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Chapter Author: Marc-Andreas Muendler

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Trade and Workforce Changeover in Brazil

Marc-Andreas Muendler

9.1 Introduction

Linked employer-employee data are uniquely suited to document labor-market responses to economic reform. While the formation of multinational enterprises shapes much of the globalization debate over labor-market consequences in industrialized countries (see chapter 10), an issue of foremost importance for developing countries is the labor-market impact of trade reform. The present chapter investigates Brazil's labor demand changes following its large-scale trade liberalization in the early 1990s. Measures of labor-demand change document that the workforce in Brazil's traded-goods sector simultaneously undergoes an occupation downgrading and an education upgrading. This workforce changeover is broadly consistent with Heckscher-Ohlin-style trade theory for a low-skill abundant economy, whose low-skill intensive activities are predicted to expand and absorb larger shares of skilled workers to maintain full employment. Tracking workers across their jobs within establishments, across establishments within industries, and across firm types and industries within Brazil's formal sector, documents how employers achieve the observed workforce changeover. The reallocation pattern is not what premises of classic trade theory imply: among the displaced workers with a successful reallocation, most shift to nontraded-output industries—but almost as

Marc-Andreas Muendler is an assistant professor of economics at the University of California, San Diego, and a faculty research fellow at the NBER.

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many displaced workers do not find formal reemployment at an annual horizon.

The linked employer-employee data source is RAIS (Relação Anual de Informações Sociais), a comprehensive register of workers formally employed in any sector in Brazil (including the public sector). The database is used to administer Brazil's federal minimum-wage supplement program and is shared across statistical agencies. RAIS offers information on worker characteristics such as age, gender, education, and job characteristics, including the wage, dates of hiring and separation, and a detailed occupational classification that permits inferences about the skill level of jobs. In this chapter, attention is limited to prime-age workers past their first entry into the active labor force and to male workers, because male workers are known to exhibit relatively low labor-supply elasticities.[1] The data are complemented with firm-level information on export status and sector-level information on economic reforms.

Much emphasis in the literature on job creation and destruction is placed on *churning:* gross job creation and destruction at shrinking or expanding employers beyond their observed net employment changes. Churning is a particular aspect of the reallocation process and, from a worker's perspective, is mostly associated with the part of job spells that are not necessarily related to ultimate reallocations across activities. By definition, churning is an employer-level phenomenon. This chapter shifts the focus from the employer to the individual worker and documents several worker-related aspects of the reallocation process. The importance of churning and excess turnover in the reallocation process notwithstanding, a paramount efficiency concern for the performance of labor markets is the ultimate reassignment of workers to new activities.

Brazil exhibits a shift toward low-skill intensive economic activities following trade reform. For the least-skilled illiterate workers and primary school dropouts, the long-term trend of dropping demand is strongly reversed during the time of trade liberalization, and results in a net labor-demand increase through 2001. For college graduates at the upper end of the skill range, demand surges before and after liberalization, especially in the nontraded sector, are so strong that the drop in their demand during trade liberalization weighs little; a net demand increase prevails through 2001. Intermediate education groups suffer a demand decline in the traded-goods industries that more than outweighs their moderate demand increase in the nontraded sector. A Katz and Murphy (1992) decomposition into between-industry and within-industry changes shows that a large part of the overall evolution is predicted by these between-industry changes. But there is also a substantial workforce changeover within industries and across occupations.

1. Statistics are similar in the overall nationwide sample. Statistics and estimates on the overall sample and alternative subsamples are available from URL econ.ucsd.edu/muendler.

Measuring jobholders' years of schooling by occupation, and subtracting the mean years of schooling across all occupations, shows a continuous and steady increase in net schooling intensity across *all* occupations in the traded-goods sector between 1990 and 2001. This workforce changeover is associated with employment shifts from high- to low-skill intensive occupations, while employers simultaneously fill the low-skill-intensive occupations with more and more educated jobholders. Both processes, occupation downgrading and education upgrading, are reminiscent of an interpretation of the Heckscher-Ohlin argument applied to occupational activities (instead of industries). Given Brazil's relatively low-skill abundant labor force, a Heckscher-Ohlin style argument would posit that Brazil increasingly specializes in less schooling-intensive occupations but that the traded-goods sector employs in these expanding low-skill occupations relatively more high-skilled workers while their relative wage declines by the Stolper-Samuelson theorem.

Among several economic reforms—including macroeconomic stabilization, privatization, and some capital-account liberalization—the trade liberalization program of 1990 played a dominant role for labor-market outcomes. In multivariate regressions at the establishment level, I control for employer-fixed and year effects as well as various variables related to economic reforms and find that an employer's export status, along with sectoral tariff protection levels, exhibits the most predictive power for employment changes. Trade-related interpretations of labor-demand changes are, therefore, emphasized.

Beyond conventional labor-demand analysis, the comprehensive linked employer-employee data for Brazil's economy as a whole permit the tracking of individual workers across occupations, establishments, firm types, and industries in Brazil's formal sector. There is no evidence that employers reallocate workers across tasks in-house in response to trade reform. The share of in-house job transitions is constant over time, and minor. Surprisingly, there is also little evidence that the economy reallocates workers across firms and industries. Trade theory would lead us to expect a shift of displaced workers from nonexporting firms to exporters, following trade reform. The dominant share of successful reallocations within the traded-goods sector is to nonexporters, however, and this share is dwarfed by reallocations to nontraded-output industries. An equally large share of displaced workers, around a third, finds no formal-sector reemployment at the annual horizon. Taken together, these findings imply that employers pursue the observed workforce changeover by laying off relatively less-skilled workers, especially from skill-intensive occupation categories. This form of workforce changeover following trade reform is potentially associated with important adjustment costs to the economy. It remains a task for future research to analyze the impact of economic reform on worker separations, accessions, and spell durations outside formal-sector employment.

In line with the descriptive evidence, but in contrast to what general-

equilibrium trade models with full employment might lead us to expect, a firm's export status predicts significant job losses. There is no conclusive evidence, however, that exporting status is causally related to employment reductions. When firm-level export status and its interaction with product-market tariffs are instrumented with sector-year varying foreign components of the real exchange rate, export status loses its statistical significance. This addresses the possible importance of employer-level workforce heterogeneity and suggests the construction of worker-level hiring and firing samples in future research.

While there are only slight differences between metropolitan areas and the nationwide average regarding employer characteristics and the sectoral composition of the labor market, metropolitan labor markets exhibit a markedly faster reallocation success. During the sample period, almost two in three successfully reallocated workers in metropolitan areas find a new job within the month of their separation. In contrast, only one in seven reallocated workers nationwide is rehired within the same month of displacement. In metropolitan areas, 95 percent of the successfully reallocated workers start their new job within twelve months. But only 77 percent of the successfully reallocated workers nationwide find new employment within a year. These stark differences in labor-market performance could be partly due to the slightly more diverse size distribution or the more varied workforce composition of employers in metropolitan areas, or to the somewhat larger nontraded-output sector in metropolitan areas. Further investigations are called for to improve our understanding of the labor-market specific differences in the reallocation process.

In related studies to examine the effects of trade liberalization on employment, Revenga (1992, 1997) finds that import competition reduces net employment at the sector level in the United States and Mexico. Meanwhile, a large part of the literature adopts the Davis, Haltiwanger, and Schuh (1996) approach of generating gross job flow statistics by industry and year and regressing those statistics on measures of trade exposure and exchange rates. In that line of research, Roberts (1996), for instance, does not find a strong effect of trade exposure on gross employment flows in Chile and Colombia, once industry characteristics are taken into account. Neither do Davis, Haltiwanger, and Schuh (1996) identify a clear effect of trade on factor reallocation using U.S. data. However, studies that consider exchange rate effects beyond trade exposure, such as Gourinchas (1999) or Klein, Schuh, and Triest (2003), do find systematic effects on employment flows. Klein, Scott, and Schuh (2003) find for the United States that job destruction, churning, and net employment growth respond to exchange rate movements, while job creation is unresponsive. In the Brazilian case, Ribeiro et al. (2004) compute industry-level rates of job creation and destruction and find that greater openness reduces employment through increased job destruction, with no effects on job creation, and that exchange

rate depreciation increases job creation with no effect on job destruction. Haltiwanger et al. (2004) use a panel of industries in six Latin American countries and report that a reduction in tariffs and exchange rate appreciations increase job reallocation within sectors and that net employment growth tends to decline as trade exposure rises. In contrast to the lacking evidence on an association between trade exposure and labor-market outcomes in much of the earlier literature, a firm-level indicator of exporting status in the employer regressions of this chapter shows a highly significant relationship between exporting status and employment reductions during a period of trade reform, and a more pronounced association in less tariff-protected sectors. Beyond the prior literature, the linked employer-employee data of this paper permit the tracking of workers across activities, employers, and industries, and document these novel aspects of the labor-market response to trade reform.

The remainder of this chapter is organized in six more sections. Section 9.2 describes the main linked employer-employee data source as well as complementary firm and sector data, while details are relegated to the Appendix. Section 9.3 presents labor demand changes over the sample period 1986–2001, discerns between-sector and within-sector changes using a Katz and Murphy (1992) labor demand decomposition, and documents the workforce changeover within sectors along educational and occupational dimensions. Section 9.4 investigates how much of the documented workforce changeover is brought about by task reassignments within firms, worker reallocations across firms and industries, and by worker separations without formal-sector reallocations. Multivariate regressions in section 9.5 document the predictive power of exports and trade-related regressors compared to competing employer and sector variables. Section 9.6 looks into labor-market performance as measured by time to successful reallocation. Section 9.7 concludes.

9.2 Linked Employer-Employee Data

Workers of particular concern for the labor-market restructuring process are prime-age male workers, who typically show a low labor-supply elasticity. Most of the evidence of this chapter nevertheless applies to workers across gender and age groups. My restriction to prime age (25 to 64 years) serves to capture workers past their first entry into the active labor force. Beyond a 1 percent nationwide random sample of prime-age male workers, a five-percent metropolitan random sample of prime-age male workers is used to assess regional differences in labor-market outcomes.

The linked employer-employee data derive from Brazil's labor force records, RAIS (Relação Anual de Informações Sociais, of the Brazilian labor ministry MTE). RAIS is a nationwide, comprehensive annual record of workers formally employed in any sector (including the public sector).

RAIS covers, by law, all formally employed workers, captures formal-sector migrants,[2] and tracks the workers over time. By design, however, workers with no current formal-sector employment are not in RAIS.

RAIS primarily provides information to a federal wage supplement program (Abono Salarial), by which every worker with formal employment during the calendar year receives the equivalent of a monthly minimum wage. RAIS records are then shared across government agencies and statistical offices. An employer's failure to report complete workforce information can, in principle, result in fines proportional to the workforce size, but fines are rarely issued. In practice, workers and employers have strong incentives to ascertain complete RAIS records, because payment of the annual public wage supplement is based exclusively on RAIS. The ministry of labor estimates that well above 90 percent of all formally employed workers in Brazil were covered in RAIS throughout the 1990s.

The full data include 71.1 million workers (with 556.3 million job spells) at 5.52 million establishments in 3.75 million firms over the sixteen-year period 1986–2001. Every observation is identified by the worker ID (PIS), the establishment ID (of which the firm ID is a systematic part), the month of accession, and the month of separation. Relevant worker information includes tenure at the establishment, age, gender, and educational attainment. Job information includes occupation and the monthly average wage; establishment information includes sector and municipality classifications. To facilitate tracking, RAIS reports formal retirements and deaths on the job. RAIS identifies the establishment and its firm, which in turn can be linked to firm information from outside sources such as export data.

This chapter's sample derives from a list of all proper worker IDs (11-digit PIS) that ever appear in RAIS at the national level, from which a 1 percent nationwide random sample of the IDs and a 5 percent metropolitan random sample was drawn, and tracks the selected workers through all their formal jobs. Industry information is based on the subsector IBGE classification (roughly comparable to the NAICS three-digit level), which is available by establishment over the full period (see table 9.10 for sector classifications). For the calculation of separation and reallocation statistics, a worker's separation is defined as the layoff or quit from the highest-paying job.[3]

2. Migration among metropolitan workers is substantial. Among the prime-age male workers in RAIS with a metropolitan job in 1990, for instance, 15 percent have a formal job outside the 1990 city of employment by 1991 and 25 percent by 1993. Similarly, among the metropolitan workers in 1994, 17 percent have a formal job elsewhere by 1995 and 27 percent by 1997.

3. Among the male prime-age workers nationwide, 3 percent of the job observations are simultaneous secondary jobs. Tables 9.3, 9.4, 9.5, and 9.9 are based on the so-restricted sample, whereas all aggregate statistics, Katz-Murphy decompositions, and regressions are based on the full sample. The restriction to a single job at any moment in time permits a precise definition of job separation as a layoff or quit from the highest-paying job (randomly dropping sec-

Table 9.1 **Employment by employer's sector and export status**

	Traded goods		Nontraded output			
	Primary (1)	Manuf. (2)	Comm. (3)	Services (4)	Other (5)	Overall[a] (6)
Allocation of workers, nationwide						
1990	.021	.238	.128	.280	.333	22,844
1997	.044	.195	.152	.320	.289	24,068
Allocation of prime-age male workers, nationwide						
1990	.029	.263	.111	.284	.314	10,763
1997	.063	.221	.131	.308	.278	11,483
Nonexporter	.882	.494	.935	.937	.930	.830
Exporter	.118	.506	.065	.063	.070	.170
Allocation of prime-age male workers, metropolitan areas						
1990	.015	.270	.104	.309	.302	5,965
1997	.024	.213	.125	.363	.275	6,060
Nonexporter	.760	.390	.887	.913	.898	.778
Exporter	.240	.610	.113	.087	.102	.222

Note: [a]Total employment (thousands of workers), scaled to population equivalent.

Sources: RAIS 1990–2001, employment on December 31, and SECEX 1990–2001. Nationwide information based on 1% random sample, metropolitan information on 5% random sample. Period mean of exporter and nonexporter workforces, 1990–2001.

Table 9.1 shows the allocation of workers across industries in 1990 and 1997 (a detailed employment-share breakdown for the RAIS universe can be found in table 9.10). The nationwide RAIS records represent almost 23 million formally employed workers of any gender and age in 1990, and more than 24 million formal workers in 1997. The bulk of Brazil's formal employment is in manufacturing, services, and other industries (which include construction, utilities, and the public sector), with roughly similar formal employment shares between a quarter and a third of the overall formal labor force. Commerce (wholesale and retail) employs around one in eight workers, and the primary sector (agriculture and mining) at most one in twenty-five formal workers.

Prime-age male workers nationwide make up slightly less than half of the total workforce in 1990 and 1997. In both years, prime-age male workers are slightly more frequently employed in the primary and manufacturing sector than the average worker of any gender and age, but less frequently in commerce, services, and other sectors. More than half of the RAIS-reported formal employment of prime-age males occurs in the six metro-

ondary jobs if there is a pay tie). Removing simultaneously held jobs does not significantly affect estimates of skill, occupation, and gender premia in Mincer (1974) regressions (Menezes-Filho, Muendler, and Ramey, 2008).

politan areas of Brazil: São Paulo city, Rio de Janeiro city, Belo Horizonte, Porto Alegre, Salvador, and Recife. Compared to the nationwide average across gender and age, prime-age males in metropolitan areas are slightly less frequently employed in the primary sector, commerce, and other sectors, and somewhat more frequently employed in manufacturing and services. Overall, however, the labor allocation across sectors is broadly similar across regions and gender and age groups, whereas changes over time between 1990 and 1997 are more pronounced. Between 1990 and 1997, there is a marked drop in formal manufacturing employment, which is accompanied by an increase of employment in primary sectors, commerce, and especially services. Overall, between roughly a quarter and a third of the nationwide and metropolitan prime-age male workforces are employed in traded-goods sectors, and two thirds to three quarters in nontraded-output sectors.

9.2.1 Complementary Firm-Level Export Data

At the firm level, annual customs office records from SECEX (Secretaria de Comércio Exterior) for 1990 through 1998 are used to infer an indicator variable for a firm's exporting status, which is set to 1 when SECEX reports exports of any product of any value from the firm in a given year. The export-status indicator is linked to RAIS at the firm level. SECEX includes merchandize shipments, but not services exports. National accounting data suggest that, during the 1990s, Brazilian services exports were of minor importance.

Table 9.1 shows the allocation of prime-age male employment by exporting status of the employer, and by sector, for the period from 1990 to 2001. Whereas nationwide only 17 percent of prime-age males work at exporters, that share is 22 percent in metropolitan areas. Not surprisingly, the largest share of prime-age male employment at exporters occurs in the manufacturing sector, with more than 50 percent of the sector's workforce nationwide and over 60 percent in metropolitan areas. Primary-goods producers in agriculture and mining employ only 12 percent (nationwide) and 24 percent (metropolitan) of the sector's workforce—possibly because some of their exports, especially in agriculture, are channelled through commercial intermediaries. My focus, therefore, lies on the manufacturing industries in the traded-goods sector. Occasional merchandize shipments also occur among the commercial, services, and other-sector firms (construction, utilities, and the public sector).[4] These firms have employment

4. Recall that the export indicator is set to 1 when SECEX reports an export shipment of any product of any value at the firm. Among the retailers and wholesalers in commerce are some specialized import-export intermediaries who employ around 7 percent of the nationwide workforce. Shipments of accessory equipment in services and construction are considered merchandize exports by law, but the SECEX data show the sales value of these exports to be expectedly minor. The main business of services and utilities firms is not merchandize sale, so that the recorded employment shares at those firms do not imply that their employees typically handle export merchandize.

shares of between 6 percent (nationwide) and 11 percent (metropolitan). Their employment shares are small, however, compared to those in the primary and manufacturing sectors, and the SECEX data show that those firms' exporting status mostly reflects occasional merchandize shipments.

9.2.2 Complementary Sector Data

Data on ad valorem tariffs by sector and year from Kume, Piani, and Souza (2003) serve as measures of output-market tariffs and, after combining them with economy-wide input-output matrices (from IBGE), provide intermediate-input tariff measures by sector and year. Those tariff series from the Nível 80 level are transformed to the subsector IBGE classification available in RAIS by taking unweighted subsector means over the original Nível 80 data.

Ramos and Zonenschain (2000) report national accounting data to calculate the *effective rate of market penetration* with foreign imports. The effective rate of market penetration is defined as imports per absorption. Absorption includes consumption, investment, and government spending, and is calculated as output less net exports. The assumption is that domestic firms find the absorption market the relevant domestic environment in which they compete. Foreign direct investment (FDI) inflow data from the Brazilian central bank (Banco Central do Brasil) are available for 1986 through 1998.

Sector-specific real exchange rates are constructed from the nominal exchange rate to the U.S. dollar E, Brazilian wholesale price indices P_j (from FGV Rio de Janeiro), and average foreign price series for groups of Brazil's main trading partners P_j^* by sector j. The real exchange rate is defined as $q_j \equiv EP_j^*/P_j$, so that a low value means an appreciated real-sector exchange rate. The underlying price series are re-based to a value of 1 in 1995. Brazil's import shares from its major twenty-five trading partners in 1995 are used as weights for P_j^*. Sector-specific annual series are obtained from producer price indexes for the twelve OECD countries among Brazil's main twenty-five trading partners (sector-specific producer price index [PPI] series from *SourceOECD;* U.S. PPI series from Bureau of Labor Statistics). These sector-specific price indexes are combined with the thirteen annual aggregate producer (wholesale if producer unavailable) price index series for Brazil's remaining major trading partners (from Global Financial Data), for whom sector-specific PPI indexes are not available.

9.3 Economic Reform and Employment Changeovers

Since the late 1980s, Brazil's federal government initiated a series of economic reforms that, by around 1997, resulted in a considerably more open economy to foreign goods and investments, a stable macroeconomy, and a somewhat smaller role of the state in the economy. In 1988, after decades of import substitution and industry protection, the Brazilian federal gov-

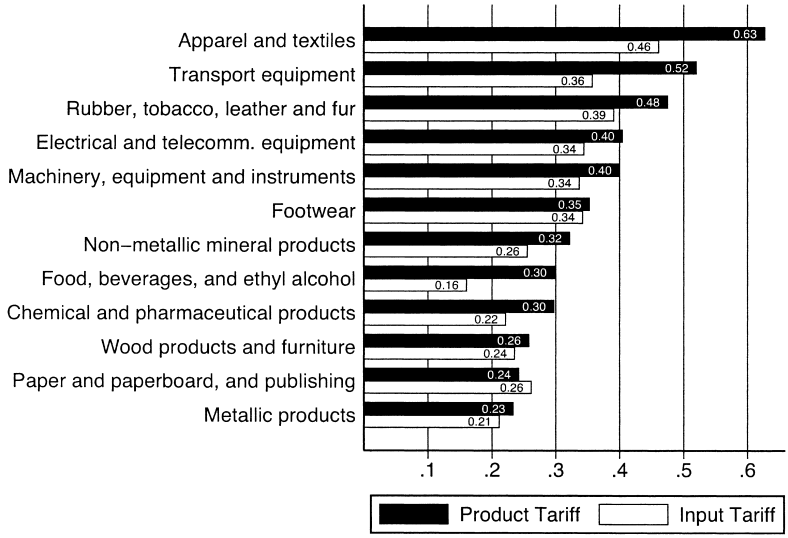
ernment under president Sarney initiated an internal planning process for trade reform and started to reduce ad valorem tariffs but, lacking public support, took little legislative initiative to remove binding nontariff barriers, so that nominal tariff reductions had little effect (Kume, Piani, and Souza 2003). In 1990, the Collor administration launched a large-scale trade reform that involved both the removal of nontariff barriers and the adoption of a new tariff structure with lower levels and smaller cross-sectoral dispersion. Implementation of these policies was largely completed by 1993.

Figure 9.1 depicts Brazil's product-market and intermediate-input tariff schedules in 1990 and 1997 for the twelve manufacturing industries at the subsector IBGE level. Intermediate-input tariff levels are calculated as reweighted product tariffs using the economywide input-output matrix. Both the level and the dispersion of tariffs drop remarkably between 1990 and 1997. While ad valorem product tariffs range from 21 (metallic products) to 63 percent (apparel and textiles) in 1990, they drop to a range from 9 percent (chemicals) to 34 percent (transport equipment) in 1997. Except for paper and publishing in 1990, sectors at the subsector IBGE level receive effective protection in both years, with mean product tariffs exceeding mean intermediate-input tariffs. By 1997, however, the relatively homogeneous tariff structure results in a small rate of effective protections for most industries—with the notable exception of transport equipment.

Brazil underwent additional reforms over the sample period. In 1994, during the Franco administration and under the watch of then-finance minister Cardoso, drastic anti-inflation measures succeeded for the first time in decades. A privatization program for public utilities was started in 1991 and accelerated in the mid-1990s, while Brazil simultaneously liberalized capital-account restrictions. These measures were accompanied by a surge in foreign direct investment inflows in the mid-1990s. The procompetitive reforms during the 1990s, mostly targeted at product markets, had been preceded by changes to Brazil's labor-market institutions in 1988. Brazil's 1988 constitution introduced a series of labor-market reforms that aimed to increase workers' benefits and the right to organize, thus raising labor costs.[5] Given their constitutional status, these labor-market institutions remained unaltered throughout the sample period.

Among the reforms, trade liberalization played a dominant role for labor-market outcomes. Multivariate regressions in section 9.5 will control

5. The 1988 reforms reduced the maximum working hours per week from 48 to 44, increased the minimum overtime premium from 20 percent to 50 percent, reduced the maximum number of hours in a continuous shift from 8 to 6 hours, increased maternity leave from three to four months, increased the value of paid vacations from 1 to 4/3 of the normal monthly wage, and increased the fine for an unjustified dismissal from 10 percent to 40 percent of the employer-funded severance pay account (FGTS). See Heckman and Pagés (2004) and Gonzaga (2003) for further details.



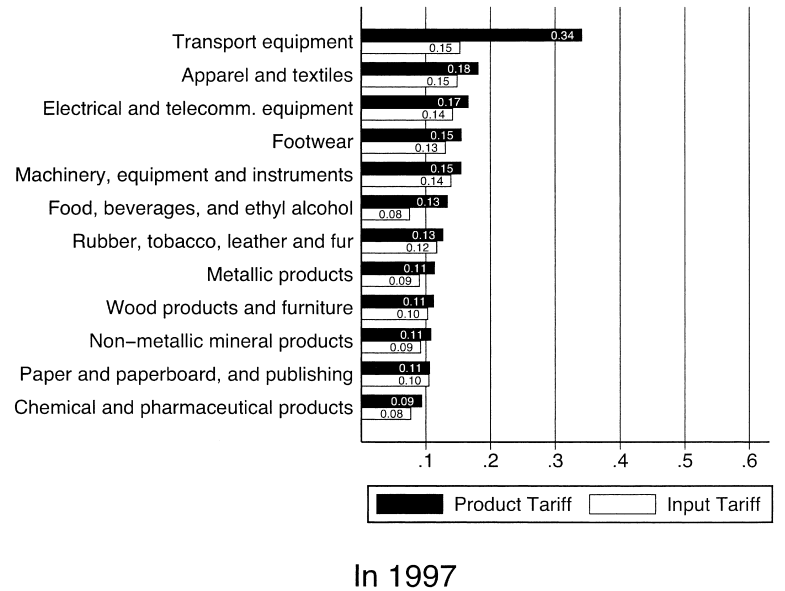


Fig. 9.1 Tariff Rates

Sources: Ad valorem product tariffs at Nível 80 from Kume et al. (2003). Intermediate input tariffs are re-weighted product-market tariffs using national input-output matrices at Nível 80 (from IBGE). Product-market and intermediate-input tariffs are averages at the subsector IBGE level using unweighted means over the Nível 80 classifications.

for sector and year effects as well as variables related to simultaneous reforms, and confirm the overwhelming predictive power of trade liberalization and employers' export status for employment changes. In light of these findings, trade-related interpretations of the labor-demand changes in this and subsequent sections are emphasized.

9.3.1 Between and within Industry Demand Shifts

Katz and Murphy (1992) derive a framework to decompose labor-demand changes into shifts between industries, associated with variations in sector sizes given sectoral occupation profiles, and within industries through changing occupation intensities. The former shifts between industries relate to the changing allocation of employment across sectors, whereas the latter shifts within industries reflect the change in relative skill intensities of occupations or alterations to the sectoral production process. Applying the Katz and Murphy (1992) framework to employment in the Brazilian formal sector over the years 1986 to 2001 reveals main patterns of labor-market adjustment. The decomposition into between and within sector variation indicates how two important sources of change contribute to workforce changeover. Between-industry shifts are arguably driven by changes in final-goods demands, sectoral differences in factor-nonneutral technical change, and changes in the sector-level penetration with foreign imports. Within-industry shifts can be related to factor-nonneutral technical change, factor-price changes for substitutes or complements to labor, and international trade in tasks that allocates activities along the value chain across countries.

The Katz and Murphy (1992) decomposition relates back to Freeman's (1980) manpower requirement index and is designed to measure the degree of between-industry labor-demand change under fixed relative wages. The decomposition tends to understate the true between-industry demand shift in absolute terms when relative wages change. Though possibly overstating the within-industry effects, the Brazilian evidence suggests that within-industry demand changes are an important source of employment changeover in Brazil, especially since 1990. Beyond the Katz and Murphy (1992) framework, statistics are offered that document time variation in the occupation profile within industries and the skill changeover within occupations.

Under the assumption that the aggregate production function is concave (so that the matrix of cross-wage elasticities of factor demands is negative semidefinite), Katz and Murphy (1992) show that an appropriate between-industry demand shift measure ΔD_k for skill group k is

$$\Delta D_k = \sum_j X_{jk} \frac{w' dX_j}{w' X_j}, \tag{1}$$

where X_{jk} is the employment of skill group k in industry j, w is a $k \times 1$ vector of constant wages, and dX_j and X_j are the $k \times 1$ vectors of employment changes and levels in industry j, respectively. Measure (1) is simply the vector of weighted sums of industry employments for each skill group k, with the weights given by the percentage changes in the overall employments in every industry j. The measure is similar to standard labor-requirement indexes (Freeman 1980), only that changes are measured in efficiency units at constant wages rather than in head counts (or hours). Intuitively, skill groups that are intensely employed in expanding sectors experience a demand increase, whereas skill groups intensely employed in contracting sectors face falling demand. Under constant wages, the measure indicates whether the data are consistent with stable labor demands within sectors. Wages change, however, so that there is a bias in the measure. Katz and Murphy (1992) show that the bias is inversely related to wage changes if substitution effects dominate the employment decisions, so that measure (1) understates the demand increase for groups with rising relative wages.

In the Brazilian context, the formal-sector economy is divided into twenty-six two-digit industries (using the subsector IBGE classification) and five occupations (professional and managerial occupations, technical and supervisory occupations, other white-collar occupations, skill-intensive blue-collar occupations, and other blue-collar occupations). The classification of activities into both sectors and occupations is motivated by the idea that international trade of intermediate and final goods can be understood as trade in tasks along the steps of the production chain. Using the resulting 130 industry-occupation cells, an empirically attractive version of the between-industry demand shift measure (1) is

$$\Delta X_k^{di} = \frac{\Delta D_k}{E_k} = \sum_i \left(\frac{E_{ik}}{E_k} \right) \left(\frac{\Delta E_i}{E_i} \right) = \frac{\Sigma_i \alpha_{ik} \Delta E_i}{E_k}, \tag{2}$$

where E_i is total labor input in sector-occupation cell i measured in efficiency units, and $\alpha_{ik} \equiv E_{ik}/E_i$ is skill group k's share of total employment in efficiency units in sector i in the base period. Measure (2) expresses the percentage change in demand for each skill group as a weighted average of the percentage changes in sectoral employments, the weights being the group-specific efficiency-unit allocations. Following Katz and Murphy (1992), I turn index (2) into a measure of relative demand changes by normalizing all efficiency-unit employments in each year to sum to unity. The base period is the average of the sample period from 1986 to 2001 so that α_{ik} is the share of total employment of group k in sector i over the 1986–2001 period and E_k is the average share of skill group k in total employment between 1986 and 2001.

The overall (industry-occupation) measure of demand shifts for skill

group k is defined as ΔX_k^{di} from equation (2), where i indexes the 130 industry-occupation cells. The between-industry component of this demand-shift measure is defined as the group-k index ΔX_k^{dj} from equation (2), where $i = j$ now indexes only twenty-six industries. Accordingly, the within-industry component of demand shifts is $\Delta X_k^{dw} \equiv \Delta X_k^{di} - \Delta X_k^{dj}$.

Table 9.2 presents the nationwide demand decomposition and the overall demand shifts by group of educational attainment for the economy as a whole, and separately for the traded-goods and the nontraded-output sectors. As in Katz and Murphy (1992), the percentage changes are transformed into log changes with the formula $\hat{\Delta} X_k^d = \log (1 + \Delta X_k^d)$. By construction, in the (vertical) sectoral dimension the economy-wide demand shift indexes for each skill group are a weighted sum of the traded and nontraded sector indexes (except for occasional rounding errors because of the log transformation), where the weights are the skill groups' shares in the sectors. In the (horizontal) time dimension, the indexes are the sum of the time periods for each skill group.

The entries for overall shifts across all sectors summarize Brazil's labor-demand evolution (five first rows of column [12]). Over the full period from 1986 to 2001, the least and the most skilled prime-age male workers experience a positive relative demand shift of 1 and 8 percent, respectively, whereas the three intermediate skill groups suffer a labor-demand drop. This overall pattern, with demand surges at the extreme ends of the skill spectrum and drops for the middle groups, can be traced back to two overlying developments. First, before and after the main economic liberalization episode—that is, in the periods 1986–1990 and 1997–2001, demand for college graduates rises by around 5 percent, while demand drops for all other skill groups in 1997–2001 and for all other skill groups but high school graduates in 1986–1990. Second, however, during the period of economic liberalization between 1990 and 1997, the reverse labor-demand change occurs, with demand for the least-educated males increasing by roughly 5 percent and dropping for college graduates by –2 percent. The demand rise for the least-educated during liberalization more than outweighs the demand drops before and after, so that a net demand increase remains by 2001. For college graduates, demand surges before and after liberalization are so strong that the drop during liberalization is of little importance and a strong net demand remains by 2001. This pattern is consistent with a Heckscher-Ohlin interpretation of the specialization pattern following trade liberalization. Brazil, whose labor force is relatively low-skill abundant, experiences a shift toward low-skill intensive economic activities between 1990 and 1997—against the longer-term trend manifested before (1986–1990) and after (1997–2001), by which demand for highly skilled workers increases but drops for lower-skilled workers.

Between and within decompositions, as well as a distinction of traded and nontraded sectors, lend additional support to a Heckscher-Ohlin

Table 9.2 **Industry- and occupation-based log demand shifts, 1986–2001 (%)**

	Between industry				Within industry				Overall industry-occupation			
	86–90 (1)	90–97 (2)	97–01 (3)	86–01 (4)	86–90 (5)	90–97 (6)	97–01 (7)	86–01 (8)	86–90 (9)	90–97 (10)	97–01 (11)	86–01 (12)
Economy-wide												
Illiterate or primary dropout	–0.1	4.7	–0.1	4.5	–2.2	–0.2	–1.0	–3.3	–2.3	4.5	–1.1	1.1
Primary school graduate	–2.1	–0.1	–1.7	–3.9	–1.4	0.5	–1.5	–2.4	–3.6	0.4	–3.2	–6.4
Middle school graduate	–1.9	–0.9	–0.5	–3.3	–0.1	1.5	–1.2	0.1	–2.0	0.6	–1.8	–3.1
High school graduate	0.3	–1.7	–0.8	–2.3	1.1	0.9	0.2	2.2	1.4	–0.9	–0.6	–0.1
College graduate	3.3	0.4	2.9	6.6	1.3	–2.4	2.5	1.4	4.6	–2.0	5.4	8.1
Traded-goods sectors												
Illiterate or primary dropout	–3.0	3.7	–1.7	–0.9	–0.7	–0.2	–0.2	–1.1	–3.7	3.6	–1.9	–2.0
Primary school graduate	–3.8	–2.0	–2.4	–8.2	–0.4	0.2	–0.6	–0.7	–4.2	–1.8	–3.0	–9.0
Middle school graduate	–3.9	–4.0	–2.6	–10.6	0.0	0.3	–0.5	–0.2	–3.9	–3.8	–3.1	–10.7
High school graduate	–3.7	–4.4	–2.4	–10.5	0.5	–0.1	0.2	0.7	–3.2	–4.5	–2.1	–9.8
College graduate	–3.6	–4.6	–2.1	–10.4	0.5	–0.5	1.4	1.4	–3.1	–5.1	–0.7	–8.9
Nontraded-output sectors												
Illiterate or primary dropout	3.6	0.4	1.9	5.9	–1.5	0.1	–0.7	–2.2	2.1	0.4	1.2	3.7
Primary school graduate	2.8	2.7	1.5	7.0	–1.0	0.3	–0.9	–1.6	1.9	2.9	0.6	5.4
Middle school graduate	2.3	3.3	2.3	7.9	–0.2	1.2	–0.7	0.3	2.1	4.6	1.6	8.3
High school graduate	3.2	1.9	1.2	6.3	0.6	0.9	0.0	1.5	3.9	2.8	1.2	7.8
College graduate	5.2	3.3	3.9	12.4	0.8	–1.8	1.4	0.4	6.0	1.5	5.3	12.8

Source: RAIS 1986–2001 (1% random sample), male workers, twenty-five years or older. Overall and between-industry demand shift measures for skill group k are of the form $\Delta D_k = \Sigma_j \alpha_{jk} (\Delta E_j / E_k)$, where α_{jk} is the average share for group k of employment in cell j over the period 1986–2001, E_j is the share of aggregate employment in cell j, and E_k is the average share of total employment of group k over the period 1986–2001 (Katz and Murphy 1992). Reported numbers are of the form $\log(1 + \Delta D_k)$. In the overall measure, j indexes 130 industry-occupation cells; in the between-industry measure, $i = j$ indexes twenty-six industries (fourteen traded-goods and twelve nontraded-output sectors). The within-industry index for group k is the difference of the overall and between-industry measures. Employment is measured in efficiency units.

interpretation of labor-demand changes. The decomposition for all sectors (five first rows) into between-industry and within-industry changes indicates that the overall evolution is mostly driven by between-industry changes, with demand surges at the extreme ends of the skill spectrum and drops for the middle groups (column [4]). In contrast, the within-industry labor-demand changes favor the least skilled the least, with a demand drop of –3 percent, and the most skilled the most, with a demand increase of 1 to 2 percent for high school educated workers and college graduates. The within-industry demand changes are almost monotonically increasing as we move up the educational attainment ranks (column [8]) in the 1986–2001 period, and would indeed monotonically increase if it were not for a within-industry drop in demand for college graduates during the liberalization period. In the following discussion I will return to the within-industry demand changes, with additional evidence. In fact, the within-industry workforce changeover will be found to reinforce a broad Heckscher-Ohlin interpretation of Brazil's experience.

A distinction by sector relates the between-industry demand evolution to differences across traded-goods industries (middle five rows) and nontraded-output industries (last five rows). In the traded-goods sectors, where trade liberalization is expected to exert its impact, Brazil experiences a salient labor-demand drop—beyond –10 percent for the three more educated skill groups between 1986 and 2001. Expectedly for a low-skill abundant country, the demand drop is the strongest for the highly skilled and the weakest for the low-skilled workers (column [4]). Most notably, during the liberalization episode illiterate workers and primary school dropouts experience a rise in demand due to between-industry shifts, whereas more skilled workers experience demand drops of monotonically larger magnitudes as we move up the skill ladder (column [2]). The nontraded-output sectors exhibit a relatively homogeneous demand increase of between 6 and 8 percent for workers with no college degree and a strong 12 percent increase for college graduates (column [4]). The demand increase for the least skilled in nontraded-output sectors, combined with only a slight demand drop for them in the traded-goods sectors, results in an overall positive demand for the skill group from the between-industry component (column [4]). Similarly, the strong demand for college graduates in nontraded-output sectors more than outweighs their demand drop in traded-goods sectors. For intermediate skill groups between these two extremes, the demand drop in the traded-goods sectors outweighs their demand increase in nontraded-output sectors and results in overall negative demand changes.

Within industries there is a clear and pronounced pattern of falling demand for the least skilled, and increasing demand for the more skilled, with monotonically stronger demand changes as we move up the skill ranks, except only for college graduates (column [8]). This pattern is similar across

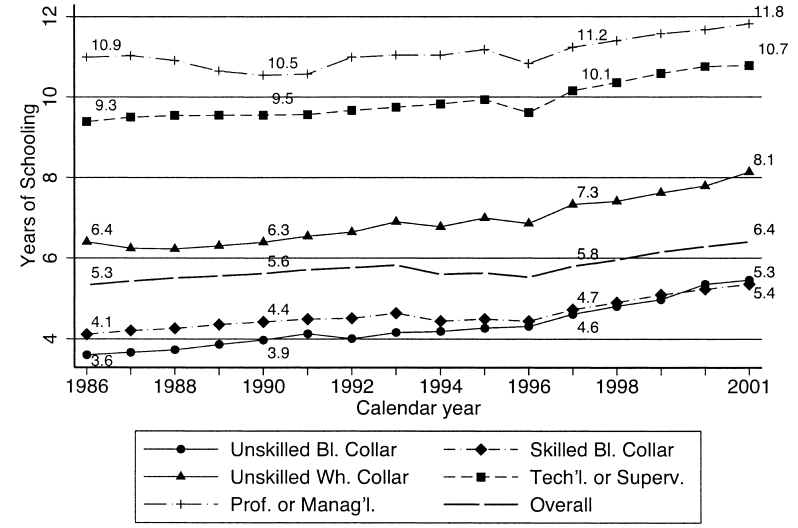
both traded and nontraded sectors and most time periods. The reason for the break in monotonicity at the college-graduate level (column [8]) is a demand drop for this skill group during the liberalization period (column [6]). A Stolper-Samuelson explanation is consistent with the outlier behavior of collage graduates during this period. Note that the Stolper-Samuelson theorem predicts wage drops for more educated workers in a low-skill abundant economy after trade reform, and Gonzaga, Menezes-Filho, and Terra (2006) document that skilled earnings differentials indeed narrow over the course of the trade liberalization period. Because labor is measured in current-period efficiency units, a relative drop in wages for college-educated workers tends to turn their within-industry demand index negative. With this explanation for the outlier behavior of collage graduates in view, there is a striking monotonicity in the increase in within-industry labor demand change as we move up the skill ranks.

9.3.2 Within-industry Employment Changeovers

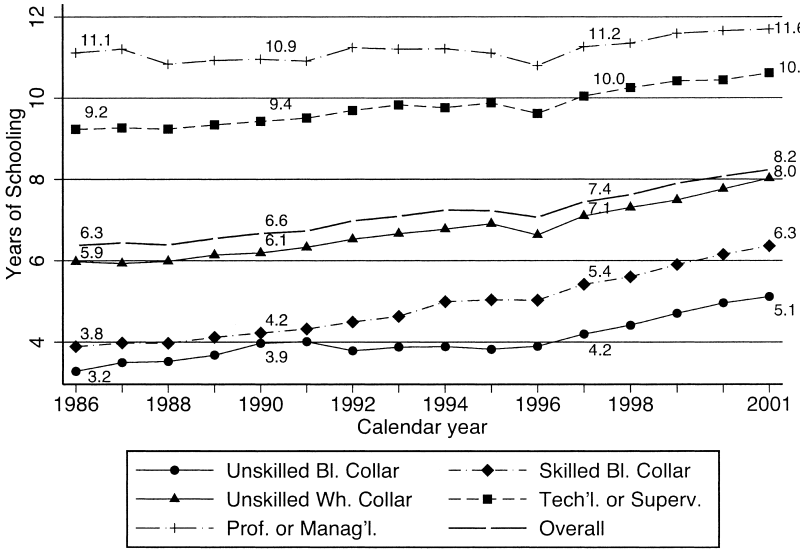
The previous demand decompositions show a noteworthy within-industry labor demand reduction for low-skilled workers and a demand increase for high-skilled workers both in traded-goods and nontraded-output sectors. The sources of this change deserve more scrutiny. Abandoning the efficiency-unit perspective on employment in favor of counts of workers to keep wage effects separate, I turn to an assessment of labor allocation to activities by period.[6]

Figure 9.2 shows the evolution of the skill assignment by occupation over time. In both traded-goods and nontraded-output sectors, there is a marked increase across all five occupation categories in the educational attainment of the job holders. From 1986 to 2001, the mean number of years of schooling in unskilled blue-collar occupations rises from below four years to more than five years in both traded and nontraded sectors (in traded sectors schooling in unskilled blue-collar occupations even slightly exceeds the schooling in skilled blue-collar jobs by 2001). The average number of school years increases from around four to more than five years for skilled blue-collar jobs in traded sectors and to more than six years in nontraded sectors by 2001. For unskilled white-collar occupations, the average jobholder's schooling goes from around six to more than eight years, both in traded and nontraded goods sectors. The shift also extends to technical and supervisory positions, where the average jobholder's schooling goes from less than ten to more than ten years of schooling both in traded and nontraded sectors, and to managerial positions, where mean schooling rises from eleven to almost twelve years over the period 1986 to 2001. These largely steady within-industry changeovers in workers' occupational

6. An efficiency unit-based analysis shows broadly the same patterns of workforce changeovers in terms of wage bills as the head-count-based analysis that follows.



Traded-goods Sectors



Nontraded-output Sectors

Fig. 9.2 Schooling intensity of occupations

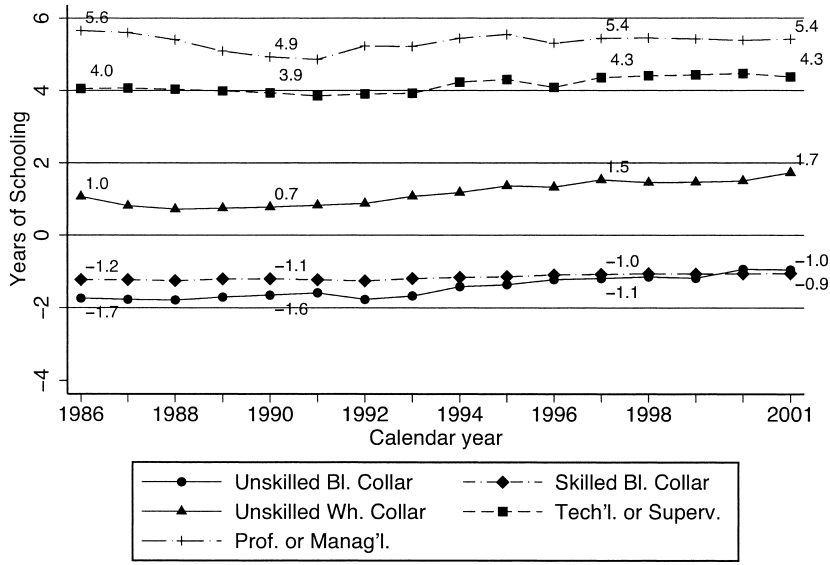
Source: RAIS 1986–2001 (1% random sample), male workers nationwide, twenty-five to sixty-four years old, with employment on December 31. Traded-goods sectors are agriculture, mining, and manufacturing (subsectors IBGE 1–13 and 25), nontraded-output industries are all other sectors. Mean years of schooling weighted by worker numbers within occupations.

assignments between 1986–2001 overlay the shorter-lived between-industry changes with much time variation across the three subperiods 1986–1990, 1990–1997, and 1997–2001.

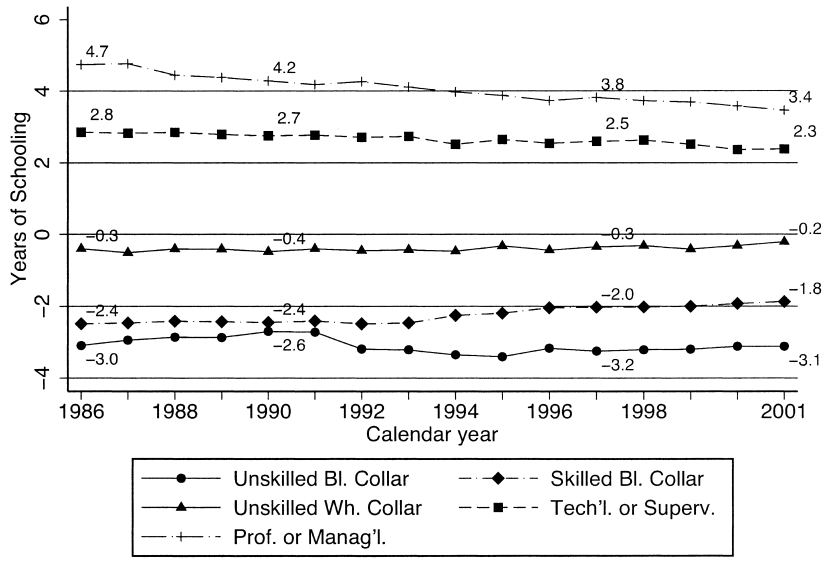
One might suspect that the considerable surge in schooling levels is partly due to labor-supply changes, such as the entry of increasingly educated cohorts of male workers into the labor force, or relatively more frequent shifts of skilled male workers from informal to formal work status over the sample period. In fact, the sector-wide average schooling level rises from less than six to more than six years in the traded-goods sector, and in the nontraded-output sector from more than six to more than eight years (as the respective overall curves in figure 9.2 show). To control for overall skill labor supply by sector, the Katz and Murphy (1992) idea is extended to the present context and the annual mean of years of schooling in a sector is subtracted from the occupation-specific mean in the sector. For this purpose, all traded-goods industries are considered as one sector, and all nontraded-output industries as another sector. Subtracting the annual mean years of schooling, instead of dividing by the annual total as in table 9.2 before, preserves the cardinal skill measure of years of schooling and expresses occupation-specific skill demands as deviations from the sector-wide employment evolution in terms of years of schooling.

Figure 9.3 presents average years of schooling by occupation, less the sectorwide mean schooling across all occupations. By this measure, skill demand within every occupation category increases in the traded-goods sector since 1990: from a difference of –1.6 to –0.9 years in unskilled blue-collar occupations, from –1.2 to –1.1 years in skilled blue-collar occupations, from 0.8 to 1.7 in unskilled white-collar jobs, from 3.9 to 4.4 in technical jobs, and from 4.9 to 5.4 in professional and managerial positions. For all three white-collar occupation categories, the schooling-intensity surge beyond the sector average since 1990 is a reversal of the opposite trend prior to 1990, while schooling intensity continually increases for blue-collar occupations in the traded sector since 1986. By construction, the persistent occupation-level increases in worker schooling since 1990 go beyond the change in the sectorwide workforce schooling. The puzzling pattern—that changes beyond the sector mean are uniformly directed toward higher schooling in every single occupation since 1990—implies that there must be an employment expansion in less skill-intensive occupations. Otherwise it would be impossible for every single occupation category to exhibit a faster skill-intensity increase than the average overall occupations. In contrast to the traded sector, nontraded-output industries do not exhibit the uniform pattern of schooling increases across all occupations but a drop in schooling intensity in the technical and managerial occupations, and a rise in schooling intensity in skilled blue-collar occupations.

The evolution of schooling intensity in Brazil's traded-goods sector is reminiscent of a Heckscher-Ohlin interpretation as well—though not for



Traded-goods Sectors



Nontraded-output Sectors

Fig. 9.3 Difference between schooling intensity of occupations and annual mean schooling level

Source: RAIS 1986–2001 (1% random sample), male workers nationwide, twenty-five to sixty-four years old, with employment on December 31. Traded-goods sectors are agriculture, mining, and manufacturing (subsectors IBGE 1–13 and 25), nontraded-output industries are all other sectors. Mean years of schooling weighted by worker numbers within occupations, less mean years of schooling weighted by worker numbers across all occupations.

industries but for tasks. Think of production activities in the Heckscher-Ohlin framework not as sectors but as occupations and suppose that Brazil has a relatively less-schooled labor force than its main trading partners. Brazil's top five trading partners in total trade volume during the 1990s are, in descending order, the United States, Argentina, Germany, Italy, and Japan. As Brazil's integration into the world economy advances, reinterpreted Heckscher-Ohlin trade theory predicts that Brazil increasingly specializes in less schooling-intensive occupations but that Brazil employs in these expanding occupations relatively more high-skilled workers, because their relative wage declines. Gonzaga, Menezes-Filho, and Terra (2006) document that Brazil's skilled earnings differential narrows over the 1990s. Of course, more research is required to discern this reinterpretation of classic trade theory from alternative explanations. The simultaneous schooling-intensity increase in every single occupation, above and beyond the sector mean, could also be related to factor-nonneutral technical change or factor-price changes for substitutes to labor, not only to international trade in tasks. Yet, the prediction of reinterpreted classic trade theory that foreign trade expands less schooling-intensive occupations in Brazil's traded-goods sector is fully consistent with the data.

Figure 9.4 depicts the nationwide occupation profile within traded-goods sectors and nontraded-output sectors for the years 1986 to 2001. In traded-goods industries, skilled blue-collar jobs expand markedly with the conclusion of the first wave of trade reforms between 1991 and 1993. The share of skilled blue-collar occupations increases from below 60 percent in 1990 to 68 percent in 1994 and to 71 percent by 2001. Recall from the evidence in figure 9.2 that the average worker's schooling in both skilled and unskilled blue-collar jobs in the traded-goods sector is roughly the same. The growing importance of skilled blue-collar occupations comes at the expense of all other occupations in the traded-goods industries. At the low-skill intensity end, the share of unskilled blue-collar occupations drops from more than 13 percent in 1990 to 8 percent in 1994 (but recovers slightly to close to 9 percent by 2001). More importantly, the expansion of skilled blue-collar occupations in traded-goods sectors comes at the expense of white-collar occupations, whose total employment share drops from 27 percent in 1990 to 24 percent in 1994 and 20 percent in 2001. In the nontraded-output sectors, in contrast, it is the unskilled blue-collar occupation category that expands the fastest, from 13 percent in 1990 to close to 16 percent by 2001, whereas skilled blue-collar jobs are cut back from a share of 34 percent in 1990 to around 29 percent by 1997. Similarly, within white-collar occupations, it is again the less skill-intensive occupations that exhibit a relative gain: the share of unskilled white-collar workers rises from 16 to 18 percent between 1990 and 1995 (with a crawling scaleback to 17 percent until 2001), and the share of technical occupations increases from 20 percent in 1990 to 21 percent in 1995. But the share of professional

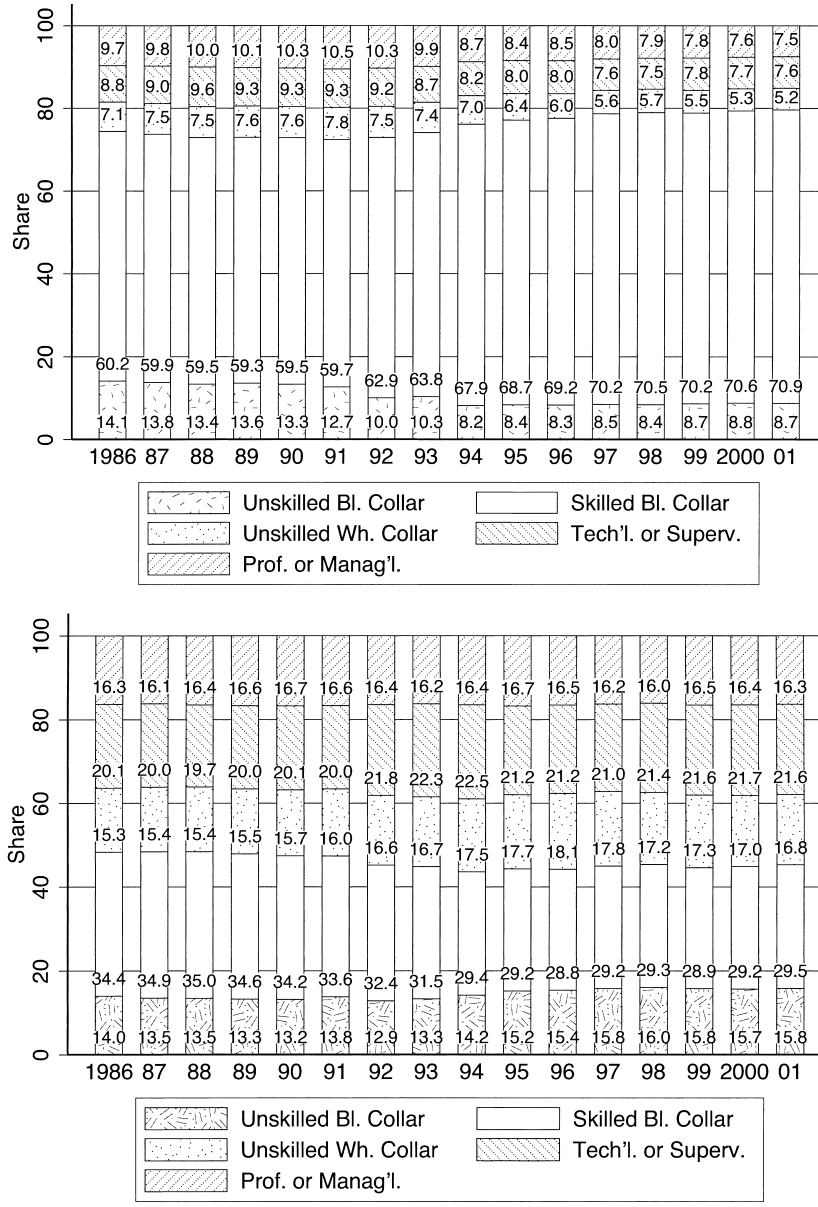


Fig. 9.4 Occupational workforce composition

Source: RAIS 1986–2001 (1% random sample), male workers nationwide, twenty-five to sixty-four years old, with employment on December 31. Traded-goods sectors are agriculture, mining, and manufacturing (subsectors IBGE 1–13 and 25), nontraded-output industries are all other sectors. Shares based on worker numbers.

and managerial positions remains roughly constant, between 16 and 17 percent, thus losing in relative importance to less skill-intensive white-collar occupations.

This shift across the occupation profile toward less skill-intensive occupations permits a skill-upgrading workforce changeover, by which less skill-intensive jobs are being filled with more educated workers, especially in the traded-goods sector. In practice, employers can achieve this workforce changeover in many ways. Employers can either reallocate workers across tasks in-house, or the economy can reallocate workers across firms and sectors, or there may be no reallocation for extended periods of time if employers pursue the workforce changeover by laying off less skilled workers from every occupation category in the absence of compensatory rehiring within the formal sector. The latter form of workforce changeover would be associated with arguably considerable adjustment costs to the economy.

9.4 Worker Reallocations across Activities

Labor-demand decompositions so far have shown that there are two main components to the observed workforce changeover in Brazil over the sample period. First, there is a labor demand shift toward the least and the most skilled male workers, which can be traced back to relatively weaker declines of traded-goods industries that use low-skilled labor intensively and to relatively stronger expansions of nontraded-output industries that intensely use higher-skilled labor. Second, there is a within-industry shift toward more educated workers, associated with a skill upgrading of all occupations in traded-goods industries. To track how employers achieve the observed workforce changeover during the sample period, the comprehensive linked employer-employee data for Brazil's economy is used to trace individual workers across their jobs within establishments, across establishments within sectors, and across firm types and sectors in Brazil's formal sector.

9.4.1 Reallocations across Tasks

Employers may choose to reallocate workers across in-house tasks. For this purpose, an in-house job change is defined as a change in employment between an occupation at the CBO base-group level to another base-group occupation. The 354 CBO base groups roughly correspond to the four-digit ISCO-88 occupations at the unit-group level.[7] Table 9.3 shows both continuing and displaced workers and tracks the workers through jobs at the annual horizon between 1986 and 1997. The task assignment pattern is

7. For a description of the Brazilian occupation classification system CBO and a mapping to ISCO-88, see Muendler, Poole, Ramey, and Wajnberg (2004).

remarkably stable, both before and after trade liberalization. Between 86 and 87 percent of formal-sector prime-age male workers remain in their job with the same employer. Only between 1 and 2 percent of the workers are assigned to new occupations within the same establishment. Less than 1 percent of workers switch establishments within the same firm. Between 7 and 9 percent of the workers change employing firm at the annual horizon. So, the bulk of successful reallocations does not take place on internal labor markets but across firms. The reallocations between exporters and nonexporters and across sectors are traced in the following. The remaining 3 to 4 percent of workers (not reported in table 9.3) are unaccounted. I will also turn to those failed reallocations shortly. Overall, the stable and minor percentages of occupation and establishment reassignments within employers suggest that the observed workforce changeovers, documented in the preceding section, are not achieved through job reassignments in internal labor markets.

9.4.2 Reallocations across Firms and Sectors

Between 1990 and 1998, around 6 percent of the formal-sector workforce nationwide is employed at primary-sector nonexporters—1 percent at primary-sector exporters, 11 percent at manufacturing nonexporters, and 12 percent at manufacturing exporters. The remaining 70 percent of the workforce are employed in the nontraded sector. I now look beyond internal labor markets and investigate whether and how the relative expansion of certain traded-goods industries, in the wake of an overall decline of the traded-goods sector, is associated with reallocations of individual workers across firms and sectors. To capture differences in the labor de-

Table 9.3 **Annual occupation continuations and transitions 1986–1997**

	Year t					
Year $t+1$	1986 (1)	1988 (2)	1990 (3)	1992 (4)	1994 (5)	1996 (6)
Employed						
In same occupation	0.867	0.859	0.864	0.859	0.850	0.856
At same establishment in new occupation	0.018	0.018	0.019	0.020	0.020	0.013
At same firm but new establishment	0.007	0.006	0.006	0.007	0.006	0.005
At new firm	0.079	0.084	0.074	0.078	0.087	0.083

Source: RAIS 1986–1997 (1% random sample), male workers, twenty-five years or older. Frequencies based on last employment of year (highest-paying job, if many); continuations at same firm exclude continuations at same establishment. Occupations are defined at the CBO three-digit base-group level with 354 categories, which roughly correspond to the four-digit ISCO-88 unit-group level.

mand responses across subsectors and firms within the traded-goods sector, individual workers are tracked across exporting and nonexporting employers in the primary and manufacturing industries.

Table 9.4 shows worker transitions between firms and sectors over the first year after trade reform, between their last observed formal-sector employment in 1990 and their last observed formal-sector employment in 1991. Only workers who experience a separation from their last employment of the year are included in the transition statistics. Trade theory might lead us to expect a shift of displaced workers from nonexporting firms to exporters following trade reform. The dominant share of successful reallocations of former nonexporter workers within the traded-goods industries, however, is again to nonexporters. Among the former nonexporter workers displaced from primary-sector employment, close to 11 percent are rehired at primary nonexporters and 10 percent at manufacturing nonexporters, but less than 2 percent shift to exporters. Among the former nonexporter workers in manufacturing, 19 percent move to manufacturing nonexporters and 7 percent no manufacturing exporters, and a very small share to primary-sector firms. Former exporter workers, in contrast, mostly transition to new formal-sector jobs within the sector of displacement and are roughly equally likely to find reemployment at an exporter or a nonexporter. These patterns suggest that reallocations within the traded-goods sectors are mostly intrasector reallocations from exporter to exporter and from nonexporter to nonexporter—contrary to what classic trade theory with full employment and only traded goods might lead us to expect.

In the initial year after trade reform, between one third and two fifths of

Table 9.4 **Year-over-year firm and sector transitions, 1990–1991 (%)**

	To primary		To manufacturing				
From	Nonexp. (1)	Exp. (2)	Nonexp. (3)	Exp. (4)	Nontraded (5)	Failure (6)	Total (7)
Primary nonexporter	10.7	.7	10.3	1.2	40.3	36.8	100.0
Primary exporter	6.7	6.7	3.3	3.3	45.0	35.0	100.0
Manufacturing nonexporter	1.4	.1	19.3	7.2	34.9	37.1	100.0
Manufacturing exporter	1.2	.1	14.5	15.5	33.5	35.2	100.0
Nontraded	1.3	.0	5.4	2.4	54.8	36.0	100.0
Failure	2.9	.3	13.2	5.6	78.0	.	100.0
Total	2.1	.2	10.1	4.8	59.7	23.2	100.0

Source: RAIS 1990–1991 (1% random sample), male workers nationwide, twenty-five to sixty-four years old. SECEX 1990–1991 for exporting status. Frequencies are job accessions in Brazil within one year after separation, based on last employment of year (highest-paying job, if many). Failed accessions are separations followed by no formal-sector accessions anywhere in Brazil within a year, excluding workers with prior retirement or death, or age sixty-five or above in earlier job.

displaced traded-sector workers with a successful reallocation end up in nontraded-sector jobs. An equally large fraction, however, fails to experience a successful reallocation to any formal-sector job within the following calendar year (retirements, deaths, and workers at or past retirement age are excluded from the displaced-worker sample).[8] Of the workers with a failed reallocation before year-end 1990, by far the largest fraction (78 percent) with a successful reallocation by year-end 1991 finds employment in the nontraded-sector. In summary, at the time of the largest impact of trade liberalization in 1990–1991, traded-goods industries exhibit little absorptive capacity for displaced workers compared to nontraded-output industries and compared to the prevalence of failed transitions out of the formal sector. Among those failed reallocations can be transitions to informal work, unemployment, or withdrawals from the active labor force, which are not directly observed in the RAIS records.

In comparison, table 9.5 tracks annual transitions six years after the beginning of trade liberalization and three years after its conclusion. By 1996–1997, more firm and sector reallocations from the primary sector are directed to jobs within the traded-goods sector. In the manufacturing sector, however, the dominant destination sector of displaced workers remains the nontraded sector in 1996–1997, both for workers from exporters and for workers from nonexporters. As in the initial period 1990–1991, in 1996–1997 former nonexporter workers most frequently find reemployment at nonexporter firms, and former exporter workers are roughly equally likely to find reemployment at exporter and nonexporter firms in manufacturing but less likely to transition to an exporter in the primary sector. By 1996–1997, an even larger fraction of displaced primary-sector workers than in 1990–1991 fails to experience a successful formal-sector reallocation and a roughly equally large share of former manufacturing workers as in 1990–1991 fails to find a formal-sector job within the following calendar year.

Together with the evidence on infrequent task reassignments in-house, these labor-market transitions suggest that the observed workforce changeovers from the preceding section are neither achieved through worker reallocations within employers nor are they brought about by labor reallocations across employers and sectors. By exclusion, the remaining explanation is that formal-sector employers in the traded-goods industries shrink their workforces by dismissing less-schooled workers more frequently than more-schooled workers, while the thus displaced workers fail to find reemployment, at least at the annual horizon. In the aggregate, the

8. The slightly smaller unaccounted percentage in table 9.3, compared to the reallocation failure rates in tables 9.4 and 9.5, is largely due to a restriction of the initial sample to workers with comprehensive occupation information in table 9.3.

Table 9.5 **Year-over-year firm and sector transitions, 1996–1997 (%)**

	To primary		To manufacturing				
From	Nonexp. (1)	Exp. (2)	Nonexp. (3)	Exp. (4)	Nontraded (5)	Failure (6)	Total (7)
Primary Nonexporter	32.1	2.5	6.0	2.9	15.4	41.1	100.0
Primary Exporter	17.1	13.0	6.5	3.3	18.7	41.5	100.0
Manufact. Nonexporter	5.6	.4	18.9	6.5	32.1	36.5	100.0
Manufact. Exporter	7.2	.7	12.1	13.9	27.3	38.8	100.0
Nontraded	1.3	.2	3.8	2.0	55.8	36.9	100.0
Failure	8.9	.7	12.2	6.1	72.1		100.0
Total	6.5	.6	8.8	4.7	56.9	22.5	100.0

Source: RAIS 1996–1997 (1% random sample), male workers nationwide, 25 to 64 years old. SECEX 1996–1997 for exporting status. Frequencies are job accessions in Brazil within one year after separation, based on last employment of year (highest paying job if many). Failed accessions are separations followed by no formal-sector accessions anywhere in Brazil within a year, excluding workers with prior retirement or death, or age sixty-five or above in earlier job.

lacking traded-sector reallocations result in a considerable decline of formal manufacturing employment, from 26 to 22 percent (table 9.1). The simultaneous expansion of nontraded-output industries can partly be driven by a long-term shift from primary to manufacturing to services activities in the economy, or by Brazil's overvalued real exchange rate during the sample period, or by foreign direct investment (FDI) flows in the wake of Brazil's concomitant capital-account liberalization and privatization program, by trade liberalization, or by a combination of these changes. The next section discusses the predictive power of these competing explanations and their associated variables. In the final section, the issue of reallocation durations beyond the annual horizon is discussed.

9.5 Establishment Workforce Changes

While the timing of labor-demand changes, workforce changeovers, and variations in the reallocation pattern is suggestive of the role that trade reform may play for the labor market, it remains to investigate the predictive power of competing policy variables. For this purpose, the universe of employment records on December 31 is aggregated to the establishment level and the discussion turns to an employer-level version of the linked employer-employee data by retaining all establishments that employ at least one worker from the nationwide and metropolitan random worker samples in the preceding sections. Employer-level regressions are most closely comparable to prior evidence (Davis, Haltiwanger, and Schuh 1996; Ribeiro et al. 2004). The interest lies on employment change at the establishment level

and its covariation with various policy variables during the 1990–1997 period. Attention is restricted to manufacturing industries, where the bulk of Brazil's traded-goods sector employment occurs.

9.5.1 Statistical Model

Consider the regression model

$$\ell_{k,t+1} - \ell_{kt} = \mathbf{1}(exp_{kt})\,\beta + \mathbf{z}_{jt}\gamma + \mathbf{x}_{kt}\delta + \alpha_k + \alpha_t + \varepsilon_{kt} \tag{3}$$

for employment change $\ell_{k,t+1} - \ell_{kt}$ at establishment k conditional on an indicator $1(exp_{kt})$ whether establishment k belongs to an exporting firm at time t, sector-level control variables z_{jt} for establishment k's sector j, and establishment-level variables x_{kt}, where α_k are time-invariant establishment-fixed effects, α_t are establishment-invariant time effects, and ε_{kt} is a well-behaved error term. The sector-level variables z_{jt} include predictors related to Brazil's time-varying trade regime. In the regression sample, t spans 1990 to 1997.

A concern is whether predictors can be causally related to employment changes. Establishment-fixed effects subsume sector-fixed effects and thus remove potentially confounding sector differences in labor-market consequences from the constitutional changes to labor-market institutions prior to trade reform. Recall that Brazil's abrupt trade policy shift in 1990, though surprisingly implemented by the executive and largely designed in the absence of private-sector consultations, hits previously highly protected industries with the strongest tariff reductions, so that the tariff dispersion drops—thus turning trade policy into an endogenous instrument, potentially correlated with sectoral labor-market differences. Similarly, differences in establishment-level employment growth rates may be related to export status, not only through an employer's export status itself. Drawing on prior work in Muendler (2004), instrumental variables (IVs) are used as foreign components of the real exchange rate. These components are: the U.S. PPI by industry, the PPI of select Western European countries by industry, the OECD-wide PPI by industry, and a worldwide mix of wholesale price index (WPI) and PPI for Brazil's twenty-five major trading partners for all OECD countries. These foreign prices are plausibly exogenous to Brazil's price and cost evolution. These four sector- and time-varying instrumental variables are used to predict the export indicator $1(exp._{kt})$ and its interaction with product tariffs as well as the product tariff and intermediate-input tariff (in z_{jt}). Brazil's nominal exchange rate is not an instrument for model (3) because time variation is already controlled for with year indicators. Four instrumental variables for these four potentially endogenous predictors make the model just identified. The sector real exchange rate itself is retained among the predictors in z_{jt} because its variation depends on Brazil's sectoral (wholesale) price index beyond the four instrumental variables.

9.5.2 Data and Estimates

As table 9.6 shows, the nationwide mean manufacturing establishment between 1990 and 1997 reduces employment by 2.5 workers over the course of the subsequent year (1991–1998), and the mean metropolitan establishment cuts employment by a net number of 2.6 workers. Though slightly higher in levels, there is less dispersion in net employment changes across metropolitan establishments. Sixteen percent of the establishments belong to an exporting firm both nationwide and in metropolitan areas (but average employment at metropolitan exporters is larger; recall table 9.1). Not conditioning on exports status, the average size of metropolitan establishments is below the nationwide average with 16.3 workers (2.792 in logs) compared to 17.7 (2.876 in logs), while the size dispersion is wider in metropolitan areas than nationwide. Metropolitan establishments retain their workers slightly longer than the nationwide average, resulting in a higher mean tenure at the establishment, and show both more-educated workforces and a more skill-intensive occupation profile. Metropolitan manufacturing establishments produce in slightly less tariff-protected sectors and in sectors with slightly higher levels of foreign penetration. In summary, metropolitan manufacturing establishments face somewhat tougher

Table 9.6 **Employer samples nationwide and in metropolitan areas**

	Nationwide		Metropolitan	
	Mean (1)	Std. Dev. (2)	Mean (3)	Std. Dev. (4)
Employment change over next year	–2.501	132.239	–2.580	131.860
Exporter status	.156	.363	.158	.365
Establishment-level variables				
Log employment	2.876	1.519	2.792	1.533
Mean: Tenure at plant (in years)	.647	.533	.671	.554
Share: Prof. or manag'l. occ.	.061	.123	.067	.134
Share: Tech'l. or superv. occ.	.120	.193	.127	.197
Share: Unskilled white collar occ.	.083	.157	.090	.164
Share: Skilled blue collar occ.	.584	.347	.558	.350
Share: Middle school or less	.771	.271	.763	.277
Share: Some high school	.173	.222	.174	.221
Sector-level variables				
Product market tariff	.190	.110	.186	.106
Intm. input tariff	.149	.084	.147	.082
Import penetration	.055	.045	.059	.047

Sources: RAIS 1990–1998 (employers of male workers, twenty-five to sixty-four years old, with manufacturing job in 1% random sample nationwide and in 5% random sample for metropolitan areas) and SECEX 1990–1998. Sector information at subsector IBGE level.

foreign competition and are slightly smaller and more skilled, but metropolitan establishments are more diverse along several dimensions.

Table 9.7 presents regression results for the nationwide sample from five alternative specifications. All specifications condition on establishment and year-fixed effects. Sector-level tariff variables have no statistically significant predictive power when included by themselves in the first specification. Establishment-level variables are statistically significant predictors. Large establishments, in terms of log employment, grow significantly less in the subsequent year; establishments with high-tenure workers (and thus high worker-retention rates) grow significantly more. Establishments that have a larger share of professional occupations or a larger share of unskilled white-collar occupations add to their workforces during the 1990–1997 period, whereas establishments with a larger share of skilled blue-collar occupations add fewer workers to the workforce (unskilled blue-collar occupations are the omitted category). Taken together with the prior evidence that the share of blue-collar occupations expands in the traded-goods sector, these findings suggest that workforce changeovers are largely driven by more than proportional worker layoffs from high-skill occupations at low-skill intensive employers. The overall goodness-of-fit of merely .6 percent indicates that the bulk of the variation in establishment-level employment changes remains unexplained. These findings continue unaltered as the specifications become richer.

Including additional sector variables related to Brazil's international economic integration and industrial structure does not result in better predictive power of tariffs in specification 2. Import penetration partly captures unobserved nontariff barriers, the sectoral real exchange rate controls for sector variation in Brazil's relative prices beyond the time variation of the year fixed effects, FDI flows into the sample manufacturing sectors partly measure the effect of capital-account liberalization and privatization on employment changes, and Herfindahl concentration indexes approximate domestic competitive conditions. No single-sector variable is a statistically significant predictor of establishment-level employment changes itself, and neither are tariff variables good predictors. The lacking statistical significance stands in surprising contrast to the salient correlation of these regressors with firm-level productivity in Brazil's manufacturing sector (Muendler 2004).

The establishment's parent-firm export status, however, is a significant predictor of employment change once included in specification 3. Being an exporter predicts a net employment loss of more than two workers, a substantial number given the mean establishment size of sixteen workers. Contrary to what classic trade theory might lead us to anticipate, exporter establishments significantly reduce their workforces over the 1990–1997 period. The predicted employment loss at exporters between 1990 and 1997 needs to be qualified, however, as the interaction of tariff protection with exporting status is a significant control variable (specification 4). The

Table 9.7 Manufacturing employment changes nationwide

	FE specifications				FE-IV
	(1)	(2)	(3)	(4)	(5)
Firm-level trade variables					
Exporter status			–2.51	–8.81	–137.24
			(1.28)**	(1.85)***	(717.76)
Exporter × product tariff				35.33	–16.35
				(7.50)***	(855.35)
Sector-level variables					
Product market tariff	4.92	1.02	1.53	–1.96	48.55
	(13.65)	(14.15)	(14.15)	(14.17)	(40.85)
Intm. input tariff	–4.61	–0.78	–1.41	–0.51	–59.72
	(20.36)	(20.94)	(20.94)	(20.94)	(122.34)
Import penetration		5.75	6.00	7.56	19.52
		(13.95)	(13.95)	(13.95)	(49.01)
Sector real exch. rate (EP^* / P)		24.46	24.44	21.73	21.37
		(19.08)	(19.08)	(19.09)	(103.85)
FDI flow (USD billion)		–0.78	–0.78	–0.87	–0.90
		(.74)	(.74)	(.74)	(2.05)
Herfindahl Index (sales)		–3.45	–3.20	–2.86	7.47
		(12.40)	(12.40)	(12.40)	(118.37)
Establishment-level variables					
Log employment	–22.33	–22.34	–22.28	–22.36	–19.27
	(.45)***	(.45)***	(.45)***	(.45)***	(20.62)
Mean: tenure at plant (in years)	4.21	4.22	4.24	4.30	5.00
	(.98)***	(.98)***	(.98)***	(.98)***	(3.44)
Share: prof. or manag'l. occ.	25.62	25.62	25.64	25.66	26.57
	(3.26)***	(3.26)***	(3.26)***	(3.26)***	(5.58)***
Share: tech'l. or superv. occ.	1.10	1.10	1.12	1.08	2.38
	(2.43)	(2.43)	(2.43)	(2.43)	(9.08)
Share: unskilled white collar occ.	10.22	10.21	10.22	10.11	10.83
	(2.87)***	(2.87)***	(2.87)***	(2.87)***	(6.60)
Share: skilled blue collar occ.	–3.51	–3.52	–3.52	–3.55	–3.39
	(1.50)**	(1.50)**	(1.50)**	(1.50)**	(2.26)
Obs.	500,659	500,659	500,659	500,659	500,659
R^2 (overall)	.006	.006	.006	.005	.003

Sources: RAIS 1990–1998 (employers of 1% random sample of male workers nationwide, twenty-five to sixty-four years old, with manufacturing job) and SECEX 1990–1998. Sector information at subsector IBGE level. Controlling for establishment-fixed and year effects. Establishment-clustered standard errors in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

typical exporter cuts almost nine jobs in an unprotected sector with zero tariffs, but tariff protection mitigates the effect. Given a .11 standard deviation of product-market tariffs in the nationwide sample, the point estimate on the interaction term implies that raising tariffs by a standard deviation reduces the predicted job loss at exporters by four jobs, from almost

nine to under five jobs lost. At the sample mean product-market tariff level of .19, the mean exporter has a predicted job loss of 2.1 jobs. There is no conclusive evidence, however, that exporting status is causally related to employment reductions. When firm-level export status and its interaction with product-market tariffs (as well as product and intermediate-input tariffs) are instrumented for with sector-year varying foreign components of the real exchange rate (specification 5), export status loses its statistical significance.[9] Yet, there is no evidence against the causal impact of exporting status on employment changes either in that the sign remains negative and the point estimate increases in absolute value. Establishment heterogeneity in unobserved workforce composition, or other unobserved sources of heterogeneity, may be associated with both exporting status and employment change and could hamper identification in the IV approach.

I estimate model (3) also for the metropolitan sample. Table 9.8 presents the results. Sign patterns and point estimates are remarkably similar between the nationwide and the metropolitan samples. The predicted number of lost jobs at exporters in unprotected sectors (with zero tariffs) is now eight—with a standard deviation increase in tariffs predicting three lost jobs less or around five lost jobs after a 1-standard deviation increase. At the sample mean product-market tariff, exporting status predicts a net job loss of 2.2 jobs, slightly above the nationwide average, arguably because of a lower tariff-protection effect. Similar to the nationwide results, an IV approach raises point estimates but shows no statistically significant effect of exporting status on net employment change.

In principle, linked employer-employee data also permit the construction of estimation samples that trace changes to establishment-level employment through accessions and separations at the job level. The construction of according estimation samples is a promising path for future research in that such samples make it possible to control for establishments' workforce heterogeneity at the individual worker and job level. A remaining concern of this chapter is what consequences the documented trade regime changes may have for labor-market outcomes.

9.6 Labor Market Performance

Most evidence so far suggests that the metropolitan areas of Brazil are strikingly similar to the national average. If anything, the lower levels of tariff protection in the sectors of the typical metropolitan exporters and the higher levels of import penetration (table 9.6) would suggest a stronger impact of trade reform on labor-market performance. Accordingly, establishment-level regressions in the preceding section predict that, at the

9. *F*-test statistics for the predictive power of the four instrumental variables are above values of 1,000 for the two endogenous sector-level regressors (product-market and intermediate-input tariffs) and above 100 for the two endogenous firm-level regressors (export status and its interaction with product-market tariffs).

Table 9.8 **Manufacturing employment changes in metropolitan areas**

	FE specifications				FE-IV
	(1)	(2)	(3)	(4)	(5)
Firm-level trade variables					
Exporter status			–2.39	–8.21	–356.09
			(1.28)*	(1.86)***	(714.07)
Exporter × product tariff				32.26	–568.96
				(7.51)***	(770.82)
Sector-level variables					
Product market tariff	9.54	5.65	5.90	1.14	59.15
	(13.60)	(14.02)	(14.02)	(14.06)	(120.18)
Intm. input tariff	–8.18	–4.99	–5.35	–3.87	4.68
	(20.19)	(20.74)	(20.74)	(20.74)	(234.58)
Import penetration		–0.28	–0.004	1.92	17.48
		(13.13)	(13.13)	(13.14)	(54.99)
Sector real exch. rate (EP^* / P)		30.05	29.98	27.91	62.31
		(18.70)	(18.70)	(18.70)	(61.50)
FDI flow (USD billion)		–0.72	–0.73	–0.79	–0.33
		(.75)	(.75)	(.75)	(1.42)
Herfindahl Index (sales)		1.58	1.79	1.92	51.84
		(11.98)	(11.98)	(11.98)	(118.14)
Establishment-level variables					
Log employment	–23.24	–23.25	–23.20	–23.26	–11.85
	(.46)***	(.46)***	(.46)***	(.46)***	(20.30)
Mean: tenure at plant (in years)	3.54	3.56	3.57	3.62	5.67
	(.96)***	(.96)***	(.96)***	(.96)***	(4.47)
Share: prof. or manag'l. occ.	23.52	23.53	23.56	23.59	27.95
	(3.11)***	(3.11)***	(3.11)***	(3.11)***	(8.87)***
Share: tech'l. or superv. occ.	1.81	1.83	1.84	1.80	4.83
	(2.33)	(2.33)	(2.33)	(2.33)	(5.76)
Share: unskilled white-collar occ.	8.60	8.58	8.60	8.50	13.53
	(2.69)***	(2.69)***	(2.69)***	(2.69)***	(8.65)
Share: skilled blue-collar occ.	–3.29	–3.29	–3.30	–3.34	–2.70
	(1.46)**	(1.46)**	(1.46)**	(1.46)**	(1.90)
Obs.	502,523	502,523	502,523	502,523	502,523
R^2 (overall)	.005	.005	.005	.005	.002

Sources: RAIS 1990–98 (employers of 5% random sample of male workers in metropolitan areas, twenty-five to sixty-four years old, with manufacturing job) and SECEX 1990–98. Sector information at subsector IBGE level. Controlling for establishment-fixed and year effects. Establishment-clustered standard errors in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

sample mean, exporters reduce employment by 2.2 jobs in metropolitan areas but only by 2.1 jobs nationwide. On the other hand, metropolitan areas have a somewhat larger services sector in employment terms (table 9.1), and a majority of displaced manufacturing workers with successful formal-sector reallocations shifts to services. Metropolitan establishments

also exhibit more diversity (as measured by standard deviations) in terms of employment size and the skill composition of their workforces (table 9.6). Inasmuch as the presence of a larger services sector or the diversity of manufacturing establishments are conducive to faster reabsorptions, it is an open question whether the stronger exposure of the metropolitan areas in Brazil to the international economy would result in a better or worse labor-market performance following trade liberalization.

The empirical answer is unambiguous. In order to measure times to successful reallocation, a sample of workers with a separation at any time between 1990 and 1997 is taken and tracked as to whether the workers are successfully rehired into a formal-sector job within the forty-eight months following their separation. Table 9.9 shows that almost two in three successfully reallocated workers in metropolitan areas find a new job within the month of their separation. In contrast, only one in seven workers nationwide is successfully rehired within the same month of displacement. In metropolitan areas, 95 percent of successfully reallocated workers start their new job within twelve months. But only 77 percent of the successfully reallocated workers nationwide find new employment nationwide within a year, 13 percent need up to two years, 6 percent need up to three years, and 4 percent need up to four years. There is a slight worsening in the time-to-reallocation in both metropolitan and nationwide labor markets between 1990 and 1997, but this time variation is small compared to the substantial regional differences. In short, metropolitan labor markets perform considerably faster in the reallocation process, even though evidence in the earlier sections shows only small differences between the metropolitan employer and employee characteristics and the nationwide characteristics.

Two candidate explanations for the substantial difference between metropolitan and national labor markets, consistent with the documented

Table 9.9 **Formal-sector reallocation time spans 1990–1997**

	Mean 1990–1997		1990		1997	
Reallocation	Nation (1)	Metro (2)	Nation (3)	Metro (4)	Nation (5)	Metro (6)
Same month	.146	.597	.163	.615	.138	.576
1 year	.627	.353	.663	.351	.614	.361
1 to 2 years	.134	.031	.101	.021	.135	.037
2 to 3 years	.058	.012	.045	.008	.065	.015
3 to 4 years	.035	.007	.027	.005	.048	.011

Source: RAIS 1990–2001. Male workers nationwide (1% random sample) or in metropolitan areas only (5% random sample), twenty-five to sixty-four years old (in highest-paying job, if many), displaced from a formal-sector job between 1990 and 1997 and rehired into a formal-sector job within forty-eight months. Columns sum to 100 percent.

Table 9.10 Employment allocation by subsector

Sector and subsectore IBGE	Employment share 1986 (1)	1990 (2)	1997 (3)
Primary			
1 Mining and quarrying	.007	.006	.004
25 Agriculture, farming, hunting, forestry, and fishing	.015	.016	.041
Manufacturing			
2 Manufacture of nonmetallic mineral products	.016	.013	.011
3 Manufacture of metallic products	.030	.024	.021
4 Manufacture of machinery, equipment, and instruments	.020	.016	.011
5 Manufacture of electrical and telecommunications equipment	.016	.014	.008
6 Manufacture of transport equipment	.019	.016	.013
7 Manufacture of wood products and furniture	.019	.015	.015
8 Manufacture of paper, paperboard, and publishing	.014	.014	.013
9 Manufacture of rubber, tobacco, leather, and products n.e.c.	.019	.016	.009
10 Manufacture of chemical and pharmaceutical products	.024	.022	.020
11 Manufacture of apparel and textiles	.042	.035	.026
12 Manufacture of footwear	.012	.010	.008
13 Manufacture of food, beverages, and ethyl alcohol	.040	.039	.041
Commerce			
16 Retail trade	.106	.103	.127
17 Wholesale trade	.024	.025	.027
Services			
18 Financial intermediation and insurance	.038	.034	.025
19 Real estate and business services	.074	.073	.079
20 Transport, storage, and telecommunications	.050	.044	.057
21 Hotels and restaurants, repair and maintenance services	.101	.101	.084
22 Medical, dental, and veterinary services	.014	.017	.039
23 Education	.008	.009	.036
Other			
14 Electricity, gas, and water supply	.013	.014	.014
15 Construction	.045	.041	.049
24 Public administration and social services	.209	.206	.224
26 Activities n.e.c.	.025	.077	.001
Total employment (thousands of workers)	22,164	23,174	24,104

Source: RAIS 1986, 1990, and 1997, universe of workers. Employment as of December 31. Slight differences to table 9.7 are due to random sampling errors.

evidence in this chapter, are the presence of a larger services sector and the diversity of the manufacturing establishments in metropolitan areas (see table 9.10). The differences along these two dimensions seem small, however, to give rise to the considerable differences in labor-market performance across regions, and more research into the functioning of labor-market adjustment seems warranted for an understanding of the economic performance after procompetitive reforms.

9.7 Conclusions

This chapter documents the changes to labor demand and workforce composition that accompanied Brazil's largescale trade reform in the early 1990s. Several aspects of the labor-market adjustment and workforce changeover in traded-goods industries are broadly consistent with the insights of Heckscher-Ohlin trade theory. Being a low-skill-abundant country relative to its main trading partners, Brazil exhibits a shift toward sectors that intensively use low-skilled labor. Within sectors, Brazil shifts toward low-skill intensive occupations and fills those occupations with relatively better-schooled workers—just as a Stolper-Samuelson argument applied to occupational activities instead of sectors would suggest. The setting of classic trade theory in a context of full employment within traded-goods industries is a less useful guide to Brazil's further evidence, however. Among the displaced traded-goods sector workers with a successful reallocation, most shift to nontraded-output industries and almost as many displaced workers do not find formal reemployment at an annual horizon. Unexpectedly, regressions show that exporter establishments exhibit a significant employment downsizing over the period following trade liberalization, controlling for a large set of other establishment-level and sector-level predictors as well as establishment and year effects.

The reduced demand for highly skilled workers following trade liberalization implies that the returns to skill drop. This raises the question whether pro-competitive reform has the side effect to lastingly weaken incentives for educational attainment. In Menezes-Filho et al. (2008), we document (with Mincer [1974]) regressions, including employer-fixed effects, that the returns to skill fall between 1990 and 1997. But the drop is slight. Especially in comparison to industrialized countries, returns to human capital remain elevated in Brazil throughout the 1990s: a typical male manufacturing worker in Brazil with a college degree in 1990, for instance, receives wages that are 150 percent higher than a comparable worker with a high school education, and 140 percent higher in 1997 (whereas this premium stands at 70 percent in the United States, and it is only 40 percent in France in the early 1990s). The small reduction in education premia between 1990 and 1997 suggests that Brazil's trade reform has not significantly diminished incentives for educational attainment.

Though a firm's exporting status is a significant predictor of employment downsizing, an instrumental-variable approach provides neither evidence in favor nor against a causal interpretation of this prediction. Substantial workforce heterogeneity may affect the prediction. To control for the heterogeneity in workforce characteristics, linked employer-employee data can be used to construct worker-level samples and assess separations from and accessions to employers at the individual job level in future research. Although Brazil's metropolitan labor markets only slightly differ from the national average in sectoral composition and establishment-level

diversity, workers experience much shorter times to successful reallocation. The striking but unexplained difference points to the limits in our current understanding of labor-market adjustment following large-scale procompetitive reform.

Appendix

Brazilian law requires all Brazilian establishments to submit detailed annual reports with individual information on their workers and employees to the ministry of labor (Ministério de Trabalho, MTE). Data collection is typically concluded at the parent firm by March following the year of observation.

Screening

In RAIS, workers are identified by individual-specific PIS (Programa de Integração Social) IDs that are similar to social security numbers in the United States (but PIS IDs are not used for identification purposes other than the administration of the wage supplement program Abono Salarial). A given establishment may report the same PIS ID multiple times within a single year in order to help the worker withdraw deposits from his or her severance pay savings account (Fundo de Garantia do Tempo de Serviço [FGTS]) through spurious layoffs and rehires. Moreover, bad compliance causes certain PIS IDs to be recorded incorrectly or repeatedly. To handle these issues, the census records are screened as follows. (1) Observations with PIS IDs having fewer than eleven digits are removed. These correspond to either informal (undocumented) workers or recording error from faulty bookkeeping. (2) Multiple employments with the same accession and separation date at the same employer are removed. For a worker with such multiple employments, the observation with the highest average monthly wage level is kept (in cases of wage level ties, duplicate random observations are dropped).

Age, Education, and Occupation

The following tables present age and education classifications from RAIS. The age range information in RAIS is used to infer the typical age of a worker in the age range, as follows (table 9A.1).

For much of the analysis, the number of education categories for presentation is reduced, and the nine education categories included in RAIS are regrouped to correspond to five categories, as shown in the following. Some statistical applications require a continuous years-of-schooling variable, which is defined as follows (table 9A.2).

The occupation indicator variables are obtained from the CBO classification codes in RAIS and are reclassified to conform to the ISCO-88 cate-

gories. For a description of the Brazilian occupation classification system CBO and a mapping to ISCO-88, see Muendler et al., 2004. In the available RAIS version for the nation as a whole, CBO classes are only reported at the three-digit level. The mapping from CBO to ISCO-88 is adjusted accordingly. For most of the aggregate analysis, the ISCO-88 categories are mapped to occupation levels as follows (table 9A.3).

Table 9A.1 Typical age of worker

RAIS age category	Imputed age
1 Child (10–14)	Excluded
2 Youth (15–17)	Excluded
3 Adolescent (18–24)	Excluded
4 Nascent career (25–29)	27
5 Early career (30–39)	34.5
6 Peak career (40–49)	44.5
7 Late career (50–64)	57
8 Post Retirement (65–)	Excluded

Table 9A.2 Education categories and years of schooling

Education level	RAIS education	Years of schooling
1 Illiterate or primary school dropout		
Illiterate	1	0
Primary school dropout	2	1
2 Primary school graduate or middle school dropout		
Primary school graduate	3	4
Middle school dropout	4	5
3 Middle school graduate or high school dropout		
Middle school graduate	5	8
High school dropout	6	9
4 High school graduate or college dropout		
High school graduate	7	12
College dropout	8	13
5 College graduate	9	16

Table 9A.3 mapping between ISCO-88 categories and occupation levels

ISCO-88 category	Occupation level
1 Legislators, senior officials, and managers	Professional and managerial
2 Professionals	Professional and managerial
3 Technicians and associate professionals	Technical and supervisory
4 Clerks	Other white collar
5 Service workers and shop and market sales workers	Other white collar
6 Skilled agricultural and fishery workers	Skill-intensive blue collar
7 Craft and related workers	Skill-intensive blue collar
8 Establishment and machine operators and assemblers	Skill-intensive blue collar
9 Elementary occupations	Other blue collar

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