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Effects of training on competitiveness in the manufacturing sector

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This article examines the effect of training on competitiveness in the manufacturing sector, drawing a distinction between industries with differing technological and productive characteristics. Using a systemic approach, it studies activities within firms and the impact that training has on them, as well as the organizational and institutional environment that supports training and the effect of the latter on the locality as a whole. An analysis is performed at two levels. At the firm level (micro analysis), econometric tools are used to study the manufacturing sector in Mexico. At the regional level (meso analysis), the electronics industry in one region of Mexico is studied. Empirical evidence shows that enterprise training has different effects on competitiveness in industries with different technological characteristics. It also has a positive impact on the region through knowledge diffusion.

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I
Introduction

Competitiveness at various levels (at the level of a firm, a region, an industry or a nation) has taken on a key role in the development agenda. In the countries of Latin America, whose economies are increasingly open and integrated into global production chains, improved competitiveness is essential to the attainment of greater economic and social development. Competitiveness is linked to the ability to successfully participate in international markets, generate value added and create jobs, among other factors.

Competitiveness can manifest itself in a variety of ways. It may arise from static competitive advantages, such as an abundance of natural resources or low wage costs. It may also be based on dynamic comparative advantages resulting from the introduction of new and improved products, the implementation of new types of corporate organization or increased production capacity (McFetridge, 1995; Spencer and Hazard, 1988; Porter, 1985). Investment in human capital is essential to the creation and strengthening of dynamic comparative advantages, which are sustainable and offer significant potential in terms of economic and social development.

In today's environment, which is dominated by continuous and rapid technological change, enterprise training —as a means of creating human capital— plays a key role in strengthening competitiveness. It supplements formal education, offering workers the knowledge and tools necessary to use, adapt and, in some cases, improve technology (Booth and Snower, 1996). Moreover, since it focuses on providing employees with the knowledge and skills they need to perform their daily functions, enterprise training can also be expected to produce rapid and significant returns for businesses (Tan and Batra, 1995; Mincer, 1994).

This paper will examine the impact of enterprise training on competitiveness in three branches of the manufacturing sector, each of which has different productive and technological characteristics. A systemic approach will be adopted; in addition to studying activities within firms and the impact of training on them, the organizational and institutional environment that supports training will also be studied, as will the impact of training on the surrounding community. An analysis will be performed at the firm (micro) and regional (meso) levels to assess the impact of training on the competitiveness of enterprises and their surrounding region, bearing in mind that competitiveness produces not only private benefits for firms, but also social benefits.

The micro analysis will be based on a statistical and econometric analysis of Mexico's 2001 National Survey on Employment, Wages, Technology and Training (ENESTYC), a public database. Unlike other empirical studies that have made use of this survey, this paper is based on the assumption that the impact of training on competitiveness varies from industry to industry. The meso (regional) analysis will be based on field work carried out in Mexico in October 2005. Since the effects of enterprise training vary from industry to industry, and such training has different characteristics in each case, the meso analysis will focus on a specific industry. The electronics industry was chosen, mainly because it displays a stronger propensity to undertake training, and because training has a greater impact on competitiveness in that industry than in the other two industries studied in this paper.

The rest of the article is divided into four sections. Section II introduces the key issues to be discussed and provides a brief overview of previous studies on the subject. Section III deals with the micro component, which, as mentioned above, includes a statistical and econometric analysis. Section IV addresses the meso component, and section V contains conclusions and policy recommendations.

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II

Competitiveness and investment in human capital

Organizations and researchers agree that stronger enterprise competitiveness is crucial to the attainment of greater economic and social development. Competitiveness can arise at different levels of aggregation: at the level of a firm, an industry or group of industries, a region or a country.

Firm-level competitiveness, which is particularly relevant to this study, is understood to mean the ability of a firm to operate profitably in a given market (McFetridge, 1995). Competitiveness manifests itself in a variety of ways. The literature on the subject usually distinguishes fleeting, artificial or spurious competitiveness from genuine, authentic competitiveness. The former is associated with low wages, non-sustainable exploitation of natural resources, inadequate labour conditions, etc. True competitiveness, on the other hand, is based on the ability to introduce new and improved products, implement new types of corporate organization and increase production capacity, among other skills (Spencer and Hazard, 1988).

This highlights the difficulty of establishing a single, commonly accepted indicator with which to measure or estimate competitiveness. There are, however, a number of factors frequently used for this purpose: profitability, productivity, costs, value added, market share, exports, technological innovation and product quality, among others.

As mentioned above, competitiveness can also be studied at the level of an industry, a region or a country. At the meso or macro level, it is associated with comparative advantages derived from the resources available in a region or a country: an abundance of natural resources or labour, or advantages created through investment in human capital, infrastructure or technological capabilities (IDB, 2004). The concept of systemic competitiveness offers a more comprehensive aggregate analysis.[1]

Firm-level competitiveness is influenced by many factors, including the following: a stable macroeconomic environment; a solid financial system; the ability to utilize, adapt and create new technologies; and the ability to attract, train and retain human capital.[2] The latter is the main topic of this paper.

Human capital, a product of formal education and subsequent learning, is widely recognized in economic theory as a key factor in economic development (Romer, 1989; Mincer, 1981; Becker, 1964). In the current globalized economy, where constant, rapid technological change is the norm and knowledge is considered one of the main determining factors of competitiveness, human capital plays a key role in raising productivity and increasing well-being (Tan and Batra, 1995). By acquiring knowledge and skills, workers are better able to adapt to new demands on the job. In order to remain competitive in an environment of constantly changing preferences and technologies, a firm needs workers who are capable of changing rapidly and innovating (Booth and Snower, 1996).

Enterprise training is one of the main components of a country's investment in human capital. In some middle- and high-income countries, it actually rivals investment in formal education in terms of importance (Tan and Batra, 1995; Mincer, 1994). Enterprise training is defined as a group of formal and informal activities that seek to convey knowledge and/or impart skills to workers. It is a broader concept than on-the-job training, which involves simply passing on knowledge informally through demonstration and practice.[3] It should be noted that enterprise training may include two different factors: general training that is applicable to more than one firm and specific training dealing with concepts and skills that are specific to one company. Given the difficulty of appropriating the results of training, firms tend to invest in the latter (Gallart, 2001).

While previous empirical studies have not directly addressed the impact of enterprise training on

[1] See Altenburg, Hillebrand and Meyer-Stamer (1998).

[2] See Nabi and Luthria (2002).

[3] For more information regarding on-the-job training, see Lara Rivero and Díaz Berrio (2003).

competitiveness, several of them have used econometric tools to show that such training has a positive and significant effect on total factor productivity (Tan and López-Acevedo, 2003; Tan and Batra, 1995; Bartel, 1989). Empirical evidence also suggests that the likelihood that an employer will offer training is linked to several different variables, including firm size, the educational attainment of employees, investment in new technologies, export position, use of quality-control methods and the presence of foreign capital.[4]

III
Training and competitiveness at the micro level

The objective of this section is to use econometric techniques to determine which variables are most closely associated with strong firm-level competitiveness, as well as to analyse the impact of training on such competitiveness.

Competitiveness is a complex concept, and there is no single, commonly agreed quantitative indicator with which to measure it. Economic literature often looks to productivity as the best indicator in this regard. Productivity is generally defined as a ratio of a volume measure of output to a volume measure of input use. The concept can be applied to labour, capital or total factor productivity. Productivity is a useful variable for competitiveness, since it covers many aspects of firm-level, regional or national competitiveness and can be reasonably estimated.[5]

While previous empirical studies have analysed the impact of training on competitiveness in the manufacturing sector as a whole, this study focuses on the fact that the need to acquire knowledge and disseminate it among employees, as well as the main source of knowledge and the factors that determine competitiveness, are different in each branch of industry. Technology-intensive industries acquire new knowledge mainly through internal design and research and development (R&D) activities, whereas low-tech manufacturing industries employ external sources, such as equipment suppliers and consulting firms, to acquire new knowledge.[6]

Bearing this distinction in mind, this section will explore the following questions: (i) Does the impact of training on competitiveness vary in industries with different technological characteristics? (ii) If so, what are the defining features of training in each industry? and (iii) Which variables are associated with high competitiveness in industries with differing technological characteristics?

In order to answer these questions, three branches of industry[7] with different productive and technological characteristics have been selected: the wearing apparel industry, the motor vehicle industry and the electronics industry.[8] The statistical and econometric analysis is based on the 2001 edition of ENESTYC —the most recent version available at the time of this writing. In addition to providing detailed information on enterprise training activities, ENESTYC supplies data on variables associated with competitiveness, as well as their determining factors. The survey focuses on the manufacturing sector, analysing it at the national level by branch and plant size.

1. Descriptive statistics

The following three branches of industry were selected for analysis: 3220 (manufacture of wearing apparel), 3832 (manufacture of radio, television and communication equipment and apparatus) and 3841 (manufacture of motor vehicles). As will be explained below, these industries have different productive and technological characteristics. This paper contends that,

[4] See Tan and López Acevedo (2003); Batra and Tan (2002); Booth and Snower (1996); Lynch and Black (1995); Tan and Batra (1995).

[5] See OECD (2001).

[6] See the seminal work of Pavitt (1984); Giuliani, Pietrobelli and Rabelotti (2005) and Cohen, Goto and others (2002).

[7] According to the International Standard Industrial Classification of all Economic Activities (ISIC/Rev. 2).

[8] For a description of the productive and technological characteristics of the wearing apparel industry, see OECD (2004a); for the motor vehicle industry, see Abdel (2004); for the electronics industry, see Padilla (2005).

as a result of these differences, the impact of training on competitiveness varies from industry to industry.

The manufacture of wearing apparel is the final link in a long value chain. It is labour-intensive and employs mature technology (OECD, 2004a). The motor vehicle industry is scale-intensive, has high quality standards and makes moderate use of technology (Abdel, 2004). The electronics industry is characterized by fast-paced technology, high quality standards and high productive efficiency (Padilla, 2005).

Table 1 provides a list of indicators for the three industries mentioned above. The indicators were computed using ENESTYC data. As of 2000, the wearing apparel industry consisted of 24,084 firms, the vast majority of them (91%) microenterprises. The average value added by manufacturing plants was relatively low (773,000 pesos). The electronics industry was comprised of 397 firms, 71% of which were microenterprises. Average value added by firms was 15.8 million pesos. The motor vehicle industry was comprised of 1,370 firms, 58% of them microenterprises. The average value added by manufacturing plants in that industry was 79.586 billion pesos.

Of the three branches studied, the electronics industry was the largest acquirer, user and generator of technologies. Electronics firms invest a higher percentage of their income in the purchase and transfer of technology, make greater use of automated machines and robots, and are more frequently engaged in R&D. The wearing apparel industry was the least technology-intensive of the three. It should be noted, however, that R&D expenditure in all three branches is significantly lower in Mexico than it is in developed countries.[9] Most innovations in that country are confined to the production process and are novel on the local, but not the global, market (CONACYT, 2003). As for the use of technology to organize production, over 75% of electronics and automotive firms possess quality-control programmes, compared to 53% in the wearing apparel industry (see table 1).

In terms of training, the electronics industry is home to the highest percentage of firms that train their workers (89%). It is followed by the automotive industry (88%) and the wearing apparel industry (62%). Automotive firms expend the highest number of training hours per worker and are the most likely to resort to outside experts for training. The electronics industry possesses the highest average percentage of employees with advanced education and graduate degrees (14.2% and 1.4%, respectively). While these percentages are similar in the figures for the motor vehicle industry (12% and 0.8%, respectively), in the wearing apparel industry they are lower (5% and 0.4%, respectively).

[9] See OECD (2004b).

TABLE 1

Mexico: indicators for the wearing apparel, electronics and motor vehicle industries, 2000

Indicator	Wearing apparel (3220)	Electronics (3832)	Motor vehicles (3841)
Number of firms	24 084	397	1 370
Value added (average, thousands of pesos)	773.0	15 838.6	79 586.2
Acquisition, use and generation of technology			
Percentage of income invested in the purchase and transfer of technology	1.5	3.6	1.8
Percentage of in-service machinery and equipment operated via automated numeric control systems	6.5	23.9	12.3
Percentage of value of in-service machinery and equipment comprised of robots	0.1	9.9	4.9
Percentage of firms engaged in R&D	3.5	25.7	22.8
Percentage of firms with quality control systems	53.6	76.8	76.7
Training and human resources			
Percentage of firms that trained their employees	61.8	89.1	88.0
Workers with advanced educations (as a percentage of regular staff)	5.0	14.2	12.0
Workers with graduate degrees (as a percentage of regular staff)	0.4	1.4	0.8

Source: Authors' own research, using data from the 2001 National Survey on Employment, Wages, Technology and Training (ENESTYC).

TABLE 2

Mexico: probit estimation for electronics, motor vehicle and wearing apparel industries

	dF/dx	Robust estimated errors	z	P>|z|
Dichotomic variable – motor vehicle industry	-0.509	0.087	-3.58	0.000
Dichotomic variable – wearing apparel industry	-0.591	0.114	-4.15	0.000
Dichotomic variable – acquisition of machinery and equipment	0.310	0.097	3.04	0.002
Size	0.211	0.081	2.59	0.010
Average educational attainment	0.038	0.017	2.12	0.034
Dichotomic variable – labour union	0.336	0.115	2.76	0.006
Dichotomic variable – outsourcing	0.384	0.137	2.49	0.013
Dichotomic variable – quality	0.228	0.130	1.72	0.085
Observations	3 971			
Prob > chi^2	0.00			
Pseudo R^2	0.47			

Source: Authors' own research, using data from the 2001 National Survey on Employment, Wages, Technology and Training (ENESTYC).

2. Econometric model

Multifactor productivity was estimated using an index equivalent to the quotient between value added and spending on capital and labour inputs.[10] Thus computed, multifactor productivity reflects economies of scale, productive efficiency and differences in installed capacity between firms.[11]

In order to determine whether the factors that influence enterprise training decisions vary from industry to industry, a probit model of the determining factors of such decisions was estimated for all three industries. The dependent variable in this model is dichotomic: 1 if a firm trains its employees, 0 if it does not. The results of the estimate are shown in table 2. The model was estimated using a group of variables which includes firm size, educational attainment of workers, presence of labour unions, presence of foreign capital, export activity, outsourcing activities, quality control and the use, acquisition and generation of technology (see appendix A).

The coefficients show dissimilar effects on the likelihood of training in the three industries studied. The dichotomic variables, which have a level of significance of 99% and are negative, suggest that automotive and wearing apparel firms are less likely to train their workers than electronics firms. This is largely attributable to the different technological dynamics of each industry. The electronics industry and, to a lesser extent, the motor vehicle industry, are characterized by rapid technological change in their production processes and their products. Hence the need for trained workers to operate in a flexible, constantly changing environment. Other variables associated significantly and positively with a higher likelihood of training include the introduction of machinery and equipment, the average educational attainment of workers, firm size and the presence of labour unions. These findings are consistent with existing empirical evidence.

The effect of employee training on competitiveness and other related variables, as well as the distinctive features of training, are analysed below, bearing in mind that the industries studied have different technological and productive characteristics. Training cannot be viewed as an exogenous variable, since the decision to train may be based on a firm's existing knowledge of its productivity (self-selection). A three-stage model is therefore suggested in order to estimate the impact of training on competitiveness (productivity as a proxy variable). Such a model would control for the effects of unobserved variables, as well as the endogeneity of the

[10] For more information on productivity indices, see OECD (2001).

[11] The variable most often used in the economic literature to estimate multifactor productivity is derived from the residuals resulting from the estimation of a Cobb-Douglas production function with constant returns. Several authors have found self-selection and simultaneity problems in the estimation of the production function, however. See Pavcnik (2002); Olley and Pakes (1996); and Griliches (1967).

treatment variable (training),[12] in accordance with the procedure developed by Barnow, Cain and Goldberger (1981). The first step is to estimate a selection model using a probit regression. The estimated probabilities obtained during the first stage are then used to compute the selection bias variable using the Heckman-Maddala-Lee adjustment method. Finally, the instrumental variable method is used to adjust the correlation between the probit model residuals and those of the second stage, ensuring consistency between the computed estimators and the standard errors.[13] The model to be estimated is as follows:

$$P_i = \mathbf{B'X_i} + \delta C_i + \gamma HML_i + \mathbf{e_i} \qquad (1)$$

This estimate captures effect B of an X_i set of exogenous variables on P_i; γ captures the effect of self-selection bias (HML) on productivity P_i; C_i captures the effect of an endogenous binary variable that shows whether or not firms trained their workers on productivity variable P_i. This C_i variable is modelled as the result of a latent unobservable C_i* variable.[14]

During the first stage —estimation of probit models— the breakdown for the three industries studied was based on a set of independent variables which included the following: prior education of workers, plant size, indicators showing the acquisition and use of technology, existence of quality-control mechanisms, origin of foreign capital, outsourcing and joint ventures with other firms.[15] Estimates were based on these variables, and progressively adjusted until a consistent estimate was obtained. During the second stage, in which factors associated with firm productivity were estimated, the variables from the preceding stage were introduced, together with other variables representing the various modalities of training[16] and the occupational categories in which it was concentrated (see appendix A). The same methodology was employed during this stage: variables were eliminated until a consistent estimate was obtained.

(a) *Electronics industry (3832)*

Table 3 shows the results of the first stage of probit model estimation for the electronics industry. First of all, R&D spending as a percentage of value added is positively linked to the likelihood of a firm training its employees. The introduction of new technologies and —what is more— the performance of knowledge-intensive activities require an active training strategy. The acquisition of machinery and equipment as a percentage of value added is also positively linked to the likelihood of training. In addition, the purchase of investment goods that require the use of new technology compels firms to train their workers.

The quality-control variable is also positively linked to the likelihood of firms training their workers. Quality assurance, which relies on modern management systems such as "Total Quality Control" and "Six Sigma", requires an active worker-training policy. Firm age is another variable positively linked to the likelihood of worker training. This may suggest that the production experience of a firm enables it to design and implement better training strategies.

Two other variables associated with a greater likelihood of enterprise training are the existence of a labour union and the index of joint ventures with other firms (including joint training initiatives), both of which are significant. The goodness of fit (0.79) is high, considering the cross-sectional nature of the model and the small number of observations.

The second stage of the estimation shows the effects of training and other variables on productivity (as a proxy variable for competitiveness). The coefficient of the effect of training on multifactor productivity is significant and positive, with a confidence level of 90% (see table 4). The selection bias adjustment —which corrects for the endogeneity of the treatment variable (training)— is negative and significant, with a confidence level of 90%. A correlation therefore exists between selection-equation and results-equation errors.

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[12] Training cannot be treated as an exogenous variable if a firm's decision to train is based on prior knowledge of its productivity; to do so would be to create a self-selection bias. In the case at hand, estimates resulting from ordinary square minimums would be biased and inconsistent.

[13] This approach employs maximum likelihood methods, maximizing the joint density of the dependent variables observed in order to obtain consistent estimators and standard errors. Estimators resulting from an ordinary least squares regression would be biased and inconsistent. Given the asymptotic properties of maximum likelihood estimators, the number of observations in the sample used in this paper makes a proper adjustment possible.

[14] $C_i^* = \alpha W_i + u_i$, C=1 if $C_i^*>0$, or C=0 if $C_i^*<0$; where C_i^* is the net gain (or loss) resulting from training, and its determining factors, while unobservable, are known. W_i is a vector of firm *i* characteristics that affect the costs and benefits associated with the decision to train; u_i is the error term for firm *i*.

[15] See appendix A for a full list of variables employed.

[16] Internal vs. external training, formal vs. informal training.

TABLE 3

Mexico: electronics industry (3832)

(Probit model of determining factors of enterprise training)

	Coefficient	Robust estimated errors	z	P>|z|
Research and development	4.855	1.605	3.03	0.002
Acquisition of machinery and equipment	3.738	1.036	3.61	0.000
Dichotomic variable – quality	1.669	0.974	1.71	0.087
Foreign capital	0.098	0.069	1.43	0.152
Age	0.209	0.043	4.87	0.000
Joint venture index	14.163	3.598	3.94	0.000
Dichotomic variable – labour union	1.533	0.597	2.56	0.010
Constant	-5.377	1.282	-4.19	0.000
Observations	394			
Prob > chi^2	0.00			
Pseudo R^2	0.79			

Source: Authors' own research, using data from the 2001 National Survey on Employment, Wages, Technology and Training (ENESTYC).

TABLE 4

Mexico: electronics industry (3832)

(Instrumental variable method)

	Coefficient	Robust estimated errors	z	P>|z|
Dichotomic variable – training	4.867	2.488	1.96	0.056
Heckman-Maddala-Lee adjustment	-3.827	2.089	-1.83	0.073
Dichotomic variable – R&D	1.862	0.746	2.5	0.016
Basic engineering	-0.199	0.060	-3.28	0.002
Acquisition of machinery and equipment	-0.063	0.034	-1.84	0.072
Dichotomic variable – quality	1.950	1.074	1.82	0.075
Employee training percentage	0.023	0.014	1.66	0.100
Average educational attainment	0.189	0.099	1.91	0.061
Percentage of employees	-0.026	0.012	-2.24	0.029
Labour regulations index	-1.657	1.042	-1.59	0.118
Constant	-2.213	1.794	-1.23	0.223
Observations	394			
Prob > chi^2	0.00			
Pseudo R^2	0.28			

Source: Authors' own research, using data from the 2001 National Survey on Employment, Wages, Technology and Training (ENESTYC).

In addition, firms that possess quality certifications display greater multifactor productivity, on average, than firms that do not. The global electronics industry is characterized by its high quality standards, which are a key factor in competitiveness (see table 4).

The dichotomic variable for R&D spending is significant and positive, which means that spending on R&D is positively associated with multifactor productivity. This is a reflection of the technological and productive characteristics of the electronics industry, as mentioned above. It also reflects internal efforts to generate new technologies in that industry. However, while R&D is positively linked to the likelihood of training and increased multifactor productivity in the electronics industry, one should bear in mind the type of R&D that is conducted in that industry in Mexico. As mentioned above, product improvements in Mexico are usually innovative at the national level only, and a significant amount of technological effort is focused on process innovations.

The average number of years of schooling completed by a firm's regular staff is a significant and positive variable. This finding —which is to be expected in any industry, and even more so in knowledge-intensive ones— suggests that prior formal education is an important factor in firm productivity.

(b) *Motor vehicle industry (3841)*

The motor vehicle industry (see table 5) is characterized by moderate R&D spending (as a percentage of value added) and intensive use of capital. Variables associated with an increased likelihood of training in this industry include the introduction of new technologies through the use and purchase of patents, as well as the introduction of machinery and equipment. Technological innovation through process improvements (improvements to machinery, production lines, etc.) is particularly important.

A firm's quality certifications and its export orientation (percentage of output exported) are positively and significantly associated with the likelihood of training. The automotive industry in Mexico is characterized by its strong export orientation and high quality standards, and these traits are found along the entire spectrum, from its assembly plants to all of its suppliers. These two factors go hand in hand and make ongoing worker training a necessity. Firms that manufacture products or components for other companies (outsourcing dichotomic variable) are also more likely to train their workers. As mentioned above, automotive industry suppliers are required to possess quality certifications and employ strong quality controls, which may explain the higher likelihood of training among such firms. Finally, the fact that the average educational attainment of a firm's regular staff is a significant and positive variable suggests that higher educational attainment is linked to an increased likelihood of training. This may have something to do with the fact that training is more profitable when it is offered to individuals who possess a higher degree of prior formal education.

The second stage of the econometric estimation shows that enterprise training has a positive and significant impact on firm productivity (though it has less so than it does in the electronics industry). The selection bias adjustment in this case is negative and significant (see table 6). Spending on patent purchases as a percentage of value added is 95% significant, with a high positive coefficient, which shows the importance of such purchases in the adoption of technology in this industry, as well as their positive impact on productivity. Process-improvement activities are also positively associated with productivity.

The average length of service of a company's workers is also positively linked to multifactor productivity in the auto industry. Low turnover probably encourages investment in the development of human capital. Finally, the outside training variable is positive and significant. Since the main sources of technology are external (patents and purchase of machinery and equipment), outside training provided by machinery suppliers or other firms and organizations is closely associated with multifactor productivity.

TABLE 5

Mexico: motor vehicle industry (3841)

(Probit model of enterprise training)

	dF/dx	Robust estimated errors	z	P>|z|
Patents	0.036	0.018	2.03	0.042
Dichotomic variable – acquisition of machinery and equipment	0.206	0.112	1.74	0.082
Dichotomic variable – process improvement	0.535	0.235	1.93	0.054
Dichotomic variable – quality	0.493	0.129	3.43	0.001
Exports	0.009	0.005	2.01	0.045
Average educational attainment	0.068	0.021	3.39	0.001
Percentage of blue-collar workers	0.009	0.003	3.08	0.002
Foreign capital	0.004	0.002	1.60	0.109
Dichotomic variable – outsourcing	0.478	0.233	1.83	0.068
Observations	1 362			
Prob > chi^2	0.000			
Pseudo R^2	0.520			

Source: Authors' own research, using data from the 2001 National Survey on Employment, Wages, Technology and Training (ENESTYC).

TABLE 6

Mexico: auto industry (3841)

(Instrumental variable method)

	Coefficient	Robust estimated errors	z	P>|z|
Dichotomic variable – training	1.147	0.627	1.83	0.068
Heckman-Maddala-Lee adjustment	-0.800	0.409	-1.96	0.052
Patents	7.637	3.350	2.28	0.024
Dichotomic variable – process improvement	0.513	0.296	1.73	0.085
Specialized worker training	0.002	0.004	0.65	0.513
Average length of worker service	0.036	0.020	1.77	0.078
Worker-to-employee ratio	0.236	0.104	2.28	0.023
Installed capacity	0.010	0.003	3.97	0.000
Dichotomic variable – quality	0.189	0.133	1.42	0.157
Dichotomic variable – outside training	0.002	0.001	1.84	0.067
Constant	-1.350	0.425	-3.18	0.002
Observations	1 362			
Prob > chi^2	0.000			
Pseudo R^2	0.22			

Source: Authors' own research, using data from the 2001 National Survey on Employment, Wages, Technology and Training (ENESTYC).

(c) *Manufacture of wearing apparel (3220)*

It should be noted that microenterprises were excluded from the estimation of the model for the wearing apparel industry, since the diversity of the data made estimation adjustment difficult. The variance of variables such as training and use of technology was especially high.[17] In the wearing apparel industry, the acquisition of machinery and equipment is positively associated with the likelihood of training. As with the other two branches, this is attributable to the manner in which firms adopt new technologies. Quality control is also a significant factor associated with a greater likelihood of worker training (see table 7).

In the wearing apparel industry, unlike the automotive industry, the average educational attainment of regular workers is not significant as an explanation for what causes firms to train or not to train their workers. Average length of service, on the other hand, is significant and negative —perhaps because experience reduces the need for training. In addition, much of the training in this industry is basic and seeks to provide new workers with no more than the simple knowledge they need to perform their tasks. Training does not appear to be an ongoing effort. Only the average educational attainment of management personnel is significant and positive. This suggests that managerial capabilities in these firms are a strategic factor that may improve the organization of production and detect training needs in a timely manner.

The results of the second stage of the econometric estimation showed a positive link between worker training and a firm's performance in terms of competitiveness. As expected, the coefficient in this branch is lower than it is in the electronics industry. The selection bias adjustment is significant and negative, with a 90% confidence level. No other consistent findings were possible, however. Other variables associated with competitiveness were contradictory due to the highly diverse nature of the observations. Indeed, the variance of data —especially that of the "use and generation of technologies" and "training" variables— made it impossible to obtain a consistent estimate. An attempt to develop a cluster-based estimation (by firm size) failed to improve the results.

[17] Microenterprises and small firms in this industry possess characteristics that are markedly different from those of larger establishments.

TABLE 7

Mexico: wearing apparel industry (3220)

(Probit model of determining factors of enterprise training)

	dF/dx	Robust estimated errors	z	P>|z|
Dichotomic variable – acquisition of machinery and equipment	0.279	0.174	1.69	0.091
Dichotomic variable – quality	0.429	0.136	2.98	0.003
Percentage of blue-collar and specialized workers	0.009	0.004	2.25	0.024
Average length of service of workers	-0.048	0.023	-1.84	0.065
Average educational attainment of management personnel	0.034	0.013	3.02	0.003
Joint venture index	0.390	0.117	2.76	0.006
Observations	2 215			
Prob > chi^2	0.000			
Pseudo R^2	0.34			

Source: Authors' own research, using data from the 2001 National Survey on Employment, Wages, Technology and Training (ENESTYC).

IV

Training and competitiveness in a regional setting

Section III analysed the impact of training on firm competitiveness. Businesses, however, are not the only economic agents that use and generate new knowledge. A large variety of public and private organizations —universities, vocational schools, chambers of commerce and government agencies, for example— encourage and support enterprise training activities. Enterprise training also has positive effects on the competitiveness of local industries and economies, thanks to the knowledge diffusion that results from interaction between firms and organizations, as well as the mobility of trained workers.

This section will therefore look at the impact of training on competitiveness in the local economy (meso level) and study the role that public and private organizations play in enterprise promotion and training. The basic argument advanced is that training not only increases firm competitiveness, but also has a positive impact on the competitiveness of the surrounding region or locale. From an evolutionary standpoint, the competitiveness of a region – particularly its ability to innovate – is attributable not only to firms, but also to a variety of public and private organizations, and to the strength of the relationships between them (Cooke, Gómez, Uranga and Etxebarria, 1997; Howells, 1999; Carlsson, Jacobsson and others, 2002; Iammarino, 2005).[18]

In order to assess the impact of training on competitiveness at the meso level, field work was conducted in Mexico in October 2005. A regional approach was adopted; the goal was to study organizations and the relationships existing among them in a specific geographic area. This was seen as an issue of particular importance given the role geographic proximity plays in the interaction between agents and the diffusion of knowledge (Cantwell and Iammarino, 2003; Cantwell and Molero, 2003; Malmberg, Sölvell and Zander, 1996).

As explained in section III, both the characteristics of training and its impact on competitiveness vary from industry to industry. Of the three branches studied, the electronics industry is the most likely to train its workers. It also obtains the highest returns from training in terms of productivity. In addition, it is characterized by rapidly changing technology, which means it must work continuously to develop human

[18] This is especially true of regional innovation systems, which have become particularly important in recent years.

capital. This makes it an interesting case study on the main topic of this article: the impact of training on competitiveness.

The field work in question focused on the electronics industry in Jalisco, Mexico, which is the most important in the interior of the country[19] in terms of the number of its firms, the amount of employment it generates and the foreign direct investment it attracts. Jalisco is also an interesting case study in Mexico, given the higher institutional development in terms of industrial policy, the strength of its higher education system and vocational schools, and the stronger links between its businesses, on the one hand, and its universities, vocational schools and research centres, on the other (Padilla, 2005).

The regional case study covers several organizations involved with enterprise training.[20] Two case studies of electronics firms were conducted, and interviews were carried out at universities, vocational schools, government agencies and private-sector organizations.

First of all, the case studies of companies demonstrate the key role of training in firm competitiveness, particularly with regard to quality, productivity and innovation. This confirms the findings of the econometric analysis. In an industry characterized by rapid change, stiff competition and stringent quality standards, training is an essential tool to ensure that products are assembled and/or manufactured in accordance with the highest quality standards. Investment in training also increases productivity, mainly by reducing the need to rework or reject products. The case studies suggest that firms which base their competitiveness on quality and innovation make employee training a key priority. This is reflected in the resources they invest in training, the professionalization of their needs-detection and training systems, the establishment of evaluation mechanisms, etc.[21]

Secondly, enterprise training in the electronics industry in Jalisco is provided and supported by public and private organizations. Three types of organizations are particularly relevant: (i) universities and vocational schools; (ii) government agencies; and (iii) private-sector organizations. Universities and vocational schools not only train human resources through formal education programmes, but also offer short courses for businesses. These courses, which may be of general interest to an industry or group of industries, are taught either at the initiative of the academic organization or at the specific request of a firm. They are tailored to the specific needs of the participants.

The government supports enterprise training through a variety of mechanisms, including tax incentives, training funds, public vocational schools and universities, and legislation and enforcement. Private-sector organizations also offer courses and provide technical assistance to identify training needs and evaluate the results of training. These courses may be of a general nature —courses on quality certification, standardization, motivation and the organization of production, for example— or may be technical courses specifically designed for a firm or group of firms.

Thirdly, enterprise training may have positive effects on regional competitiveness, mainly through knowledge diffusion. An analysis of the electronics industry in Jalisco reveals three main mechanisms in this regard. The first is the movement of workers between firms in the same industry or different industries. Engineers, technicians or workers who switch employers bring with them the training and skills acquired at their previous jobs. This may be beneficial for the competitiveness of their new firm. Trained employees may also start their own companies, known in the literature as "spin-offs", using the knowledge they have acquired at their jobs. The second mechanism is the interaction between skilled employees (engineers, technicians, managers) and the region's universities and vocational schools. Academic institutions tend to hire part-time teachers who also work in the industry. These teachers are trained and conversant with new technologies, and they pass their knowledge on to their students. Courses —in addition to technical assistance, joint research projects and corporate internships, among other factors— provide academic institutions with new knowledge through interaction with employees who have received training. The third mechanism is the interaction that occurs between employees and the private-sector organizations that provide them with services. Joint projects —training and technical-assistance initiatives, for example— are a means of transferring knowledge from company employees to the staffs of private organizations that support the industry.

The mechanisms described above are particularly relevant to high-tech industries in developing countries,

[19] Larger concentrations of electronics firms are found in border states such as Baja California and Chihuahua.

[20] Institutions were selected based on the literature in the field, as well as interviews with experts (see Padilla, 2005; Dussel, Palacios and Woo, 2003).

[21] For a detailed description of enterprise training activities and their impact on competitiveness, see Padilla and Juárez (2006).

such as the electronics industry in Jalisco. These industries are usually dominated by transnational corporations whose technology is either cutting-edge or more advanced than that of local firms, universities, vocational schools and private organizations that support the business sector. Consequently, the knowledge that is initially transferred to the employees of transnationals through formal and informal training may become a valuable source of updated information for the rest of the industry, as well as the local economy in general. Trained employees do, in fact, transfer the knowledge acquired from transnationals to the receiving economy. It should be noted, however, that such spillovers are neither immediate nor direct. Empirical evidence in several developing countries shows that transnationals may operate in enclaves, with few ties to the local economy and basic productive and technological capabilities. In such cases, spillover to the rest of the region is significantly restricted.

V

Conclusions

At the micro level, the econometric analysis presented above shows that enterprise training in each of the three industries studied is positively associated with firm competitiveness. Training enhances competitiveness by improving product quality and increasing efficiency (less reworking and fewer product rejections), flexibility and the ability to develop innovative products and processes.

The variables associated with a higher likelihood of enterprise training vary from industry to industry. However, quality control was significant and positive in every branch, which demonstrates the key role that training plays in the attainment of high quality standards and the fact that quality-control procedures require an active training policy. Training is also closely linked to the introduction and generation of new technologies. Mechanisms in this regard vary from branch to branch: R&D spending in the electronics industry, acquisition of machinery and equipment and patent purchases in the automotive industry, acquisition of machinery and equipment in the wearing apparel industry.

The main result of the econometric model is that training has a positive effect on firm competitiveness, and that the magnitude of its impact is greater in industries characterized by rapidly changing technology. Industries that employ and develop new technologies in their processes and products must invest in training in order to absorb and generate such technologies. This may create a virtuous circle: technological change requires training, which is itself crucial to innovation. Training is therefore linked to an active process of use, improvement and generation of knowledge.

Firm-level competitiveness is also linked to a number of different variables, depending on the productive and technological characteristics of each industry. In the electronics branch, R&D spending (an internal generator of knowledge) and quality control are positively associated with competitiveness. As mentioned above, the type of R&D conducted by electronics firms in Mexico must be borne in mind when interpreting this result. In the motor vehicle industry, the training of specialized workers has the greatest impact on firm competitiveness; patent purchases and quality-control procedures also play a part. No consistent estimation was possible in the wearing apparel industry due to the large variance of independent variables.

Segmentation by technological content was useful in identifying differences in enterprise training strategies and their impact on industry competitiveness. It should be noted, however, that this is not the only type of segmentation that is relevant when analysing the impact of training on competitiveness. Two future lines of research can be pursued on the basis of this study: (a) the lower likelihood of enterprise training among smaller firms, and the limitations they face in terms of developing an active training strategy that meets their needs; and (b) the impact that the position in the value chain (design, R&D, assembly, manufacture, marketing, etc.) has on decisions regarding employee training and the resources available for that purpose. Furthermore, the addition of panel data would be an extension of the econometric model mentioned above and might yield interesting findings regarding changes or trends in the impact of training on competitiveness.

At the meso level, the case study of the electronics industry in Mexico also shows that enterprise training has a positive impact on regional competitiveness. The diffusion throughout the region of the technological knowledge initially transferred to company employees constitutes a clear social benefit. Worker mobility, ties binding companies with each other and with universities and vocational schools, and the hiring of training services from private firms are some of the mechanisms by which new knowledge is disseminated, improved and generated. All of this may help to significantly increase regional competitiveness.

Consequently, a joint training strategy, based on partnerships or cooperation between firms and public organizations, may have highly positive effects at the macro and meso levels. On the one hand, it may reinforce corporate training strategies; on the other, it may strengthen the regional capabilities that make the local manufacturing sector more competitive and help the region attract new and better investments.

The public sector in particular can play a key role by encouraging and facilitating enterprise training activities and knowledge diffusion. The findings noted above suggest that public initiatives aimed at encouraging or directly supporting enterprise training should consider the specific needs of each industry —namely, its productive and technological characteristics. Public training policies should be designed with a comprehensive, regional approach in mind —one which recognizes the importance of integrating the efforts of universities, vocational schools, private technical-assistance organizations and chambers of commerce, while also acknowledging the particular characteristics and needs of the local community.

Human capital development techniques will have to be adjusted and changed continuously to keep pace with rapid technological transformations, which are accentuated by the expansion and penetration of information technologies. Enterprise training, by its very nature, is better able to absorb new knowledge and skills. Professional training —including enterprise training— must make use of new teaching techniques, such as autonomy development and individual creativity, that are suited to rapid technological change and facilitate learning and the continuous development of skills (Rolf, 2002).

Finally, given the close relationship that exists among training, innovation and quality, public policies that support training must be designed in conjunction with policies to encourage innovation and quality. A comprehensive approach in this regard will lead to a better use of resources and to better results.

APPENDIX A

List of variables

Variables	Variable construction
Total factor productivity (index)	Quotient between value added and capital and labour inputs in production in 2000
Dichotomic variable – training	1 if training took place, 0 if it did not
Dichotomic variable – wearing apparel industry	1 if a firm belongs to the wearing apparel industry, 0 if it does not
Dichotomic variable – electronics industry	1 if a firm belongs to the electronics industry, 0 if it does not
Dichotomic variable – auto industry	1 if a firm belongs to the auto industry, 0 if it does not
Size	Variable with four possible values: 1 if a firm has fewer than 16 employees; 2 if it has between 16 and 100; 3 if it has between 101 and 250; 4 if it has more than 250.
Foreign capital	Percentage of foreign equity in firm
Dichotomic variable – labour union	1 if a labour union exists, 0 if it does not
Dichotomic variable – outsourcing	1 if a firm has engaged in outsourcing, 0 if it has not
Worker-to-employee ratio	Quotient between the number of employees and the number of workers
Percentage of management personnel	Percentage of workers in an occupational category associated with managerial functions
Percentage of employees	Percentage of workers classified as employees (category includes professionals, technicians, administrative staff and supervisors)
Percentage of specialized workers	Percentage of workers in an independent occupational category who are highly skilled at their functions
Percentage of blue-collar workers	Percentage of regular staff classified as blue-collar workers
Installed capacity	Percentage of utilisation of a firm's productive capacity

Variables	Variable construction
Firm age	Number of years a firm has been in operation
Exports	Percentage of production exported
Dichotomic variable – quality	1 if a firm possesses quality control mechanisms, 0 if it does not
Joint venture index	Percentage of activities undertaken jointly with other firms: sales, purchase of raw materials, access to credit, training, R&D, use of machinery and equipment, acquisition of machinery and equipment
Labour regulations index	Shows whether a firm has policies regarding wage categories, staff rotation, hiring of temporary workers, outsourcing, creation of upper management positions, staff cuts, recruitment and employee promotion
Average educational attainment	Average number of schooling years of overall regular staff
Average length of service	Average years of service of regular staff
Training percentage by occupational category	Percentage of man-hours devoted to training of managers, employees, semi-skilled workers or general labourers
Dichotomic variable – internal formal training	1 if firm provided training through a co-worker, 0 if it did not
Dichotomic variable – internal informal training	1 if firm provided training through an instructor, 0 if it did not
Dichotomic variable – outside training	1 if firm provided training through an outside expert, 0 if it did not
Acquisition of machinery and equipment	Spending on the acquisition of machinery and equipment in 2000, as a percentage of value added
Dichotomic variable – acquisition of machinery and equipment	1 if machinery and equipment were acquired in 2000, 0 if they were not
Patent purchases	Spending on patent purchases in 2000, as a percentage of value added
Patents	Spending on patent use in 2000, as a percentage of value added
Basic engineering	Spending on basic engineering in 2000, as a percentage of value added
Research and development (R&D)	Spending on R&D in 2000, as a percentage of value added
Dichotomic variable – process improvement	1 if process improvement took place in 2000, 0 if it did not
Dichotomic variable – R&D	1 if firm engaged in R&D in 2000, 0 if it did not

(Original: Spanish)

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