RESEARCH REPORTS AND NOTES

TECHNOLOGY TRANSFERS AND MANAGERIAL-PROFESSIONAL EMPLOYMENT:

Brazilian Manufacturing, 1960–1975*

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In recent years, much of the discussion of North-South dependency relations has shifted from the role of capital flows and trade patterns to the importance of technology transfers. As in the earlier debate, two seemingly opposed positions have emerged, contesting in this case the long-range effects of technology transfers on the receiving countries in the developing world.

On one side is the widespread belief that the transfer of technology fosters the development of human capital among less-developed countries. Advanced technologies from the developed countries demand skilled human resources, even if only to adapt the technology to local conditions (Katz 1978). Traditional industries such as textiles and food processing, which often predominate in less-developed countries, typically involve low technology and require little scientific personnel. According to this perspective, the route to an advanced industrial economy

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requires importing modern technology from the West in order to shift domestic industry to a more advanced technological base.

An opposing view posits that the present international division of labor imposes technological dependence on countries in the periphery and that this dependence inhibits the development of human capital. According to this perspective, technological dependence implies that the dependent country is not self-reliant in scientific and technological activities. In order to grow, the country must incorporate into its productive system technological knowledge that has been developed abroad and must pay monopoly prices to the companies that possess this knowledge. Technical innovation remains in the hands of companies supplying the technology, a situation that, when "coupled to the legal control given by the contract, assures dependency over time and, consequently, the maintenance of income flow and other benefits arising from the relationship" (Erber 1981, 19).

Two reasons have been given for the long-term negative effect of technology transfer on the composition of the labor force. First, research and development remains primarily a core activity (Frobel, Heinrichs, and Kreye 1980). Peter Evans has observed that multinational corporations keep the innovative side of their operations "as close to home as possible" (1979, 37). Concurring with product life-cycle theorists, he points out that multinationals manufacture new products in the periphery only after their manufacture has become routinized (see also Vernon 1966). Second, the technology that is transferred tends to embody low-skill components. In general, imported technology is capital-intensive because it corresponds to the level of development of the productive forces in the developed countries. Arrighi has suggested that imported capital-intensive techniques require a different composition of the labor force from labor-intensive techniques (1970, 228–29). Capital-intensive techniques "make possible the division of complex operations, which would need skilled labor, into simple operations that can be performed by semiskilled labor."

Moreover, studies of the labor process in the core countries suggest an increasing separation of conception and execution of work, which results in "de-skilling" much of the work force and relying on only a small proportion of mental laborers. Braverman (1974), for example, has argued that labor-saving machinery simplifies and routinizes the work so that formerly complex work tasks can be performed by semiskilled workers who require less training. The older the product, the more completely this rationalization process has progressed. Wright and Singelmann (1982) have demonstrated that within industries, the proportion of skilled workers declines over time, although this decline is balanced by the rise of new industries that then require high proportions of skilled workers. Again, because the products whose manufacture is transferred to the periphery are established products, they have already undergone a substantial rationalization. Palloix presents a similar view in observing that the present stage of international capital accumulation has reached the point in which certain manufactures are shifted to the periphery, "with the imperialist centres reserving for themselves those processes which require some know-how, some technological knowledge and a skilled labor force" (Palloix 1976, 57).

Intermediate perspectives can also be found in the literature. According to Frances Stewart, although the "unrestricted inflow of foreign technology may severely inhibit the learning process," policies aimed at increasing internal technological mastery and promoting technological autonomy may contribute to the training and employment of high-level personnel (Stewart 1979, 40). Dahlman and Westphal discuss the positive effect that technological effort has on technological mastery through the formation of human capital (1981, 14). This outcome results not simply from the transfer of technology but from the technological effort to assimilate, adapt, and create new technology. Thus, according to these intermediate perspectives, the critical factor is not technology transfer per se but the environment surrounding the incorporation of new technologies. The key question is: are adaptation and training encouraged, or do all technologically sophisticated activities remain in a core country?

Although many studies have been made of technological dependence as well as of de-skilling and the separation of conception and execution of work, further investigation is needed to link these concepts. Most studies of the labor process have focused on the core countries. In addition, studies of dependence have not yet systematically investigated changes in the skills of the labor force, a gap that needs filling. As Erber noted in his extensive review of the literature on science and technology research in Brazil, "there remain several aspects that are only slightly studied, such as the consequences of modifications of the labor process on the composition and control of the labor force" (1981, 46).

The Brazilian case is especially appropriate for this kind of study because of the type of dependent development adopted by the country. Beginning in the 1930s, Brazil favored an import-substitution policy through protective barriers on industrial imports as the route to industrialization. This policy increased Brazilian reliance on foreign manufacturing technology. In the mid-1950s, multinational corporations began to transfer certain manufacturing operations to Brazil. In some industries like pharmaceuticals, foreign investment led to multinational control of the industry and the concentration of most research and development activities in the core countries (Evans 1979). During the same period, new local industries became more reliant on foreign technology. The economic boom of the 1960s and 1970s, the so-called Brazilian miracle, was built on virtually unrestricted importation of foreign technologies. The evidence available suggests that this approach resulted in a deepening of Brazil's technological dependence (Biato et al. 1971).

The main question to be raised is: what is the effect of this technological dependence on changes in the skill composition of the Brazilian labor force? Theories of dependency and the labor process would predict a shift toward a higher proportion of semiskilled and unskilled workers in relation to engineers, technicians, and skilled workers. The higher proportion of semiskilled and unskilled workers results from the tendency toward increasing separation of conception and execution of work on a world scale with semiperipheral countries like Brazil specializing in more mechanized operations. Technology transfer theories, in contrast, predict a change toward a higher proportion of engineers and skilled workers as required by the more advanced technologies.

This study will concentrate on changes in university-trained personnel—technicians, engineers, and managers (a future study will examine the fate of skilled craftsmen). We will compare industries that are heavily dependent on foreign technology (such as transportation, electrical, and pharmaceutical) with industries that import little technology (such as food processing and apparel). Somewhere in between lie industries requiring moderate levels of technology imports (such as paper and metal processing).

The Data and Measurement

Design / A longitudinal design is essential for studying the effect of technological dependence on labor force composition because cross-sectional designs easily confuse two countervailing tendencies. On the one hand, technology transfer tends to occur in more complex industries that already employ a higher proportion of university-trained technicians. On the other hand, as substantial technologies are transferred, they may inhibit subsequent growth in those occupations. To separate opposing causal forces, we have constructed a panel design to study the change in the proportion of university-trained technicians from 1960 to 1975. Technological dependency theories would predict a negative effect of technology transfers on this change, although a positive correlation might exist with the starting-point level of university-trained technicians. Technological dependence was measured as an average for the period 1965–1970, resulting in a five-year time lag before the finishing point.

University-Trained Technicians / The dependent variable in this analysis is the difference between the proportions of university-trained technicians in 1960 and 1975. These proportions are the ratio of the number of university-trained technicians to the number of laborers in the same year. The proportion of university-trained personnel in 1960 is also included as a control variable to compute the effect of technological dependence on change in the proportion of university-trained technicians independent of the initial level in 1960 (Heise 1970).

The data were taken from the Brazilian industrial censuses of 1960 and 1975 (IBGE 1967, 1981). The 1960 census made no distinction about whether engineers and technicians were directly connected with production. The 1975 census separated those connected with production from those unconnected. For purposes of comparison, university-trained technicians in 1975 have been collapsed into one category.

Technological Dependence / The measure of technological dependence used in this study was developed by Bonelli (1976), using data gathered by Biato et al. (1973) on contracts for technology payments registered at the Banco Central do Brasil. Bonelli divided the real value of the payments per industry by the value of production for each year from 1965 to 1970. An average for the period was then computed. Brazilian law requires that contracts for technology transfer be registered at the Banco Central. Contracts include payments for technical assistance, manufacturing and patent licenses, trademark licenses, engineering services, and elaboration of projects. Biato et al. (1973) warned that the data may also include profit remittance as payment for "technical assistance," the largest item constituting 68.6 percent of all payments in the period considered. A logarithmic transformation of this variable was used.[1]

This indicator of technological dependence is appropriate for our purpose here. But if data were available, other indicators could be computed and used in combination with this one. One such indicator would be the performance of each industry on research and development activities. Such information would answer the question of whether increasing payment for technological information would also represent a way to reduce dependence. Technology transfers can become a way to overcome dependence only when coupled with an effort to achieve technological mastery (Dahlman and Westphal 1981). The secret of the success of countries that used technology transfers to overcome dependence (like Japan) lies not in the mere adaptation of technology to local conditions but in the process of technological mastery.

The composition of the labor force in each industry is influenced by technological dependence but also by other factors like the size of the firms in an industry, foreign or national ownership, capital intensity of the firms in the industry, whether the industry is competitive or monopolized, and whether or not the industry is expanding. These control variables represent the internal aspects of the organization of Brazilian industries that influence change in the occupational structure. Because some of these factors are correlated with both technology transfer and change in the proportion of university-trained technicians, these variables need to be controlled so that the relationship between technological dependence and labor force change is not spurious.

Growth of Employment / Growth of employment is measured by the percentage rate of change in total employment of industry between 1960 and 1975. Some industries expanded rapidly in the period while other stagnated. In general, the rapidly expanding industries added laborers faster than university-trained personnel. This variable measures the growth of the industries during the period, making the effect of technological dependence independent of whether the industries were expanding or not.

Average Establishment Size / This factor is measured by the average number of workers per establishment, that is, the ratio of the number of workers to the number of establishments in 1960. These data were taken from the 1960 industrial census. Large industries were expected to display more hierarchization and division of labor, resulting in a positive effect on the proportion of university-trained technicians.

Foreign Capital / Two measures of the degree of participation of foreign firms were used: first, the percentage of industry-wide sales in 1965 corresponding to foreign firms, available from Morley and Smith (1971); and second, the percentage of the capital of the industry in 1972 that was held by foreign firms. The latter figures were calculated by Regis Bonelli, Pedro Malan, and Luiz Villela from data published in the magazine *Visão* (available in Bonelli 1976). Foreign ownership also indicates the direct transfer of technology by means of foreign direct investment (Lall and Mohammad 1983, 530). Foreign capital participation was expected to affect the composition of the labor force independent of the effect of technological dependence, although much technological dependence already reflects the operation of multinational corporations. Those companies' operations institutionalize an international division of labor in which the level of skills being created in the peripheral countries is not high (Frobel, Heinrichs, and Kreye 1980). More specifically, foreign capital was expected to reduce the proportion of university-trained technicians.

Interpretation of this variable was hindered by the substantial multicollinearity between foreign ownership and technology transfer. Moreover, foreign companies may transfer productive technology and forms of organization that may not coincide with the technological dependence being measured by the contract payments. Biato et al. (1973) have shown that although the transfer of technology to a Brazilian company requires a contract between the national company and the foreign supplier of the technology, in the case of subsidiaries of transnational corporations, it is possible to transfer technology without a contract.

Industrial Concentration / Concentration is measured by the value of production in 1968 accounted for by the top four establishments in each industry. This measure is available from Fajnzylber (1971, 104), who used data from IBGE. Moreira (1983) hypothesized that firms operating in concentrated markets are less responsive to relative factor prices and consequently would maintain a higher proportion of skilled workers (university-trained technicians plus skilled workers). It was therefore expected that industrial concentration would positively affect the change in the proportion of university-trained technicians.

Capital Intensity / This factor was measured as the capital per worker in 1960. The information on capital and number of workers was taken from the 1960 industrial census. Capital intensity is meant to represent the complexity of the technology used in each industry. The more capital-intensive the industry, the more complex its technology. According to Arrighi, capital-intensive techniques require a labor force in which high-level and semiskilled labor predominate, while in labor-intensive industries skilled and unskilled labor predominate (1970, 228). It was therefore expected that capital intensity would have a positive effect on change in the proportion of university-trained technicians.

Analysis of Results

Initial analysis of a scattergram of university-trained technicians and technological dependence suggested a curvilinear relationship between these variables.[2] This prediction is confirmed in table 1, a hierarchical regression specifying the shape of the relationship. A regression analysis of the change in the proportion of university-trained technicians from 1960 to 1975 in relation to the proportion of university-trained technicians in 1960 and a linear technological dependence measure show that the coefficient of the technological dependence variable is not significant. Adding technological dependence squared increases the R-square an additional 11 percent. The quadratic term approaches the 0.10 level of statistical significance, but without additional controls, it does not quite reach the level of statistical significance. Nevertheless, at this stage it seems that the relationship between technological dependence and change in the proportion of university-trained technicians is curvilinear.[3]

The quadratic equation describes an inverted U-shaped curve where the maximum increase (inflection point) in the proportion of university-trained technicians is predicted at a value of 0.67 for the logarithm of technological dependence or, in the original metric, a value of 1.95.[4] This level is approximately that of technological dependence of the metallurgic and nonmetallic minerals industry. These industries all experienced substantial growth in the proportion of university-trained technicians.

TABLE 1 *Hierarchical Regression of Change in the Proportion of University-Trained Technicians between 1960 and 1975 in Brazil*

Independent Variables		*Steps* (1)	(2)	(3)
	b	0.07	0.05	0.05
PRUNV60[a]	Beta	0.19	0.13	0.12
	t	0.82	0.45	0.45
	b	—	0.60	2.75
LTECHDEP[b]	Beta	—	0.12	0.56
	t	—	0.45	1.42
	b	—	—	-2.04
SQLTECH[c]	Beta	—	—	-0.56
	t	—	—	1.50
Constant		0.47	0.63	2.08
Increment in R-Square		0.04	0.01	0.11
R-Square		0.04	0.05	0.16
Adjusted R-Square		-0.02	-0.07	0.01

Note: The number of cases involved was twenty.
[a] Proportion of university-trained technicians in 1960.
[b] Technological dependence (logged).
[c] Technological dependence squared.

Industries with lower levels of technological dependence revealed slower growth in the proportion of university-trained technicians (in foods and textiles) or decline (in leather and beverages). But industries with especially high levels of technological dependence (transportation equipment, rubber, and electrical equipment) also experienced slow or negative growth in the proportion of university-trained technicians.

Most of the highly dependent industries began with high levels of university-trained personnel. Thus it appears that technology is positively associated with university-trained personnel. Indeed, the correlation of technological dependence and the 1960 level of university-trained technicians is substantial ($r = 0.51$). But this correlation does not reflect the causal effect of technological dependence on change in the proportion of university-trained technicians because these highly dependent industries failed to increase their proportion of university-trained personnel. Yet industries with only moderate levels of technological dependence increased their proportion of university-trained personnel, despite beginning at similarly high 1960 levels. On the other hand, the industries with the lowest levels of technological dependence began with low levels of university-trained technicians that remained low or dropped even lower.

This finding suggests that at low to moderate levels, the transfer of technology is beneficial in terms of creating more high-level jobs. It is possible to speculate that as technological dependence increases, so does the need for high-level expertise to adapt this technology as well as to staff the firms receiving this technology.

The next step in the analysis is to introduce control variables into the equation. Given the few cases in the analysis and the number of independent variables already in the equation, controls for growth of employment and each structural variable were introduced separately. Because analysis of a few cases and a large number of variables would result in very unstable coefficients, it was more prudent to use fewer variables in the analysis.

The results in table 2 show that the curvilinear relationship between technological dependence and change in the proportion of university-trained technicians continues to hold when controlling simultaneously for growth of employment and the structural variables. Both the linear and curvilinear coefficients are statistically significant in all the equations at the 0.10 levels at least. Technological dependence remains between 2.0 and 2.5 in the original index of technological dependence. Only growth of employment, industrial concentration, and capital intensity affect changes in the proportion of university-trained technicians. Growth of employment has a moderate negative effect in all the equations. Expansion between 1960 and 1975 caused the number of laborers to increase at a faster rate than the number of university-trained technicians.

Industrial concentration has a strong negative effect (Beta equals -0.54) on change in the proportion of university-trained technicians, indicating that when the level of technological dependence and growth of employment are held constant, more concentrated industries are less likely to increase their proportion of skilled workers. The results do not support the hypothesis that concentrated industries are less responsive to relative factor prices and more likely to maintain a higher proportion of university-trained personnel. The data suggest that the oligopolistic structure of Brazilian industry inhibits the growth of university-trained technicians. According to Fajnzylber (1971), this oligopolistic structure affects innovation. It may be that industrial concentration affects the change in the proportion of university-trained technicians by affecting innovation, which requires university-trained personnel.

Capital intensity had a moderately negative effect (Beta equals -0.39). Contrary to our expectations, capital intensity was found to decrease the proportion of university-trained technicians. Therefore, as the complexity of the technology increases, the proportion of university-trained technicians is reduced. The effects of size and foreign capital were not statistically significant.

TABLE 2 *Panel Regression Analysis of the Effects of Technological Dependence, Growth of Employment, and Structural Variables on Change in the Proportion of University-Trained Technicians, 1960–1975*

Independent Variables		Equations (1)	(2)	(3)	(4)	(5)
PRUNV60[a]	b	0.11	0.13	0.00	0.08	0.12
	Beta	0.30	0.35	0.01	0.22	0.30
	t	1.33	1.71	0.04	0.92	1.22
LTECHDEP[b]	b	2.31	2.13	4.86	1.72	2.03
	Beta	0.47	0.43	0.99	0.35	0.40
	t	1.39	1.46	2.44	1.03	0.97
SQLTECH[c]	b	-1.95	-1.70	-2.69	-1.91	-1.73
	Beta	-0.53	-0.46	-0.73	-0.52	-0.48
	t	1.76	1.71	2.54	1.60	1.40
Growth of employment	b	-0.01	-0.01	-0.01	-0.02	-0.02
	Beta	-0.59	-0.56	-0.57	-0.58	-0.58
	t	3.09	3.27	3.35	2.94	2.74
Size in 1960 (logged)	b	-1.86	—	—	—	—
	Beta	-0.23	—	—	—	—
	t	1.21	—	—	—	—
Capital intensity (logged)	b	—	-3.81	—	—	—
	Beta	—	-0.39	—	—	—
	t	—	3.27	—	—	—
Industrial concentration	b	—	—	-0.15	—	—
	Beta	—	—	-0.54	—	—
	t	—	—	2.23	—	—
Foreign capital	b	—	—	—	0.02	—
	Beta	—	—	—	0.07	—
	t	—	—	—	0.28	—
Foreign sales	b	—	—	—	—	-0.02
	Beta	—	—	—	—	-0.11
	t	—	—	—	—	0.42
Constant		10.85	23.78	11.35	3.78	4.30
R-Square		0.53	0.61	0.62	0.49	0.51
Adj. R-Square		0.36	0.47	0.48	0.31	0.30
Number		20	20	20	20	18

[a] Proportion of university-trained technicians in 1960.
[b] Technological dependence (logged).
[c] Technological dependence squared.

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Discussion and Conclusions

This research note has offered a possible resolution of the debate over the long-term impact of technology transfers. In a sense, both sides of the debate are partially correct. In moderate amounts, importation of foreign technology does lead to increases in university-trained personnel. Traditional industries based on established technologies with little foreign import do not substantially increase their technically trained personnel on their own. But moderate levels of technology imports were found to be consistently related to growth in university-trained personnel. All industries that spent between 0.1 percent and 0.3 percent of the value of production on technology transfers also increased their proportion of university-trained personnel. For these industries, adapting and using new technologies does appear to stimulate the employment of highly trained personnel.

The problem with this finding is that it cannot be extrapolated indefinitely. It does not hold that the more technology that is imported, the more university-trained employees are required. In fact, beyond a certain point, the reverse appears to become the case. Other processes seem to take hold that override the positive impact of new technologies.

In our view, dependency processes determine the negative impact of very high levels of imported technologies because the internationalization of these industries makes it possible for firms to utilize home-country technicians without having to increase the proportion of university-trained technicians. Companies in these industries do not have to replicate the structure of employment found in their country of origin. The operations performed by the firms in these industries are part of a larger process that vertically integrates the companies with other core companies or with their own headquarters in core countries. This process is planned and coordinated by the conceptual apparatus located in the developed countries, subordinating these firms to the process of capital accumulation that is directed from these countries (see Frobel, Heinrichs, and Kreye 1980). The results support the idea that at very high levels, technology transfers become technological dependence and thus inhibit the growth of university-trained personnel.

It should be noted that these conclusions require considerably more investigation before they can be widely accepted. This study, while suggestive, has obvious limitations.[5] In particular, it focuses on a single country during an intense period of growth. Whether or not the conclusions can be generalized to other countries or to other economic environments remains to be seen.

Moreover, the available Brazilian data include only broad categories. For instance, the occupational data cannot distinguish among research and development, production, marketing, and financial personnel. All these categories may be university-trained, but the effects of technology transfers may diverge for different types of personnel.

Finally, we should note some inherent limitations in curvilinear models, such as the one used in this research. While often intuitively plausible, such models need to be specified carefully. If too much foreign technology is a bad thing, how do we know what is "too much"? In the present study, technology transfers beyond 0.3 percent of the value of production seem to have an inhibiting effect on the employment of university-trained personnel. But what determines the inflection point, and how general is such a result? It would help if we could study the intervening processes that may determine the impact of foreign technologies. How much is spent in each industry on research and development? What are the precise characteristics of the imported technologies, such as their age or their demands on operating and maintenance personnel? What level of control is retained in the host country, and how much control is transferred to less-developed countries? Although some of these questions might be answerable with more detailed statistics, the need remains for historical investigations of the impact of technology transfers in specific industries.

Another aspect requiring discussion is whether absorption of university-trained technicians is influenced by their availability. In Brazil the supply of technicians exceeded the demand. Therefore, the poor performance of some industries in absorbing university-trained personnel was not due to the supply side (the educational system). As shown by Morley (1982), the supply of university-trained personnel during the 1960s in Brazil grew faster than demand. His estimate indicates an "oversupply of over 50 percent relative to demand" between 1960 and 1970 (Morley 1982).

Despite the limitations of this study, it emphasizes the significant need to consider curvilinear relationships when testing dependency models. Even in the many studies of capital flows and trade patterns (where adequate quantitative data are far more abundant), little if any explicit consideration of curvilinear models has occurred. Second, this study has focused on changes in the composition of skills in the labor force. Previous studies using a dual-economy model compared the skills of the labor force in core and peripheral industries, but they did not address the issue of changes in this composition. Although they found a higher proportion of university-trained technicians in core industries, these studies did not investigate the direction of change in the composition of the labor force across industries. In the case of developing countries, it is generally agreed that modern industries have a higher proportion of university-trained technicians than traditional industries. Although these findings are confirmed by the present research, the result is causally ambiguous. It may be that imported technology is attracted to those industries that already have a high proportion of university-trained personnel. The subsequent impact of this imported technology may consequently be masked by the original high levels of university-trained personnel. To investigate causal impacts adequately, longitudinal designs are absolutely essential. Our study found that the effects on changes in university-trained personnel differed noticeably from the cross-sectional relationships.

These points are not mere methodological nuances. We suspect that support for the two contending theories is often based on an intuitive interpretation of technology transfers that ignores problems of curvilinearity and causal order. Dependency theorists typically concentrate on the most heavily dependent industries (like the pharmaceuticals analyzed by Evans in 1979), where the lack of autonomous technological capability is most evident. But these theories rarely attempt to explain technological stagnation in thoroughly traditional industries like food processing and apparel. On the other side, the benefits of technology transfer appear obvious to observers of contemporary less-developed countries who see the heaviest concentrations of sophisticated university-trained engineers and managers in precisely those industries that are most dependent on technology imported from the West. This association is deceptive, however, because it describes only a cross-sectional correlation; the long-term causal impact varies considerably. Relying too much on foreign technology restricts the eventual growth of employment of university-trained personnel, effectively biting the hand that first welcomed it.

NOTES

1. The distribution of the technological dependence variable in the original index is skewed by industries like transportation, electrical, and rubber industries having large values of technological dependence. This distribution was expected because, according to the study by Biato et al. (1971), transportation, electrical, and chemical industries were responsible for almost half of the payments for technology transfer between 1965 and 1970. The logarithmic transformation is intended to make the distribution less skewed by bringing these extreme cases close to the others. Because the leather industry had a value of zero on this variable and the beverages, food, tobacco, lumber, furniture and apparel industries had a value of technological dependence smaller than 0.5, a value of 0.5 was assigned to the technological dependence of these industries, permitting a logarithmic transformation in the first case and avoiding extreme negative values in the other cases. The variable of technological dependence was measured in cruzeiros paid for the transfer of technology per thousand cruzeiros produced (value of gross output).
2. Inspection of a scatterplot of the variables "change in the proportion of university-trained technicians" with technological dependence also reveals that the printing and publishing industry is an outlier that grew from 21 university-trained technicians in 1960 to 3434 in 1975. This change results in a very large value of the dependent variable. When the printing industry is excluded from the analysis, the standard deviation of change in the proportion of university-trained technicians decreases from 10.45 to 4.66. We excluded this industry from our analysis.
3. This and other regressions use the change in proportion as the dependent variable. Controversy still surrounds the use of such ratio variables. An alternative analysis, using the log of the number of university-trained technicians in 1975 as the dependent

variable, yields much the same conclusion. In this analysis, the other elements in the proportions are included as control variables in the regression rather than denominators in the proportions; that is, controls are added for the logged number of laborers in 1975, the logged number of laborers in 1960, and the logged number of university-trained technicians in 1960. The coefficients for technological dependence are 0.554 (linear) and -0.324 (quadratic). The inflection point of this curve is 0.86, which is only slightly higher than that found using the change in proportions (0.67). The standard error for the quadratic term is 0.100, indicating significant curvilinearity.

4. The maximum predicted increase, the inflection point, corresponds to the value where the unstandardized effect of technological dependence is zero. This value is given in the formula, $2ax$ plus b equals zero, where a equals the coefficient of the quadratic term, b equals the coefficient of the linear term, and x equals the level of the independent variable. Substituting into the results from table 1 yields 2 times (-2.04) times LTECHDEP plus 2.75 equals zero. This equals zero when LTECHDEP equals 0.67.
5. A methodological limitation of the study is its inability to measure the impact that technology transfers in one industry have on the composition of the labor force in other industries and in the service sector of the economy.

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