is strongest in training from external sources; in training for unskilled workers in Colombia, and for skilled workers in Malaysia, and in Mexico, unionization has a positive impact on training from all sources and for both skilled and unskilled groups.

Table 9: Effects of Female Workers and Unionization on Probability of Any Training and Training by Skill Group and Training Source

Country	*Any Formal Training*	*Skilled Worker Training*	*Unskilled Worker Training*	*Internal Formal Training*	*External Training*
COLOMBIA					
Female Workers	-0.665[b]	-0.765[a]	-0.416	0.034	-0.703[b]
Unionization	0.742[a]	0.745	0.329[c]	-0.189	0.779[a]
MEXICO					
Female Workers	0.057	0.081	-0.017	0.055	0.003
Unionization	0.310[a]	0.259[a]	0.356[a]	0.336[a]	0.198[a]
INDONESIA					
Female Workers	-1.629[a]	-1.538[a]	-2.178[b]	-1.947[a]	-1.425[a]
Unionization	n.a.	n.a.	n.a.	n.a.	n.a.
MALAYSIA					
Female Workers	0.065	-0.167	0.016	0.025	0.048
Unionization	0.158[c]	0.207[b]	0.059	0.082	0.215[a]
TAIWAN					
Female Workers	-0.005	n.a.	n.a.	n.a.	n.a.
Employer assocation or union	0.246[a]	n.a.	n.a.	n.a.	n.a.

Notes:

[a]: Significant at 1%
[b]: Significant at 5%
[c]: Significant at 10%
Source: Annex Tables A1-A5.

4

Training and Firm-Level Productivity

4.1 We now turn to an empirical analysis of the productivity effects of worker training within a production function framework. We are interested in finding out whether employer investments in formal training are associated with higher firm-level productivity, in whether there are productivity differences in the training provided to different groups of workers, and in which source of training (inhouse training or external training) has the largest impact on productivity. Answers to these questions have important ramifications not only for employers--whether to train, who to train, and what kinds of training to sponsor--but also for policymakers concerned with issues of economic performance, education and training policy, and income distribution.

4.2 For each country, we estimate Cobb-Douglas production function models augmented to include one or more training variables. The dependent variable--the logarithm of value added--is regressed on the logarithms of capital (book value of physical plant and equipment assets) and labor (total employment), a measure of training, and a vector of control variables. These include the rate of capacity utilization, the mean educational attainment of the firm's workforce, indicator variables for key characteristics of the employer--whether the firm exports its output, conducts R&D, possesses foreign technology licenses or know-how agreements, or has foreign capital--and a set of two-digit industry dummy variables. This model specification is common to all countries in the sample, with minor modifications where information on specific variables was not collected.[10]

4.3 We experiment with alternative training measures. First, we treat training as an indicator variable for whether the employer provided any formal training. This basic model specification can be estimated for all five countries, including Taiwan where only limited training information is available. Next, we distinguish between training provided to skilled and unskilled workers, but this time, training indicator variables are weighted by the fraction receiving training in each skill group (termed "training intensity"). Finally, we disaggregate training by skill group **and** by whether training is provided inhouse or externally; the four training variables are again weighted by the fraction trained in each skill group and from each source. Since training expenditures are the only information available for Taiwan, these model specifications with skill and source-specific training intensity measures are restricted to the other four countries.

[10] Information was not elicited on education in Taiwan, foreign capital in Colombia, and capacity utilization rates in Indonesia and Malaysia.

4.4 We recognize that the firm's decision to train is endogenous so that the production function estimates may be subject to selectivity bias. We address this issue for the simplest model specification using an instrumental variable approach. The selectivity correction for training provided to different skill groups and from multiple sources is complex, and we defer the econometric modeling of selectivity bias in those models to future research.[11]

Productivity Impact of Any Formal Training

4.5 Table 10 reports the estimated production function parameters for the five developing countries. The estimated capital and labor coefficients are all positive and statistically significant, and generally exhibit constant or mildly increasing returns to scale--a result commonly found in cross-sectional production function estimates. The estimated labor coefficients are broadly consistent with labor shares of about two-thirds to three-quarters (see Tables 10 through 13), with relatively high labor coefficients for Mexico (0.8 to 0.9) and low labor coefficients for Indonesia (0.4 to 0.5). One possible explanation for the low labor coefficients estimated for Indonesia is the survey's focus on relatively capital-intensive, medium and large firms.

4.6 Before turning to training, we briefly discuss the estimated parameters of the other control variables. These results are not without interest, given the paucity of research on these correlates of productivity in developing countries. First, consistent with the belief that educational attainment raises productivity, the results indicate that the mean education of the workforce is positively related to firm-level productivity in all four countries where this variable was available (except Taiwan). However, the effect of education is statistically significant only in Malaysia and Mexico, but not in Colombia or Indonesia, possibly because of small sample sizes in the latter countries. Second, exports--which we interpret as an informal source of foreign know-how--are associated with higher firm-level productivity in all countries; however, exporting only attains statistical significance in Colombia, Mexico, and Taiwan. Third, the two sources of technology--R&D and technology licenses--have mixed effects on firm-level productivity. Consistent with the findings of a large body of industrialized country research,[12] both R&D and technology licenses have positive and statistically significant impacts on productivity in Mexico and Taiwan. R&D did not appear to have a statistically significant productivity impact in Malaysia and Indonesia. Finally, only in Taiwan does foreign ownership have a positive and significant impact on productivity; in the other countries, lack of significance of this variable may simply reflect our inclusion of control variables for the productivity benefits of foreign capital participation, namely, increased training, R&D, and know-how.

[11] See Madalla (1983).

[12] See Griliches (1979) and Mairesse and Sassenou (1991) for a review of the R&D literature in industrialized countries, and Pack and Westphal (1986) for developing country experiences.

Table 10: Production Function Estimates with Training Indicator Variable

Dependent Variable: log (Value Added)

Independent Variable	*Colombia*	*Indonesia*	*Malaysia*	*Mexico*	*Taiwan*
Constant	5.852[a]	-0.851	6.048[a]	0.765[a]	3.289[a]
	(0.359)	(0.899)	(0.319)	(0.095)	(0.028)
Log (labor)	0.703[a]	0.470[a]	0.662[a]	0.923[a]	0.667[a]
	(0.075)	(0.126)	(0.031)	(0.016)	(0.003)
Log (capital)	0.262[a]	0.657[a]	0.332[a]	0.252[a]	0.336[a]
	(0.036)	(0.078)	(0.021)	(0.009)	(0.003)
Capacity utilization	-0.114	n.a.	n.a.	0.005[a]	0.003[a]
	(0.133)			(0.001)	(0.0001
Training[d]	0.142	0.831[a]	0.025	0.131[a]	0.097[a]
	(0.133)	(0.308)	(0.062)	(0.033)	(0.017)
Education	0.006	0.053	0.061[a]	0.104[a]	n.a.
	(0.017)	(0.067)	(0.017)	(0.008)	
R & D[e]	0.005	-1.170	-0.137[c]	0.066[a]	0.116[a]
	(0.144)	(0.561)	(0.069)	(0.036)	(0.015)
Technology transfer[f]	0.068	0.125	0.044	0.073[b]	0.081[b]
	(0.151)	(0.482)	(0.091)	(0.034)	(0.034)
Exports[g]	0.255[c]	0.298	0.077	0.083[b]	0.161[a]
	(0.136)	(0.318)	(0.064)	(0.042)	(0.008)
Foreign ownership[h]	n.a.	-0.045	0.029	0.053	0.132[a]
		(0.457)	(0.066)	(0.042)	(0.027)

Notes:

1. Numbers in parentheses are standard errors
2. Industry dummies have been included in all regressions.

[a]: Significant at 1%.
[b]: Significant at 5%
[c]: Significant at 10%
[d]: Training is defined as a dummy variable with a value of one if the firm reports investments in internal formal/external training or positive training expenditures (Taiwan).
[e]: R&D is measured by a dummy variable with a value equal to 1 for firms reporting positive R&D-sales ratios.
[f]: Technology transfer is represented by a dummy with a value equal to 1 if the firm has licensing agreements with foreign firms.
[g]: Foreign ownership is represented by a dummy variable with a value equal to 1 for firms with foreign financial capital.
[h]: Exports are represented by a dummy variable with a value of one if the firm reports a positive export-sales ratio.

4.7 Training, as measured by a simple indicator variable, is positively associated with firm-level productivity in all five countries. This training-productivity relationship is statistically significant in Indonesia, Mexico and Taiwan but not in Colombia and Malaysia. The estimated coefficients range from a low of 0.097 in Taiwan to a high of 0.831 in Indonesia, with Mexico in between with a 0.131 point estimate. Notwithstanding the poor results for Colombia and Malaysia, these first, cross-country results are suggestive of the potentially important effects that enterprise training can have on firm-level productivity.

4.8 In the following sections, we refine these training estimates in two ways. First, the possibility exists that the parameter estimates of training (and other variables) are biased by the inclusion of an endogenous variable--training--in the production function. Indeed, we found

evidence of sample selectivity bias. When a simple and, admittedly crude, correction for selectivity was used, training was found to have a positive and statistically significant impact on firm-level productivity in all five countries. Second, the treatment of training as a simple indicator variable ignores a great deal of information about the intensity of training, the skilled and unskilled worker groups being trained, and the training provided to workers from different sources, both inhouse and external. We estimated production function models with more comprehensive training measures, and these revealed patterns of training effects varying by skill group and training source.

Table 11: Production Function Estimates with Predicted Training

Dependent Variable: log (Value Added)

Independent Variable	*Colombia*	*Indonesia*	*Malaysia*	*Mexico*	*Taiwan*
Constant	6.219[a]	-3.027	6.891[a]	1.496[a]	3.273[a]
	(0.441)	(1.545)	(0.395)	(0.147)	(0.045)
Log (labor)	0.706[a]	0.351[c]	0.593[a]	0.814[a]	0.634[a]
	(0.079)	(0.158)	(0.038)	(0.024)	(0.004)
Log (capital)	0.261[a]	0.704[a]	0.320[a]	0.249[a]	0.353[a]
	(0.037)	(0.100)	(0.021)	(0.009)	(0.003)
Capacity utilization	-0.043	n.a.	n.a.	0.005[a]	0.003[a]
	(0.152)			(0.001)	(0.0001)
Training Instrument[d]	0.266[b]	0.711[c]	0.282[a]	0.444[a]	0.028[a]
	(0.132)	(0.423)	(0.078)	(0.068)	(0.009)
Education	-0.011	0.267[a]	0.031[c]	0.087[a]	n.a.
	(0.020)	(0.087)	(0.019)	(0.008)	
R & D[e]	-0.039	-1.192c	-0.167[c]	0.068[c]	0.177[a]
	(0.144)	(0.599)	(0.069)	(0.036)	(0.014)
Technology transfer[f]	0.045	-0.412	0.020	0.075[b]	0.103[a]
	(0.153)	(0.556)	(0.091)	(0.034)	(0.033)
Exports[g]	0.162	0.402	0.041	0.057	0.158[a]
	(0.139)	(0.359)	(0.064)	(0.042)	(0.009)
Foreign ownership[h]	n.a.	-0.494	-0.033	0.037	0.088[a]
		(0.570)	(0.068)	(0.042)	(0.027)

Notes:

1. Numbers in parentheses are standard errors
2. Industry dummies have been included in all regressions.

[a]: Significant at 1%.
[b]: Significant at 5%
[c]: Significant at 10%
[d]: Training variable replaced by its predicted value (see text).
[e]: R&D is measured by a dummy variable with a value equal to 1 for firms reporting positive R&D-sales ratios.
[f]: Technology transfer is represented by a dummy with a value equal to 1 if the firm has licensing agreements with foreign firms.
[g]: Foreign ownership is represented by a dummy variable with a value equal to 1 for firms with foreign financial capital.
[h]: Exports are represented by a dummy variable with a value of one if the firm reports a positive export-sales ratio.

A Simple Correction for Self-Selection

4.9 We use an instrumental variable approach to correct for selectivity bias in estimating the productivity impact of training. If firms that find it productive to train do so, and they differ systematically from non-training firms in both their observed and unobserved attributes, then the possibility arises that the errors of the training choice and production function equations are correlated. Instrumental variables is one approach to addressing this problem. The training probit model estimates can be used to generate a predicted value for the training variable that, by construction, is purged of any correlation with the error term in the production function model. Recognizing that employer decisions to invest in R&D are also endogenous, we re-estimated the training probits without R&D and, in a second step, replaced the training variable with its predicted value in the production function estimation.[13]

4.10 Table 11 reports the production function results for each country using the training instrumental variable. The estimated parameters of the production function and control variables are moderately affected by the use of this instrumental variable approach, but the principal results remain. The statistical significance of two control variables change across countries--exports lose statistical significance in Colombia and Mexico (but not Taiwan), while mean education becomes statistically significant in Indonesia (joining Malaysia and Mexico). The most striking change is on the training variable, which now has a positive and statistically significant impact on productivity in all five economies. As before, the estimated training coefficients are lowest for Taiwan (0.028) and highest for Indonesia (0.711); falling in between are the training effects of Colombia (0.266), Malaysia (0.282), and Mexico (0.444).

Training Effects by Skill Group and by Training Source

4.11 Tables 12 and 13 report the production function parameters with more comprehensive training measures for Colombia, Indonesia, Malaysia and Mexico (no disaggregated training data are available for Taiwan). In Table 12, separate training intensity measures are included for skilled and unskilled workers; these training measures are further disaggregated by whether training is provided inhouse or from all external sources of training combined in Table 13. Given the broadly similar results obtained for the other control variables, the following discussion will focus only on the estimated productivity effects of training.

[13] This observation, of course, naturally suggests that an instrument also be used for R&D in the production function. This was not done, given our focus on training. Interested readers are referred to Aw and Tan (1993) for such an econometric exercise.

Table 12: Production Function Estimates with Training Intensity by Skill Group

Dependent Variable: log (Value Added)

Independent Variable	*Colombia*	*Indonesia*	*Malaysia*	*Mexico*
Constant	6.231[a]	-1.134	6.876[a]	0.966[a]
	(0.385)	(0.901)	(0.217)	(0.108)
Log (labor)	0.809[a]	0.460[a]	0.692[a]	0.909[a]
	(0.071)	(0.129)	(0.031)	(0.017)
Log (capital)	0.244[a]	0.665[a]	0.286[a]	0.249[a]
	(0.036)	(0.082)	(0.018)	(0.009)
Capacity utilization rate	0.092	n.a.	n.a.	0.004[a]
	(0.148)			(0.001)
Skilled & formal training[d]	0.386[c]	1.431[c]	0.252[b]	0.204[b]
	(0.229)	(0.756)	(0.122)	(0.051)
Unskilled & formal training[d]	-0.263	-0.550	-0.041	-0.132
	(0.292)	(1.592)	(0.114)	(0.073)
Education	-0.021	0.097	0.059[a]	0.104[a]
	(0.017)	(0.067)	(0.017)	(0.008)
R & D[e]	-0.104	-1.204[b]	-0.117	0.068[c]
	(0.139)	(0.495)	(0.069)	(0.036)
Technology transfer[f]	-0.059	0.082	0.099	0.061[c]
	(0.149)	(0.483)	(0.091)	(0.034)
Exports[g]	0.287[a]	0.288	0.078	0.083[b]
	(0.138)	(0.321)	(0.062)	(0.041)
Foreign ownership[h]	n.a.	0.009	0.037	0.078[c]
		(0.458)	(0.065)	(0.042)

Notes:

1. Numbers in parentheses are standard errors
2. Industry dummies have been included in all regressions.

[a]: Significant at 1%.
[b]: Significant at 5%
[c]: Significant at 10%
[d]: Training is weighted by the proportion of workers trained by source in each skill group
[e]: R&D is measured by a dummy variable with a value equal to 1 for firms reporting positive R&D-sales ratios.
[f]: Technology transfer is represented by a dummy with a value equal to 1 if the firm has licensing agreements with foreign firms.
[g]: Foreign ownership is represented by a dummy variable with a value equal to 1 for firms with foreign financial capital.
[h]: Exports are represented by a dummy variable with a value of one if the firm reports a positive export-sales ratio.

4.12 The results in Table 12 indicate, first, that the formal training of skilled workers has a positive and significant impact on firm-level productivity in all four countries. The coefficient estimates for skilled worker training range from 0.204 in Mexico to 1.431 in Indonesia; Malaysia with 0.252 and Colombia with 0.386 lie in between these two estimates. Second, and in direct contrast to the results for skilled workers, the productivity effects of unskilled worker training are statistically insignificant. It appears that the productivity effects of training are enhanced by a skilled (and educated) workforce, which might explain the greater propensity of employers to train their skilled employees.

Table 13: Production Function Estimates with Training Intensity by Skill Group and Training Source

Independent Variable	*Colombia*	*Indonesia*	*Malaysia*	*Mexico*
Constant	6.319[a]	-1.131	6.602[a]	0.922[a]
	(0.379)	(0.913)	(0.302)	(0.108)
Log (labor)	0.809[a]	0.462[a]	0.647[a]	0.908[a]
	(0.069)	(0.133)	(0.032)	(0.017)
Log (capital)	0.233[a]	0.664[a]	0.328[a]	0.249[a]
	(0.036)	(0.083)	(0.021)	(0.009)
Capacity utilization rate	0.119	n.a.	n.a.	0.004[a]
	(0.146)			(0.001)
Skilled & internal formal training[d]	0.217	1.454	0.077[c]	0.191[b]
	(0.513)	(1.032)	(0.041)	(0.072)
Unskilled & internal formal training[d]	-0.858[c]	-0.823	-0.061	-0.089
	(0.473)	(1.723)	(0.197)	(0.088)
Skilled & external training[d]	0.346	0.875	-0.021	0.132[b]
	(0.242)	(1.092)	(0.121)	(0.060)
Unskilled & external training[d]	1.046[a]	1.044	-0.108	-0.032
	(0.439)	(3.892)	(0.256)	(0.106)
Education	-0.025	0.095	0.062[a]	0.104[a]
	(0.018)	(0.068)	(0.018)	(0.008)
R & D[e]	-0.099	-1.201[b]	-0.123	0.069[b]
	(0.137)	(0.501)	(0.074)	(0.036)
Technology transfer[f]	-0.039	0.105	0.077	0.061[c]
	(0.149)	(0.487)	(0.097)	(0.034)
Exports[g]	0.341[a]	0.282	0.085	0.080[b]
	(0.137)	(0.324)	(0.068)	(0.041)
Foreign ownership[h]	n.a.	-0.019	0.041	0.079[c]
		(0.461)	(0.071)	(0.042)

Notes:

1. Numbers in parentheses are standard errors
2. Industry dummies have been included in all regressions.

[a]: Significant at 1%.
[b]: Significant at 5%
[c]: Significant at 10%
[d]: Training is weighted by the proportion of workers trained by source in each skill group
[e]: R&D is measured by a dummy variable with a value equal to 1 for firms reporting positive R&D-sales ratios.
[f]: Technology transfer is represented by a dummy with a value equal to 1 if the firm has licensing agreements with foreign firms.
[g] :Foreign ownership is represented by a dummy variable with a value equal to 1 for firms with foreign financial capital.
[h] :Exports are represented by a dummy variable with a value of one if the firm reports a positive export-sales ratio.

4.13 Is training provided to unskilled workers always unproductive? Table 13 reports the results of disaggregating skilled and unskilled worker training by internal and external training sources. For skilled workers, the estimated productivity effects of both internal and external training are positive across all countries, with one exception--skilled external training in Malaysia. The skilled training coefficient estimates attain statistical significance for both inhouse and external training in Mexico (0.191 and 0.132, respectively), and for inhouse training in

Malaysia (0.077). For unskilled workers, the training effects are not statistically significant in all countries except Colombia. In Colombia, external training for unskilled workers is positive and statistically significant while inhouse training for unskilled workers is negative and marginally significant.

Table 14: Estimated Training Coefficients from a Production Function With Training Intensity by Disaggregated Training Source

Independent Variable	*Malaysia*	*Colombia*
INTERNAL FORMAL TRAINING		
Skilled & internal training	0.069[c]	0.344
	(0.041)	(0.525)
Unskilled & internal training	0.085	-0.889[c]
	(0.125)	(0.485)
EXTERNAL SOURCES OF TRAINING: SKILLED		
Government training centers/SENA	-0.292	-0.249
	(0.436)	(0.311)
University/colleges	-0.162	0.776[a]
	(0.488)	(0.391)
Industry associations.	1.714[b]	0.125
	(0.767)	(0.278)
Buyers/suppliers	0.202	0.212
	(0.839)	(0.340)
Others external	-0.092	-0.562
	(0.257)	(0.661)
EXTERNAL SOURCES OF TRAINING: UNSKILLED		
Government training centers/SENA	-0.509	0.247
	(0.949)	(0.447)
University/colleges	1.718	0.839
	(1.779)	(0.636)
Industry associations	-2.033	-0.017
	(1.028)	(0.349)
Buyers/suppliers	-0.324	0.752[c]
	(1.240)	(0.470)
Other external	-0.052	0.612
	(0.219)	(0.927)

Notes:

1. Numbers in parentheses are standard errors
2. The production function estimates for the other variables are not reported, but are available from the authors. Industry dummies have been included in all regressions.

[a]: Significant at 1%
[b]: Significant at 5%
[c]: Significant at 10%

4.14 Table 14 reports the estimated training effects by skill groups, further disaggregating training by each individual source of external training. This exercise is restricted to Malaysia and Colombia, where detailed information on external training is available and sample size makes this exercise feasible. For Malaysia, three training estimates attain statistical significance--positive effects for skilled inhouse training and skilled training from industry associations, but negative effects for training provided to unskilled workers by industry

associations. For Colombia, positive significant effects are found for skilled worker training in universities and colleges, and for training provided to unskilled workers by buyers and suppliers; as before, inhouse training for unskilled workers was associated with lower productivity.

5

Conclusions and Policy Implications

5.1 Skills figure prominently in corporate strategies for productivity growth and international competitiveness. Despite its importance for private sector firms and for policymakers, there has hitherto been little effort made to collect information on, and study, the role of firm-led training in developing countries. To address this knowledge gap, we assembled an unusually rich set of firm-level surveys from five developing countries to provide a first look at the incidence, determinants, and productivity effects of enterprise training. The following findings and implications were suggested by our analyses.

5.2 The surveys indicated that a sizable fraction of firms in the manufacturing sector do not provide any training--formal or informal--for their employees. This is especially pronounced for small and micro firms--over half of them give no formal structured training, and over one-third do not provide any informal on-the-job training. Even among large firms, a significant number also report no training, either formal or informal. This finding suggests that several constraints on training--poor information about the benefits of training, the high training costs from the inability to exploit scale economies in training, weak managerial capabilities, absence of competitive pressures, or market imperfections--may be operative, and that policy initiatives to address these constraints should be explored.

5.3 Firms that train use a variety of inhouse and external providers. The surveys indicate that government-run training institutions are but one source of training. Private sector providers--firms themselves, industry associations, buyers and equipment suppliers, and private training institutes and colleges--are as important, if not more important, sources of in-service training. To the extent that many of these private sector providers can deliver training that meets employer needs and is cost effective, they offer an important means of expanding the resources available for skill development.

5.4 Several common training determinants were identified in our sample of developing countries. Firms are more likely to train when they are large, employ an educated and skilled workforce, invest in R&D and technology licenses, emphasize quality control methods, have foreign capital participation, and export to foreign markets. These results are evidence of strong complementarities between training and schooling, and of critical links between firms' training, technology, and exports. To be effective, the design of development policies should reflect this interdependence of human resource and industrial strategies.

5.5 The production analyses provided the first, broad-based evidence of the productivity enhancing effects of training in developing countries. In general, a large and significant impact of training on productivity was found for skilled workers but not unskilled workers, and for inhouse formal training as compared to most external sources of training. In other words, firm investments in training, especially inhouse training and training of skilled workers, has large payoffs. For employers, these results should dispel any skepticism about the beneficial effects of training on productivity; for policymakers, they form the basis for the design of appropriate policy instruments to encourage a larger private sector role in skills development and productivity growth.

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Annex Tables

Table A.1: Probit Estimates of the Training Equation by Source of Training, Colombia

Dependent Variable: Do Train

Independent Variable	*Any Formal Training*	*Internal Formal Training*	*External Training*
Size 2 (16-100 workers)	0.499[b]	-0.550	0.474[b]
	(0.223)	(0.442)	(0.223)
Size 3 (101-250 workers)	1.178[a]	0.189	1.079[a]
	(0.251)	(0.417)	(0.249)
Size 4 (>250 workers)	0.839[a]	0.129	0.824[a]
	(0.303)	(0.471)	(0.302)
Exports	0.368[b]	0.631[a]	0.311[b]
	(0.155)	(0.215)	(0.152)
Age	-0.006	0.002	-0.006
	(0.004)	(0.006)	(0.004)
Multi-plant status	0.236	0.390[c]	0.224
	(0.181)	(0.216)	(0.178)
Education	0.070[a]	0.064[b]	0.063[a]
	(0.020)	(0.032)	(0.020)
Proportion of skilled labor	0.245	-0.028	0.026
	(0.489)	(0.695)	(0.479)
% Value of Automatic machinery	0.001	0.001	0.002
	(0.002)	(0.002)	(0.002)
Quality control	0.301	0.187	0.305
	(0.205)	(0.248)	(0.203)
Proportion of female workers	-0.665[b]	0.034	-0.703[b]
	(0.292)	(0.438)	(0.289)
Unionization	0.742[a]	-0.189	0.779[a]
	(0.242)	(0.258)	(0.239)
R&D	0.103	0.595[c]	0.104
	(0.157)	(0.315)	(0.156)
Constant	-0.879[a]	-2.775[a]	-0.758[b]
	(0.343)	(0.580)	(0.337)
Log (likelihood)	-250.81	-114.87	-256.58

Notes:

[a]: Significant at 1%
[b]: Significant at 5%
[c]: Significant at 10%
Numbers in parantheses are standard errors.
The size categories are defined with respect to micro enterprises (those with 15 or fewer workers).

Table A.2: Probit Estimates of the Training Equation by Source of Training, Indonesia

Dependent Variable: Do Train

Independent Variable	*Any Formal Training*	*Internal Formal Training*	*External Training*
Size 2 (16-100 workers)	0.416	0.069	0.575[a]
	(0.268)	(0.383)	(0.282)
Exports	0.055	0.099[c]	0.059
	(0.045)	(0.054)	(0.046)
Age	-0.006	-0.007	-0.004
	(0.007)	(0.011)	(0.007)
Multi-plant status	-0.030	0.011	-0.034
	(0.035)	(0.041)	(0.036)
Education	-0.137[b]	-0.058	-0.136[b]
	(0.058)	(0.079)	(0.059)
Proportion of skilled labor	-0.070	-1.029	-0.176
	(1.399)	(2.155)	(1.461)
% Value of Automatic machinery	0.002	0.005	0.002
	(0.004)	(0.005)	(0.004)
Quality control	0.148	0.288	0.091
	(0.223)	(0.309)	(0.229)
Proportion of female workers	-1.629[a]	-1.947[a]	-1.425[a]
	(0.485)	(0.748)	(0.497)
Foreign ownership	0.469	0.371	0.587[c]
	(0.310)	(0.383)	(0.314)
R&D	0.074	0.382	-0.101
	(0.331)	(0.399)	(0.344)
Constant	0.987	-0.167	0.400
	(0.893)	(1.118)	(0.913)
Log (likelihood)	-98.50	-51.57	-92.22

Notes:

[a]: Significant at 1%
[b]: Significant at 5%
[c]: Significant at 10%
Numbers in parantheses are standard errors.
The size category is defined with respect to micro enterprises (those with 15 or fewer workers).
The negative effect of education on the likelihood of training is probably due to the high proportion of female labor employed. Female workers, on average have lower educational levels, and the education and female labor variables are negatively correlated (magnitude of the correlation coefficient is 0.55 and above in these three specifications).

Table A.3: Probit Estimates of the Training Equation by Source of Training, Malaysia

Dependent Variable: Do Train

Independent Variable	*Any Formal Training*	*Internal Formal Training*	*External Training*
Size 2 (16-100 workers)	0.362[b]	0.385[b]	0.221
	(0.176)	(0.193)	(0.232)
Size 3 (101-250 workers)	0.939[a]	0.801[a]	0.924[a]
	(0.176)	(0.192)	(0.228)
Size 4 (>250 workers)	1.446[a]	1.182[a]	1.477[a]
	(0.193)	(0.207)	(0.084)
Exports	0.027	-0.012	0.030
	(0.074)	(0.077)	(0.084)
Age	-0.005	-0.003	-0.003
	(0.003)	(0.003)	(0.003)
Multiplant status	0.106	-0.019	0.116
	(0.076)	(0.076)	(0.079)
Education	0.064[a]	0.088[a]	0.062[a]
	(0.019)	(0.019)	(0.021)
Proportion of skilled labor	1.742[a]	0.635[a]	1.938[a]
	(0.255)	(0.254)	(0.259)
% Value of Automatic machinery	0.002	0.001	0.004[a]
	(0.001)	(0.001)	(0.001)
Quality control	0.272[a]	0.309[a]	0.160[b]
	(0.070)	(0.071)	(0.076)
Proportion of female workers	0.065	0.025	0.048
	(0.127)	(0.128)	(0.141)
Unionization	0.158[c]	0.082	0.215[a]
	(0.083)	(0.083)	(0.086)
R&D	0.365[a]	0.395[a]	0.334[a]
	(0.078)	(0.076)	(0.080)
Foreign ownership	0.188[a]	0.243[a]	-0.029[a]
	(0.072)	(0.073)	(0.079)
Constant	-1.808[a]	-2.305[a]	-2.331[a]
	(0.326)	(0.336)	(0.374)
Log (likelihood)	-1133.40	-1090.86	-918.22

Notes:

[a]: Significant at 1%
[b]: Significant at 5%
[c]: Significant at 10%
Numbers in parantheses are standard errors.
The size categories are defined with respect to micro enterprises (those with 15 or fewer workers).

Table A.4: Probit Estimates of the Training Equation by Source of Training, Mexico

Dependent Variable: Do Train

Independent Variable	*Any Formal Training*	*Internal Formal Training*	*External Training*
Size 2 (16-100 workers)	0.802[a]	0.569[a]	0.856[a]
	(0.079)	(0.091)	(0.086)
Size 3 (101-250 workers)	1.116[a]	0.971[a]	1.112[a]
	(0.081)	(0.091)	(0.087)
Size 4 (>250 workers)	1.261[a]	1.251[a]	1.281[a]
	(0.085)	(0.094)	(0.091)
Exports	0.131[a]	0.118[b]	0.113[b]
	(0.049)	(0.048)	(0.047)
Age	0.001	-0.001	0.001
	(0.001)	(0.001)	(0.001)
Multi-plant status	0.097[c]	0.161[a]	0.060
	(0.049)	(0.048)	(0.048)
Education	0.034[a]	0.029[a]	0.035[a]
	(0.009)	(0.010)	(0.009)
Proportion of skilled labor	0.137	0.240	0.354[b]
	(0.144)	(0.154)	(0.145)
% Value of Automatic machinery	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Quality control	0.231[b]	0.242[b]	0.215[b]
	(0..096)	(0.107)	(0.099)
Proportion of female workers	0.057	0.055	0.003
	(0.089)	(0.091)	(0.088)
Unionization	0.310[b]	0.336[a]	0.198[a]
	(0.051)	(0.053)	(0.051)
R&D	0.209[a]	0.186[a]	0.183[a]
	(0.042)	(0.041)	(0.041)
Foreign ownership	0.045	0.064	0.078
	(0.057)	(0.055)	(0.055)
Constant	-1.783[a]	-2.164[a]	-2.029[a]
	(0.143)	(0.158)	(0.149)
Log (likelihood)	-2971.97	-2982.29	-3116.32

Notes:

[a]: Significant at 1%
[b]: Significant at 5%
[c]: Significant at 10%
Numbers in parantheses are standard errors.
The size categories are defined with respect to micro enterprises (those with 15 or fewer workers).

Table A.5: Probit Estimates of the Training Equation, Taiwan (China)

Dependent Variable: Do Train

Independent Variable	*Any Formal Training*
Size 2 (16-100 workers)	0.495[a]
	(0.036)
Size 3 (101-250 workers)	0.687[a]
	(0.055)
Size 4 (>250 workers)	0.682[a]
	(0.069)
Exports	0.257[a]
	(0.034)
Age	0.004[b]
	(0.002)
Multi-plant Status	-0.001
	(0.001)
Proportion Skill Labor	0.371[a]
	(0.069)
Female Workers	-0.005
	(0.009)
R&D	1.689[a]
	(0.035)
Foreign Ownership	0.347[a]
	(0.069)
% Value of Automatic Machinery	0.344[a]
	(0.051)
Unionization	0.246[a]
	(0.037)
Constant	-2.898[a]
	(0.074)
Log Likelihood	-4617.93

Notes:

[a]: Significant at 1% level.
[b]: Significant at 5% level.
Numbers in parantheses are standard errors.
The size categories are defined with respect to micro enterprises (firms with 15 or fewer workers).