

Knowledge Transfers from Multinational to Domestic Firms: Evidence from Worker Mobility*

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Abstract

Labor turnover is a commonly-cited mechanism for the transmission of spillovers from multinational to domestic firms, but until now there has been little direct evidence for this mechanism. Using a novel matched establishment-worker database from Brazil, I present evidence consistent with the existence of positive multinational spillovers through worker mobility in Brazil. The paper explores *where* spillovers occur and *how* they are absorbed. The main results suggest that the magnitude of wage spillovers from multinational firms depends on the sector and the worker under consideration. The results provide support for the hypothesis that higher-skilled former multinational-establishment workers are better able to convey information and higher-skilled incumbent domestic-establishment workers are better able to absorb information. Information is best transferred between similarly-skilled groups of high-skilled workers and from higher-skilled former multinational-establishment workers to lower-skilled incumbent domestic-establishment workers. The results are robust to various model specifications, including worker and establishment fixed effects, as well as time-varying, establishment-level productivity shocks.

Keywords: foreign direct investment, worker mobility, spillovers, technology transfer.

JEL Classification: F16, F23, J3, J6.

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1 Introduction

Despite the long history of academic work testing the implications from increased multinational presence on domestic firms, the exact mechanisms through which spillovers occur are rarely tested. Within the few studies that do address a particular mechanism of transmission, the existing empirical evidence on spillovers through worker turnover is limited, even though many multinational establishments devote a great deal of effort to retaining workers they train with valuable technological capital. In this paper, I present evidence consistent with this single mechanism for spillovers from multinational establishments locating in Brazil. More precisely, I investigate multinational spillovers resulting from worker mobility. This paper also explores *where* spillovers occur and *how* spillovers are absorbed. I discern the spillover effect by sector, and distinguish it by the skill-level of the displaced former multinational-establishment worker and the incumbent domestic-establishment worker.

Multinational enterprises (MNE) may instill positive technological knowledge on workers at their subsidiaries through labor training regarding new process innovations, high-quality intermediate inputs, and management styles. This imported technology, however, is a public good and knowledge transfer to local firms may occur as domestic firms discover the multinational's technology and attempt to imitate it in the local production process. Domestic firms may gain access to the multinational's technology by hiring a former MNE-trained worker with special skills. It is precisely this mechanism of technology spillovers that I uncover in the analysis that follows.

This research offers a number of important contributions to the current literature on multinational knowledge spillovers, in large part due to the depth of a novel linked employer-employee database from Brazil. This is the first research, to my knowledge, to offer direct evidence from a large database for a developing country for evidence consistent with positive multinational spillovers through the worker mobility channel. Using matched establishment-worker data, I am able to trace individual workers over time across establishment types. The detailed labor force characteristics allow me to estimate heterogeneous responses of wages depending on worker-level characteristics beyond prior work. In addition, the data include a rich set of establishment-level controls. Moreover, to the best of my knowledge, this is the

first research to span all sectors of the economy, rather than a single industry case study. I go beyond the common manufacturing focus and estimate multinational spillovers in the services sectors where much of the foreign investment in Brazil flowed beginning in 1996. Also, I do not restrict the analysis to senior-level management. I will show that multinational spillovers occur at all skill-levels, and vary by both the skill-level of the former multinational-establishment worker and the skill-level of the incumbent domestic-establishment worker.

In contrast to earlier work on this subject, I focus on the worker rather than the firm as the unit of analysis. I measure spillovers as increases in the incumbent domestic-establishment worker's wages as a function of the proportion of workers employed at the domestic establishment with some multinational experience. Motivated by the social interactions model proposed by Manski (1993), I picture the growth of knowledge occurring when meetings between workers take place. Empirically, the transmission of knowledge occurs through interactions between workers; more precisely, between workers who are displaced from multinational establishments and rehired at domestic establishments on the one hand and the existing (incumbent) domestic-establishment workforce on the other hand. The greater the share of former multinational-establishment workers in the domestic-owned establishment, the greater the number of possible interactions and the greater the potential transfer of knowledge. If multinational spillovers through worker mobility exist, I expect workers in domestic establishments hiring a greater share of former multinational-establishment workers to earn higher wages through their potential social interactions with former multinational-establishment workers.

I estimate worker-level regressions using a matched employer-employee data set from Brazil. The Brazilian worker data are collected by the Brazilian Labor Ministry and record characteristics for all formally-registered workers at formally-registered establishments for the years covering 1996 through 2001. The foreign direct investment inflows data are from the Brazilian Central Bank's Registry of Foreign Capital. The two data sources are matched by establishment tax number for the first time in this research to identify workers at foreign-owned and domestic-owned establishments over time. The main benefit of the matched data is the ability to trace workers who "switch" between foreign-owned and domestic-owned establishments.

The findings can be summarized as follows. The main results are consistent with the existence of positive multinational spillovers defined to be the effects of the share of former multinational-establishment workers in the domestic-owned establishment on incumbent domestic-establishment workers' wages. Ex-ante identical workers in establishments with a higher proportion of workers with some experience at a multinational firm earn higher wages. The magnitude of wage spillovers from workers with experience at multinational establishments depends on the sector under consideration. Though multinational spillovers are not economy-wide, and in fact, most sectors and most workers do not receive spillover benefits, the results are consistent with the idea that local conditions, such as the level of education, may play an important role in the ability of a country to absorb foreign technological capital.

Evidence by the skill-level of the worker supports the hypothesis that higher-skilled former multinational-establishment workers are better able to convey a multinational's technology to incumbent domestic-establishment workers and higher-skilled incumbent domestic-establishment workers are better able to absorb the MNE's technology from former multinational-establishment workers. The data also report that information is best transferred between similarly-skilled groups of high-skilled workers and from higher-skilled former multinational-establishment workers to lower-skilled incumbent domestic-establishment workers. The results are robust to worker and establishment fixed effects as well as to different specifications controlling for time-varying, establishment-specific productivity shocks, worker sorting, learning over time, and MNE screening.

The remainder of this paper is organized as follows. In the next section, I briefly summarize the literature on multinational spillovers and discuss in detail the evidence for the different potential mechanisms of transmission. In section 3, I discuss the empirical methodology, motivated by the social interactions model proposed by Manski (1993). Section 4 details the data with descriptive statistics. I present the results from the analysis of multinational spillovers through worker mobility in section 5 and identify the sectors that exhibit spillovers. In section 6, I distinguish the spillover effect by the skill-level of the displaced former multinational-establishment worker and the incumbent domestic-establishment worker in order to uncover how spillovers are absorbed. Additional robustness

checks are offered in section 7. I conclude with final remarks.

2 Literature Review

There is a long history of academic work testing the implications from increased multinational presence on domestic firms.¹ These early studies ask whether multinational spillovers exist, but the mechanisms through which spillovers occur are treated as a black box. However, foreign investment may generate productivity spillovers through a number of different channels: imitation, competition, market access, linkages, and labor turnover.

Domestic competitors might successfully imitate technological innovations introduced by MNEs. Similarly, production externalities may occur if an increase in competition, as a result of foreign entry, induces firms to become more efficient or to discover new technologies. Aitken and Harrison (1999) show the competition effect may not be positive. For the case of Venezuela, they find increased foreign investment to be negatively-related to productivity growth for establishments in the same sector. The authors attribute this negative relationship to the market-squeezing effect of foreign investment. Competition from foreign producers forces out low productivity domestic producers, raising the average productivity of the industry. Hale and Long (2007) study the effects of labor market competition induced by the presence of foreign firms in China. Private domestic firms in industries with a higher foreign presence share also pay higher average wages to skilled workers. No similar effect is found for workers in state-owned enterprises, suggesting foreign and domestic firms compete for high-skilled labor.

Another possible mechanism for the transmission of technology spillovers from MNEs is through market access. The MNE may possess strong links to the home country and world markets helping to establish informational networks for local firms. Aitken, Hanson and Harrison (1997) show that Mexican plants have a higher propensity to export the higher is the concentration of MNE exporters in the industry in which the firm produces. This is consistent with the idea that there exist informational externalities to having a foreign presence in a firm's industry. Greenaway, Sousa and Wakelin (2004) confirm the results for

¹For a review of earlier work, see Blomstrom and Kokko (1998), Saggi (2002), and Keller (2004).

an industrialized country, the United Kingdom.

Local firms may also benefit from increased multinational presence if they are suppliers to MNEs. To the extent that multinational firms compete with domestic firms in the same sector, MNEs have an incentive to prevent the leakage of private technology and information. For this reason, evidence of positive *horizontal* spillovers is lacking.² However, it is to the benefit of the MNE if their intermediate input suppliers increase productivity and efficiency. Javorcik (2004) finds evidence consistent with positive *vertical* productivity spillovers from multinational firms to their domestic suppliers using data from Lithuanian plants. In contrast, Alfaro and Rodríguez-Clare (2004) account for the fact that multinational firms may not source inputs from local firms, but rather may import from the home country. With this in mind, they find little evidence of positive vertical spillovers created by backward linkages from multinational firms in Brazil, Chile, Mexico, and Venezuela.

There is evidence at the firm-level, however, for positive horizontal productivity spillovers in industrialized countries (e.g., see Haskel, Pereira and Slaughter (2004) for the United Kingdom and Keller and Yeaple (forthcoming) for the United States), suggesting host country characteristics, such as the level of education of the labor force and institutions, may play an important role in the ability of the country to absorb multinational spillovers. Cohen and Levinthal (1990) first argued that a skill set must be built up by domestic workers in order to implement foreign technologies. This *absorptive capacity* of a firm or an economy is necessary in order to recognize the value of new information and to integrate it into the current production process.³

Labor turnover Worker mobility is a commonly-cited mechanism for the transmission of multinational spillovers. Multinational corporations devote more resources to labor training than domestic firms (e.g., Lindsey (1986) and Gerschenberg (1987)). Under the

²The literature defines horizontal spillovers to be within-industry and vertical spillovers to be between-industry.

³Keller (1995) argues that the higher initial stock of human capital in Korea relative to Brazil prior to their respective trade-liberalizing experiences and faster Korean growth post-liberalization fits well with this argument. The theoretical model in Glass and Saggi (2002) predicts technology transfer will be greatest when the host domestic country is as developed as the source multinational country. Iranzo and Peri (forthcoming) attribute the positive externalities from college graduates in the United States to advanced technologies complementary to high-skilled workers.

assumption that this knowledge is not firm-specific, worker mobility can serve as a mechanism for domestic workers' and domestic firms' acquisition of externally-developed knowledge.⁴ Malchow-Moller, Markusen and Schjerning (2006) provide empirical support from Denmark for the hypothesis that workers with experience in a foreign-owned firm can transfer acquired skills from one job to the next. Using data from Colombia, Markusen and Trofimenko (2007) offer evidence to support the hypothesis that "experts" hired from abroad can transfer skills to domestic workers. In this paper, I combine these efforts and ask whether a worker with experience in a foreign-owned establishment transfers acquired skills to the domestic workers employed alongside him in his next job.

Though there is a large theoretical body of work on inter-firm worker mobility and knowledge transfer (e.g., Fosfuri, Motta and Ronde (2001), Cooper (2001), and Glass and Saggi (2002)), the existing empirical literature on spillovers through labor turnover is limited to small-sample survey data from a single industry. Gerschenberg (1987) surveyed 72 top- and middle-level managers from 41 manufacturing firms in Kenya. He finds that MNEs in Kenya provide more training for Kenyan managers than locally-owned firms and that labor mobility is lower for managers at multinational firms. He attributes this to the wage premium paid at most MNE firms. The sample in Gerschenberg (1987) includes 15 managers who moved from an MNE to a local firm, 4 managers who moved from an MNE to a joint-venture firm, and 9 managers who moved from an MNE to the public sector. The author concludes that the dissemination of managerial know-how is low.

With detailed firm-level data from a sample of 204 Ghanian manufacturing firms, Gorg and Strobl (2005) focus on the owners of domestic firms who were previously employed at a multinational. The authors investigate whether domestic firms which have entrepreneurs with foreign training have a productivity advantage compared to other firms. Out of the 204 domestic firms in the sample, owners of 13 firms have immediate prior experience working in foreign firms in the same industry, 9 have immediate prior experience working with foreign firms in different industries, and 14 received training provided by foreign firms. Gorg and

⁴In fact, it is not a necessary condition for multinational spillovers through worker mobility that multinational firms offer formal training. If MNEs adopt a new technology or process innovation not available to domestic firms, and workers at multinational firms learn-by-doing, on-the-job training is a sufficient condition for absorbing and transferring the technology.

Strobl (2005) find that firms whose owners once worked in MNEs in the same industry are more productive than similar domestic firms, while firms whose owners worked in MNEs in different industries have no productivity advantage. The authors argue that MNE knowledge, therefore, may be industry-specific.

Hale and Long (2006) find evidence that labor mobility facilitates multinational productivity spillovers using a sample of 1500 firms in China. In their study, the percentage of managers in domestic firms who have foreign firm experience is positively- and significantly-associated with FDI presence in the same industry-city cell, even after controlling for industry and city fixed effects. Moreover, the percentage of managers with foreign work experience is positively-associated with a firm's total factor productivity.

3 Empirical Methodology

The objective of this paper is to identify if multinational spillovers through worker mobility exist. In this paper, I go beyond the current literature to define wage spillovers at the worker level.

3.1 A conceptual framework for multinational spillovers

I define “spillovers” to be the relationship between an incumbent domestic worker's wages and the share of workers in the domestically-oriented establishment with some experience at a multinational establishment. The greater is the share of former multinational-establishment workers in the incumbent domestic worker's plant, the greater is the probability of some interaction, and the greater is the probability of a transfer of knowledge or technology. If positive multinational knowledge spillovers exist through worker turnover, I expect workers in plants with higher shares of former multinational-establishment workers to earn higher wages, all else equal.

While I am able to break down the black box that is the estimation of multinational spillovers to a large degree, some speculation remains. What exactly might be occurring inside the domestic-owned firm is beyond the scope of this paper and remains an open and fruitful question for future research. I highlight some possibilities as follows.

If firm performance and wages are linked (for example, through a simple assumption of rent-sharing or fair-wage compensation packages⁵), the wage outcomes for otherwise homogeneous workers may differ depending on the mix of workers within the establishment. Suppose for instance the newly-hired former-MNE worker enhances the organizational structure of the domestic-owned establishment, increasing firm productivity and profits, which are then transferred to incumbent domestic workers as higher wages. Similarly, the former-MNE worker may have knowledge about new physical capital, new process innovations, new intermediate inputs, or new export markets—all ways in which the establishment may increase productivity and profits, leading to higher wages for incumbent domestic workers. As not all former multinational-establishment workers will carry enhanced knowledge, or have the capacity to transfer enhanced knowledge, the higher is the share of MNE-switchers in the domestic establishment’s workforce, the higher is the probability of knowledge transfer.

By contrast, labor markets may also be competitive and pay workers their marginal product. Workers in globally-engaged firms are often more productive.⁶ The theory outlined in Antràs, Garciano and Rossi-Hansberg (2006) describes a scenario in which the wages of “southern” workers unambiguously increase post-globalization as they match with better “northern” managers as an enhanced match quality allows for an increase in the marginal productivity of all workers. Similarly, Mas and Moretti (2009) use data from cashier clerks at a local supermarket chain to investigate the impact of high productivity co-workers. They report that social norms outweigh any possible free-riding to suggest that having highly productive peers at work enhances the marginal productivity of existing workers. By the same token, individual interactions between the former-MNE worker and the incumbent domestic worker may help to transfer unobserved human capital, increasing the marginal productivity of the domestic worker. Once again, in any scenario, the higher is the share of former-MNE workers in the incumbent domestic worker’s establishment, the higher is the likelihood that any given incumbent domestic worker will interact (with a better manager, through social norms, or a direct transfer of human capital) with a former multinational-

⁵Models with imperfectly competitive labor markets include Akerlof and Yellen (1990) and the more recent application to international trade Helpman, Itskhoki and Redding (2008).

⁶See, for example, the pioneering work of Bernard and Jensen (1995).

establishment worker increasing his marginal productivity and wage.

3.2 An econometric model of multinational spillovers

My estimation procedure, therefore, derives from social interactions theory and allows an individual’s outcome to depend on the characteristics of the individual’s economic environment, the establishment in which she works.⁷ In particular, the approach allows an individual’s wage to be a function of a key establishment characteristic, the share of former multinational-establishment workers in the establishment, as follows:

$$\ln y_{ijt} = \gamma S_{jt} + \psi_i + \lambda_{j(i)} + \delta_t + \beta_1 X_{it} + \beta_2 Z_{jt} + \epsilon_{ijt}, \quad (3.1)$$

where i indexes the individual, j indexes the establishment, t indexes time, and $\ln y_{ijt}$ are individual-level log wages. S_{jt} refers to the share of the domestic-owned establishment’s workforce with experience in a multinational establishment. This variable is designed to capture the probability that an individual in the domestic-owned establishment interacts with a former multinational-establishment worker.

In an ideal setting, domestic firms would randomly draw new hires from the unemployed labor pool which includes former multinational-establishment workers, workers with experience at other domestic firms (but no experience at a multinational firm), and workers new to the labor force with no previous work experience. In the absence of such a randomization, one can imagine an experiment along the lines of Greenstone and Moretti (2003) and Greenstone, Hornbeck and Moretti (2008)⁸ to identify the exogenous variation in the establishment’s share of former multinational-establishment workers as a function of the availability of local displaced multinational-establishment workers—that is, workers displaced from an MNE located in the same municipality or state. However, this Greenstone and Moretti (2003)-type of local agglomeration experiment will not generate the establishment-level, time-varying characteristic necessary for this analysis, but rather, at best, a municipality-

⁷See Brock and Durlauf (2001b) and Manski (1993).

⁸Greenstone and Moretti (2003) and Greenstone et al. (2008) identify the productivity spillovers from “million-dollar plants” using information from a local real estate journal which identified not only the ultimate locations of the plant, but “runner-up” counties as well.

by-year characteristic of the availability of displaced former-MNE workers. Moreover, as demonstrated in the work by Aguayo-Tellez, Muendler and Poole (forthcoming), globalization acts on internal migration flows in Brazil as workers seek employment opportunities at locations with a concentration of foreign-owned enterprises. Therefore, it is arguable the local displaced MNE workforce is not a good approximation of the actual availability of former multinational-establishment workers to establishment j .

Instead, I exploit the differential effect of hiring decisions within the establishment—the differential effect of hiring an additional worker with multinational experience over an additional worker with no multinational experience. This estimation strategy serves two purposes. First, periods of establishment hiring may coincide with general periods of increased investment. Establishments hiring recently displaced multinational-establishment workers may be hiring displaced workers from other domestic-owned establishments as well. These growing establishments may also be increasing wages for all domestic workers. With this control, I can be sure to exclude any omitted variable bias for this reason. Second, if workers from other domestic-owned firms also bring with them outside knowledge or technology, or enhance the productivity of incumbent domestic workers, I do not want to attribute this “domestic spillover”—plausibly, a more general human capital spillover—to former multinational-establishment workers. For these reasons, I include a control for the share of recently-hired workers from other domestic-owned establishments in the establishment, as follows:

$$\ln y_{ijt} = \gamma_M S_{jt}^M + \gamma_D S_{jt}^D + \psi_i + \lambda_{j(i)} + \delta_t + \beta_1 X_{it} + \beta_2 Z_{jt} + \epsilon_{ijt}, \quad (3.2)$$

where S_{jt}^M refers to the previously-defined S_{jt} , the share of the domestic-owned establishment’s workforce with experience in a multinational establishment. I distinguish this term from S_{jt}^D , the share of the domestic-owned establishment’s workforce employed and displaced from another domestic-owned establishment (with no previous experience at a multinational establishment). In order to avoid any selection bias due to poaching, only workers who were laid-off from the previous employer are included as switchers in the analysis. These are presumably on-average low productivity workers and estimates are ultimately biased against

finding significant effects. It is for this reason I am comfortable to make the assumption that firms view all workers in the unemployed labor pool equally.⁹

Equation (3.2) is the basis for the estimation of the empirical results that follow. If positive multinational spillovers through worker mobility exist, I expect $\gamma_M > 0$ and $\gamma_M > \gamma_D$. The main concern in estimating the key coefficient γ_M in (3.2) is the presence of unobservable shocks to individual wages that are correlated with the share of former multinational-establishment workers in the domestic-owned establishment. Any positive correlation between S_{jt}^M and ϵ_{ijt} will result in overestimates of γ_M . A major advantage of using a panel of linked worker-establishment data is that I am able to control for many permanent and time-varying factors that may affect both wages and the overall hiring share. Specifically, I estimate a model that includes individual fixed effects (ψ_i), establishment fixed effects ($\lambda_{j(i)}$), time fixed effects (δ_t), time-varying, worker characteristics (X_{it}), such as age, experience, tenure at the establishment, education, and skill-intensity of occupation, and time-varying, establishment characteristics (Z_{jt}), such as log average establishment size, average establishment tenure, average establishment experience, average establishment education, and average skill-intensity of the occupations in the establishment.

Due to the inclusion of S_{jt}^D and the desire to ensure that the estimates measure pure spillover effects and not compositional effects, I restrict the data to the retained domestic workforce. Because the sample of workers is restricted to remain in the same establishment, individual fixed effects (ψ_i) fully absorb the establishment-specific effects ($\lambda_{j(i)}$) (Abowd, Kramarz and Margolis 1999). ψ_i captures unmeasured individual characteristics that do not change over time, such as unobserved ability and motivation, while $\lambda_{j(i)}$ captures unobserved, time-invariant establishment-level characteristics, such as unobserved productivity. δ_t captures general trends in wages that affect all workers, in particular related to Brazil's currency crisis in 1999. ϵ_{ijt} represents an error term that is assumed to be well-behaved, that is, to exhibit no serial correlation, and to be orthogonal to all regressors.

⁹Further details on the data construction process are available in appendix A.

4 Data

My main data source is a database of Brazilian formal-sector workers. I match key worker characteristics to a complementary data source on establishment-level foreign investment inflows.

4.1 Worker data

The worker data come from the Brazilian Labor Ministry (*Ministério do Trabalho e Emprego* (MTE)) which requires all formally-registered firms to report on all formally-employed workers in every year. The *Relação Anual de Informações Sociais* (RAIS) is an individual-level data set consisting of all workers for the years 1996 through 2001. The main variables of interest are the worker's identification code (*Programa de Integração* (PIS)),¹⁰ annual real wages in *reais*, job tenure in years, contracted hours of work, month and type of job accession, month and type of job separation, gender, nationality, age, educational attainment of the worker, the occupational classification of the worker (*Classificação Brasileira de Ocupações* (CBO)), the tax number of the worker's establishment (*Cadastro Nacional de Pessoa Jurídica* (CNPJ)), and the industrial classification of the worker's establishment (*Classificação Nacional de Atividades Econômicas* (CNAE)).

The RAIS worker data is particularly valuable to this research agenda as it offers variables beyond the available information in many other matched employer-employee databases. First, the industry classifications (CNAE) cover workers beyond the common manufacturing focus. Workers in the services and utilities industries, where much of the foreign investments flowed starting in 1996 are included in the database.¹¹ Next, RAIS has a depth of information

¹⁰A worker's ID remains with the worker throughout his work history. The process for establishments to report on their workers is extensive and costly. However, PIS records are used to administer payment of the annual public wage supplements to every formally-employed worker, thus creating a strong incentive for workers to urge their employers to report accurately.

¹¹The data include workers in all private sectors of the economy: agriculture, commerce, construction, manufacturing, and services. For this study, sectors are classified into 2-digit CNAE sectors. I exclude 7 2-digit sectors from the analysis: Manufacture of furniture, manufacture not elsewhere classified (36); Other business activities (74); Public administration and defense, compulsory social security (75); Activities of membership organizations (91); Recreational, cultural, and sporting activities (92); Other Service Activities (93); and Activities of households as employers of domestic staff (95). For some levels of analysis, I further aggregate the data into the three major sectors: primary, manufacturing, and services. Primary includes 2-digit CNAE codes 1-14; manufacturing includes 2-digit CNAE codes 15-37; and services includes 2-digit

on the cause of job separation, as well as a worker's tenure at the establishment and detailed skills (as defined by occupation and education) which are paramount to the analysis.

The main advantage of the RAIS database is the ability to trace individual workers in establishments over time by worker identification codes and establishment tax numbers, respectively. I restrict observations as follows. First, only workers with correct eleven-digit worker identification numbers are included.¹² Next, the sample includes only full-time, prime-age workers; that is, workers between the ages of 15 and 64 years¹³ who work at least 40 contracted hours per week. Following Abowd et al. (1999), I restrict the set of workers to only those workers receiving positive wages in a private sector job. Finally, for workers with multiple jobs within the same establishment in a given year, only the most recent job is included in the sample. If a worker has multiple current jobs, only the highest paying job is included.¹⁴

Muendler, Poole, Ramey and Wajenberg (2004) map the CBO to the *International Standard Classification of Occupations* (ISCO-88). The CBO-94 is a detailed, task-oriented classification system, while ISCO-88 reflects a less-detailed and more skill-oriented classification system. The skill classification is intended to incorporate on-the-job experience, informal training, and the technological skill content of the occupation.¹⁵ The ISCO occupations are then grouped into four broad occupational categories following Abowd, Kramarz, Margolis and Troske (2001). I consider these occupational categories to reflect the skill-intensity of the occupation. Table B.1 in appendix B presents the breakdown of the skill-intensity of occupations by major ISCO occupational grouping.

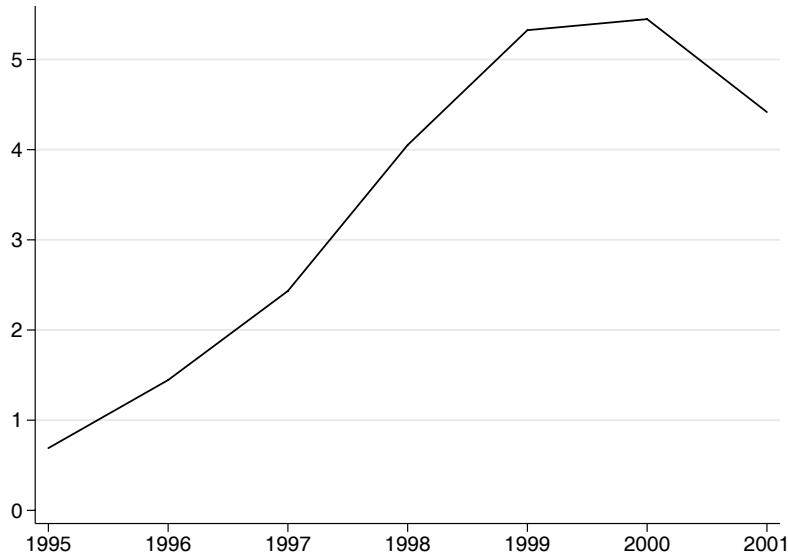
CNAE codes 40-90.

¹²Eleven digits is the traditional length of the social security number in Brazil. Firms that report false identification numbers are either reporting informal workers or the data are more likely to have measurement error due to faulty bookkeeping.

¹³The legal working age in Brazil is 16 years of age. Before the social security reform of 1999, the earliest retirement age for women and men in Brazil was 55 and 60, respectively.

¹⁴There is high turnover within establishments within a year in part due to a Brazilian labor law (*Fundo de Garantia de Tempo de Serviço* (FGTS)) in which formally-employed workers may receive a guaranteed fund upon termination. This fund is filled by the employer in monthly contributions and subsidized by the government. It is meant to serve both as unemployment insurance upon layoff and as a social security payment at retirement.

¹⁵Created by the International Labor Organization, the ISCO is ideal for developing and industrialized cross-country comparisons. See Elias and Birch (1994) for more information on the skill classification of the ISCO.



Source: World Bank, 2005.

Figure 4.1: Foreign Direct Investment Inflows as Percentage of GDP, 1995-2001

4.2 Foreign direct investment in Brazil

Figure 4.1 shows foreign direct investment inflows as a percentage of GDP for the Brazilian economy from 1995 to 2001. Direct investments increased significantly beginning in 1996, and more than quadrupled by 2001.¹⁶ There is also considerable variation in the amount of foreign investment across sectors. In 1995, the total stock of foreign investment in Brazil was US\$116 billion, with 65 percent in manufacturing, 31 percent in services, and 4 percent in agricultural industries. Starting in 1996, the scope of foreign investment shifted towards the service sectors in part due to the government's privatization of many public services (Rodrigues (2000)). Table 4.1 documents the variation across major sectors and the rise in foreign investment inflows to the services sector. Between 1996 and 2001, 73 percent of foreign investments flowed to service sectors, 24 percent flowed to manufacturing sectors, and just 3 percent to primary sectors. The telecommunications, banking, and electricity sectors, which underwent large-scale privatizations, received the largest flows of foreign funds.

Foreign Investment Data By law, all foreign investments are registered with the Central Bank of Brazil (*Banco Central do Brasil*, BCB) in its *Registro Declaratório Eletrônico*—

¹⁶Appendix C offers a detailed description of the policy reforms in Brazil that contributed to the marked increases in investment inflows.

Table 4.1: Foreign Direct Investment Inflows, 1996-2001

| | Average | Standard Deviation | Minimum | Maximum |
|---------------|---------|--------------------|---------|---------|
| Services | 584.6 | 1,183.7 | 0.1 | 4,528.6 |
| Manufacturing | 192.8 | 272.5 | 3.2 | 985.0 |
| Primary | 78.0 | 134.1 | 0.0 | 370.2 |
| All Sectors | 346.0 | 816.9 | 0.0 | 4,528.6 |

Note: Inflows data are expressed in US\$ millions. Statistics are calculated across 2-digit CNAE sectors within services, manufacturing, and primary. Services includes 2-digit CNAE codes 40-90, manufacturing includes 2-digit CNAE codes 15-37, and primary includes 2-digit CNAE codes 1-14.

Source: BCB, 1996-2001.

Investimentos Externos Diretos (RDE-IED). These establishment level data are not publicly available, but the BCB made available portions of the RDE-IED for the years 1996 through 2001 for the purpose of this research, including information on both flows and stocks of foreign investment. The data include: first, a list of all establishments (CNPJ tax numbers) with a positive inflow of FDI for the years 1996 through 2001; and second, a list of all establishments (CNPJ tax numbers) with a positive stock of foreign capital in the year 2001. Lacking direct information on an establishment's FDI stock by year, these data allow for a procedure to infer with considerable confidence which establishments are at least partially foreign-owned in a given year between 1996 and 2001.

I define an establishment to be at least partly *foreign-owned* in year t if the establishment received an inflow of foreign capital in year t . I note that establishments receiving inflows of foreign capital in year t may maintain a stock of foreign capital in later years. Therefore, establishments with a positive stock of foreign capital in 2001 are classified as foreign-owned in all years $\tau \geq t$ after the initially observed inflow at year t , even if no inflow is observed in the intervening years. If I observe no FDI inflow to an establishment but an FDI stock in 2001, I consider the establishment foreign-owned for the entire sample period. Conversely, if I observe no foreign ownership in 2001, I assign the year with the last FDI inflow as the final year of foreign ownership.¹⁷

¹⁷Consider the following examples. An establishment with foreign investment inflows in 1997 and 1998 and a stock of foreign capital in 2001 is classified as a foreign-owned establishment for the years 1997 through 2001. If an establishment with foreign inflows in 1997 and 1998 records no stock of foreign capital by 2001, the establishment is classified as foreign-owned for 1997 and 1998 only. Finally, an establishment with a positive stock of foreign investment in 2001, but without any recorded inflows over the period 1996 to 2001, is classified as foreign-owned for the years 1996 to 2001.

Table 4.2: Multinational Share, 1996-2001

| | Average | Standard Deviation | Minimum | Maximum |
|---------------|---------|-----------------------|---------|---------|
| Services | 0.0070 | 0.0064 | 0.0003 | 0.0193 |
| Manufacturing | 0.0181 | 0.0147 | 0.0006 | 0.0483 |
| Primary | 0.0289 | 0.0415 | 0.0013 | 0.0971 |
| All Sectors | 0.0148 | 0.0193 | 0.0003 | 0.0971 |

Note: The multinational share in the sector is defined to be the number of multinational establishments as a share of total establishments in the sector. Statistics are calculated across 2-digit CNAE sectors within services, manufacturing, and primary. Services includes 2-digit CNAE codes 40-90, manufacturing includes 2-digit CNAE codes 15-37, and primary includes 2-digit CNAE codes 1-14.

Sources: RAIS, RDE-IED, 1996-2001.

The main concerns are establishments without any recorded inflows of foreign investment and no stock of foreign capital in 2001. By my definition, these are considered domestically-owned enterprises. So, I may miss foreign-owned establishments if there was an initial inflow of foreign capital before the sample period and a full divestiture at some point during the sample period. Note, however, that retained earnings are inflows under common FDI definitions so that inflows are likely to be observed in every year of foreign ownership. Nevertheless, missing some (partly) foreign-owned establishments moves the odds of detecting a statistically-significant effect of foreign ownership against me and potentially weakens later results.

I consider partial foreign ownership of a holding company to affect all establishments of the corporate group. Using BCB information on the corporate ownership relations among Brazilian firms, I count an establishment as at least partly foreign-owned in year t if it is a subsidiary of a foreign-owned enterprise.

Table 4.2 presents a summary of the share of foreign-owned establishments for each 2-digit CNAE sector in my sample. As a share of the number of establishments in the sector, the health and social work and education service sectors have the smallest multinational shares, 0.03 and 0.04 percent, respectively, while almost 10 percent of the establishments in the metal mining industry received foreign investment inflows between 1996 and 2001 according to RDE-IED.

The data are matched by establishment tax number to the RAIS worker data for the first time in this research. I define an indicator variable equal to one if and only if a worker holds a job at a foreign-owned establishment. Workers employed at foreign-owned

establishments are hereafter referred to as “multinational-establishment workers”, while workers employed at domestic-owned establishments are hereafter referred to as “domestic-establishment workers”. The matched RAIS-RDE-IED data traces workers who “switch” between foreign-owned and domestic-owned establishments. I call workers displaced from multinational establishments and rehired in domestic establishments “MNE switchers”. The sample includes 205,465 domestic establishments hiring 1,626,105 MNE switchers from 13,009 multinational establishments over the period 1996 to 2001.¹⁸

4.3 Descriptive statistics

Given that this is a new database for empirical analysis, in this section, I present statistics that describe the MNE-switcher workers, the domestic-owned establishments that hire them, and the incumbent domestic-establishment workforce.¹⁹

National Data First, I offer statistics from a nationally-representative sample of workers by major industrial sector.²⁰ Table 4.3 displays average worker characteristics for the Brazilian labor force. Between 1996 and 2001, the average worker earned approximately 4,024 *reais* per year (approximately US\$2,000 at current exchange rates). The worker is early in his career at 33 years of age. Approximately 26 percent of the labor force is female. Fifty-seven percent of the formal-sector labor force have a primary school education, close to 30 percent have a high school diploma, and just over 13 percent have a college degree. The majority of workers in Brazil are skilled blue collar workers (43 percent), while almost 12 percent of workers are unskilled blue collar workers, 13 percent are other white collar workers, and 30 percent are professional and technical workers.

The services sector pays a wage 0.1 percent higher than average, employs older workers, and employs more women. Workers in the services sector are more skilled than the national average, by measures of education and the skill-intensity of the occupation. The

¹⁸For some parts of the analysis that follows, I draw a 10 percent random sample of the domestic workers employed at the 205,465 domestic establishments hiring MNE-switchers.

¹⁹Please see appendix A for a complete description of the data construction.

²⁰Statistics are calculated across 2-digit CNAE sectors within services, manufacturing, and primary. Services includes 2-digit CNAE codes 40-90, manufacturing includes 2-digit CNAE codes 15-37, and primary includes 2-digit CNAE codes 1-14. Detailed data are available by request from the author.

Table 4.3: National Worker Characteristics, 1996-2001

| | Services | Manufacturing | Primary | All Sectors |
|-------------------------------|----------|---------------|---------|-------------|
| Ave. Wage (in logs) | 8.4 | 8.2 | 8.2 | 8.3 |
| Ave. Age (in years) | 34 | 32 | 35 | 33 |
| Percent Female | 0.311 | 0.260 | 0.096 | 0.260 |
| <i>Share of Workers with:</i> | | | | |
| Primary School | 0.455 | 0.626 | 0.744 | 0.568 |
| High School | 0.346 | 0.285 | 0.187 | 0.298 |
| College Degree | 0.198 | 0.088 | 0.067 | 0.132 |
| <i>Share of Workers:</i> | | | | |
| Unskilled Blue Collar | 0.122 | 0.100 | 0.142 | 0.115 |
| Skilled Blue Collar | 0.198 | 0.612 | 0.599 | 0.431 |
| Other White Collar | 0.221 | 0.071 | 0.045 | 0.132 |
| Professional & Technical | 0.442 | 0.197 | 0.187 | 0.301 |

Note: Statistics are calculated across 2-digit CNAE sectors within services, manufacturing, and primary. Services includes 2-digit CNAE codes 40-90, manufacturing includes 2-digit CNAE codes 15-37, and primary includes 2-digit CNAE codes 1-14. Source: RAIS, 1 percent random sample, 1996-2001.

manufacturing sector pays 0.1 percent less than the national average and employs workers on average one year younger. Workers in the manufacturing sector are less skilled than the national average, by both measures of skill. The primary sector pays 0.1 percent less than the national average, employs older workers, and fewer women. Workers in the primary sector are also less skilled than the national average, by measures of education and the skill-intensity of the occupation.

Former Multinational-Establishment Workers Table 4.4 presents the same statistics for the set of MNE-switcher workers, post-switch, by major industrial sector. The average wage of a switcher worker for the period 1996 to 2001 was 0.3 percent higher than the national average. This wage differential is most significant in the manufacturing and services sectors, where MNE switchers earn, on average, 0.4 percent higher than the average national worker in the sector. The higher wages may reflect the wage premium often paid by MNEs (e.g., Gerschenberg (1987) and Lipsey (2004)). However, it is clear that this wage differential does not reflect the complete skill differential. Across all sectors, former multinational-establishment workers are relatively higher-skilled, as defined by education and occupation, than the average national worker. Given the evidence in the literature on the high-skill-

Table 4.4: Former Multinational-Establishment Worker Characteristics, 1996-2001

| | Services | Manufacturing | Primary | All Sectors |
|-------------------------------|----------|---------------|---------|-------------|
| Ave. Wage (in logs) | 8.8 | 8.6 | 8.4 | 8.6 |
| Ave. Age (in years) | 33 | 33 | 34 | 33 |
| Percent Female | 0.262 | 0.225 | 0.068 | 0.219 |
| <i>Share of Workers with:</i> | | | | |
| Primary School | 0.313 | 0.455 | 0.651 | 0.421 |
| High School | 0.346 | 0.351 | 0.224 | 0.332 |
| College Degree | 0.330 | 0.194 | 0.125 | 0.243 |
| <i>Share of Workers:</i> | | | | |
| Unskilled Blue Collar | 0.091 | 0.100 | 0.128 | 0.100 |
| Skilled Blue Collar | 0.191 | 0.534 | 0.606 | 0.396 |
| Other White Collar | 0.197 | 0.073 | 0.036 | 0.121 |
| Professional & Technical | 0.501 | 0.276 | 0.216 | 0.365 |
| MNE Switcher Share | 0.019 | 0.026 | 0.023 | 0.023 |

Note: The MNE switcher share in the sector is defined as the number of MNE switchers hired by the establishment as a share of the establishment workforce. Statistics are calculated across 2-digit CNAE sectors within services, manufacturing, and primary. Services includes 2-digit CNAE codes 40-90, manufacturing includes 2-digit CNAE codes 15-37, and primary includes 2-digit CNAE codes 1-14.

Sources: RAIS, RDE-IED, 1996-2001.

intensity of MNEs, it is not surprising that workers displaced from MNEs are relatively higher skilled. The combination of these pieces of evidence reflect a common finding in the labor economics literature of earnings losses for displaced workers (Jacobson, LaLonde and Sullivan (1993) and Kletzer (1998)). Workers displaced from foreign-owned establishments and rehired by domestic-owned establishments are, on average, in their early careers, no different from the national average. Switchers are less likely to be female.

Across all sectors, 2.3 percent of the workforce switched from a multinational to a domestic establishment during the period 1996 to 2001. The switcher share, defined to be the number of MNE switchers hired by each establishment as a share of the establishment workforce, is highest in the manufacturing sector at 2.6 percent. Almost 2.0 percent of workers in the services sector switched from a multinational to a domestic establishment during the period 1996 to 2001, while 2.3 percent of workers in the primary sector have experience in a foreign-owned establishment.

Table 4.5: Domestic-Owned Establishments Hiring Switchers, 1996-2001

| | Services | Manufacturing | Primary | All Sectors |
|-------------------------------|----------|---------------|---------|-------------|
| Ave. Wage (in logs) | 8.6 | 8.4 | 8.3 | 8.5 |
| Percent Female | 0.319 | 0.254 | 0.096 | 0.260 |
| <i>Share of Workers with:</i> | | | | |
| Primary School | 0.402 | 0.593 | 0.713 | 0.527 |
| High School | 0.371 | 0.305 | 0.211 | 0.320 |
| College Degree | 0.227 | 0.102 | 0.076 | 0.153 |
| <i>Share of Workers:</i> | | | | |
| Unskilled Blue Collar | 0.114 | 0.098 | 0.148 | 0.112 |
| Skilled Blue Collar | 0.187 | 0.559 | 0.580 | 0.401 |
| Other White Collar | 0.213 | 0.081 | 0.057 | 0.134 |
| Professional & Technical | 0.472 | 0.237 | 0.194 | 0.332 |
| Ave. Establishment Size | 145.3 | 143.6 | 163.0 | 147.0 |

Note: Statistics are calculated across 2-digit CNAE sectors within services, manufacturing, and primary. Services includes 2-digit CNAE codes 40-90, manufacturing includes 2-digit CNAE codes 15-37, and primary includes 2-digit CNAE codes 1-14. Source: RAIS, 1996-2001.

Table 4.6: Domestic-Owned Establishments Not Hiring Switchers, 1996-2001

| | Services | Manufacturing | Primary | All Sectors |
|-------------------------------|----------|---------------|---------|-------------|
| Ave. Wage (in logs) | 8.2 | 8.0 | 7.9 | 8.1 |
| Percent Female | 0.342 | 0.262 | 0.116 | 0.276 |
| <i>Share of Workers with:</i> | | | | |
| Primary School | 0.472 | 0.684 | 0.780 | 0.606 |
| High School | 0.383 | 0.258 | 0.157 | 0.298 |
| College Degree | 0.143 | 0.056 | 0.060 | 0.094 |
| <i>Share of Workers:</i> | | | | |
| Unskilled Blue Collar | 0.116 | 0.105 | 0.184 | 0.120 |
| Skilled Blue Collar | 0.207 | 0.580 | 0.524 | 0.411 |
| Other White Collar | 0.226 | 0.076 | 0.074 | 0.140 |
| Professional & Technical | 0.435 | 0.207 | 0.190 | 0.303 |
| Ave. Establishment Size | 29.9 | 35.7 | 38.5 | 33.6 |

Note: Statistics are calculated across 2-digit CNAE sectors within services, manufacturing, and primary. Services includes 2-digit CNAE codes 40-90, manufacturing includes 2-digit CNAE codes 15-37, and primary includes 2-digit CNAE codes 1-14. Source: RAIS, 1996-2001.

Domestic-Owned Establishments Table 4.5 reports statistics across domestic-owned establishments that hire the MNE switchers. Here, the appropriate comparison group is the set of domestic-owned establishments that did not hire any MNE switchers. Descriptive

statistics for these establishments are reported in table 4.6 that follows.

Domestic-owned establishments hiring former multinational-establishment workers pay average wages 0.4 percent higher than establishments which did not hire switcher workers. Similarly, the average establishment size, as measured by the number of workers, is greater, across all sectors, for establishments hiring switcher workers than for establishments not hiring a single MNE switcher. The extensive literature documenting the employer-size wage premium may explain the wage differentials between these establishment types (Brown and Medoff (1989)). Domestic-owned establishments hiring switchers and domestic-owned establishments not hiring switchers do not otherwise appear to be systematically different by measures of gender composition and the skill sets of the workforce.

The availability of the matched establishment-employee database allows me to control for these important observable establishment-level characteristics in the estimation of multinational spillovers through worker mobility. Furthermore, if there are unobservable characteristics underlying these observable differences, the estimation method proposed in section 3 will control for these unobservable differences through the establishment fixed effects nested within the worker fixed effects.

Incumbent Domestic-Establishment Workers Descriptive statistics on the incumbent domestic-establishment workforce in the domestic-owned establishments hiring MNE switchers are reported in table 4.7. The incumbent domestic-establishment worker earned 0.1 percent more than the average national worker, across all sectors, during the period 1996 to 2001. This wage differential carries to the manufacturing and services sectors, but the average incumbent domestic-establishment worker earned equally much, on average, as the average national worker in the primary sector. With respect to MNE-switcher workers, however, the incumbent domestic-establishment workforce earned 0.2 percent less over the 1996 to 2001 period, suggesting switcher workers find themselves in the top of the hiring establishment's wage distribution. I will exclude all switcher workers from the multinational spillovers regression on incumbent domestic-establishment workers' wages in order to ensure the analysis measures pure spillovers effects and not compositional effects.

The incumbent domestic-establishment worker is, on average, one year older than the

Table 4.7: Incumbent Domestic-Establishment Worker Characteristics, 1996-2001

| | Services | Manufacturing | Primary | All Sectors |
|-------------------------------|----------|---------------|---------|-------------|
| Ave. Wage (in logs) | 8.5 | 8.3 | 8.2 | 8.4 |
| Ave. Age (in years) | 35 | 33 | 36 | 34 |
| Percent Female | 0.316 | 0.272 | 0.137 | 0.272 |
| <i>Share of Workers with:</i> | | | | |
| Primary School | 0.456 | 0.646 | 0.711 | 0.573 |
| High School | 0.346 | 0.272 | 0.207 | 0.295 |
| College Degree | 0.198 | 0.082 | 0.081 | 0.132 |
| <i>Share of Workers:</i> | | | | |
| Unskilled Blue Collar | 0.124 | 0.093 | 0.132 | 0.112 |
| Skilled Blue Collar | 0.188 | 0.621 | 0.568 | 0.427 |
| Other White Collar | 0.215 | 0.071 | 0.062 | 0.132 |
| Professional & Technical | 0.460 | 0.198 | 0.222 | 0.314 |

Note: Statistics are calculated across 2-digit CNAE sectors within services, manufacturing, and primary. Services includes 2-digit CNAE codes 40-90, manufacturing includes 2-digit CNAE codes 15-37, and primary includes 2-digit CNAE codes 1-14. Source: RAIS, 1996-2001.

national-average worker, while the MNE switcher workers are younger than the incumbent domestic-establishment workforce. The workers in domestic establishments hiring switchers in the primary sector are more likely to be female than the national-average worker in a primary sector establishment. Otherwise, the incumbent domestic-establishment workforce appears similar in terms of gender composition to the national sample. However, as I mentioned in the previous section, MNE-switcher workers are more likely to be male. Therefore, the incumbent domestic-establishment workforce appears disproportionately female with respect to this group. Similarly, incumbent domestic-establishment workers in hiring domestic establishments mirror the skill composition of the national sample, while they are relatively less skilled than MNE-switcher workers. Switcher workers, on average, are among the top of the hiring establishment's skill distribution, when skill is measured by both education and occupation.

Share of Former Multinational-Establishment Workers Table 4.8 reports descriptive statistics for the main variable of interest, the share of former multinational-establishment workers, S_{jt}^M .²¹ Consistent with the evidence presented in table 4.2, workers in the

²¹A detailed listing of the average shares of former multinational-establishment workers by 2-digit CNAE sector is reported in tables 5.2 and 5.3.

Table 4.8: Share of Former Multinational-Establishment Workers, 1996-2001

| | Average | Standard Deviation | Minimum | Maximum |
|---------------|---------|-----------------------|---------|---------|
| Services | 0.019 | 0.010 | 0.006 | 0.045 |
| Manufacturing | 0.026 | 0.021 | 0.008 | 0.109 |
| Primary | 0.023 | 0.017 | 0.007 | 0.049 |
| All Sectors | 0.023 | 0.017 | 0.006 | 0.109 |

Note: The share of former multinational-establishment workers in an establishment is defined as the number of MNE switchers as a share of the establishment workforce. Statistics are calculated across 2-digit CNAE sectors within services, manufacturing, and primary. Services includes 2-digit CNAE codes 40-90, manufacturing includes 2-digit CNAE codes 15-37, and primary includes 2-digit CNAE codes 1-14.

Source: RAIS, 1996-2001.

manufacturing and primary sectors most often have experience in a foreign-owned establishment.

Almost three percent of workers in domestic-owned establishments in the manufacturing sector and 2.3 percent of workers in domestic-owned establishments in the primary sector were once employed at a foreign-owned establishment, while only 1.9 percent of domestic-establishment workers in the services sector have some foreign experience. On average, domestic-owned establishments in the tobacco manufacturing sector have the largest foreign presence in their workforces (10.9 percent), while domestic-owned establishments in the education and health services sectors have the least foreign presence in their workforces (0.6 percent).

5 Estimation of Multinational Spillovers

The final matched worker-establishment database includes the full employment history of incumbent domestic-establishment workers in domestically-owned formally-registered establishments in Brazil from 1996 through 2001. Because the sample is limited to domestically-owned establishments and their employees, it is not subject to the endogeneity problem inherent to many studies of multinational spillovers that occurs when comparing foreign and domestic firms and workers.

Recall from section 3 the main empirical specification:

$$\ln y_{ijt} = \gamma_M S_{jt}^M + \gamma_D S_{jt}^D + \psi_i + \lambda_{j(i)} + \delta_t + \beta_1 X_{it} + \beta_2 Z_{jt} + \epsilon_{ijt}.$$

where S_{jt}^M refers to the share of the domestic-owned establishment’s workforce with experience in a multinational establishment and S_{jt}^D measures the share of the domestic-owned establishment’s workforce employed and displaced from another domestic-owned establishment (and no experience in a multinational enterprise). If positive multinational spillovers through worker mobility exist, I expect $\gamma_M > 0$ and $\gamma_M > \gamma_D$. Identification in this model, then, is based on changes over time in the share of former multinational-establishment workers within an establishment for each worker. The issue of what determines the establishment’s hiring choice is mitigated as the coefficient of interest measures the differential effect of hiring an additional worker with multinational experience over an additional worker with no multinational experience.

Other covariates include a vector of time-varying individual-specific characteristics, X_{it} , and a vector of time-varying establishment-specific characteristics, Z_{jt} . The individual characteristics²² include age, age-squared, experience, experience-squared, tenure at the establishment, education,²³ and the skill-intensity of occupation.²⁴ The establishment characteristics include log average establishment size, average age of the workforce,²⁵ average tenure of the workforce, average experience of the workforce, share of the establishment female, average education of the workforce,²⁶ and average skill-intensity of occupation.²⁷

5.1 Main results

Table 5.1 presents results from the estimation of worker-level multinational spillovers with individual, establishment, and annual fixed effects, unless otherwise indicated. For this analysis, I draw a ten percent random sample of the incumbent domestic-establishment workforce across all sectors. I report the coefficient difference for $\gamma_M - \gamma_D$ as the multinational

²²Because I include individual fixed effects, variables that do not change over time such as gender and nationality are not included.

²³Education enters into the equation as 3 dummies; primary school, high school, and college graduate (primary school is the omitted category).

²⁴Skill-intensity of occupation enters into the equation as 4 dummies; unskilled blue collar, skilled blue collar, other white collar, and professional (unskilled blue collar is the omitted category).

²⁵Age enters as 7 shares; share of the establishment aged child (10-14 years), youth (15-17 years), adolescent (18-24 years), nascent career (25-29 years), early career (30-39 years), peak career (40-49 years), late career (50-64 years), and post retirement (65 years or older).

²⁶Education enters as 3 shares; share of the establishment with primary school, high school, and college.

²⁷Skill-intensity of occupation enters as 4 shares; share of the establishment working as an unskilled blue collar worker, skilled blue collar worker, other white collar worker, and professional worker.

Table 5.1: Multinational Spillovers, 1996-2001

| Dep. Variable: Log Annual Wages | (1) | (2) | (3) | (4) | (5) |
|---------------------------------|---------------------|---------------------|--------------------|--------------------|--------------------|
| $\gamma_M - \gamma_D$ | 0.977** | 1.071** | -0.025 | 0.075** | 0.077** |
| <i>F-statistic</i> | 15.29 | 75.87 | 1.00 | 10.38 | 13.10 |
| <i>p-value</i> | 0.0001 | 0.0000 | 0.3183 | 0.0013 | 0.0003 |
| γ_M | 0.443* (0.183) | 0.561** (0.106) | 0.033** (0.013) | 0.085** (0.016) | 0.073** (0.015) |
| γ_D | -0.535** (0.105) | -0.510** (0.044) | 0.058** (0.022) | 0.010 (0.017) | -0.004 (0.015) |
| Average Establishment Wages | | | | | 0.220** (0.017) |
| Individual Fixed Effects | NO | NO | NO | YES | YES |
| Establishment Fixed Effects | NO | NO | YES | YES | YES |
| Time Fixed Effects | NO | YES | YES | YES | YES |
| Number of Observations | 450,842 | 2,634,947 | 2,634,947 | 2,634,947 | 2,629,404 |
| Overall R-squared | 0.5483 | 0.5403 | 0.3948 | 0.2658 | 0.5181 |

Note: Robust standard errors, clustered at the establishment-level, are in parentheses. ** denotes significance at 1 percent level; * denotes significance at 5 percent level. See section 5 for other independent variables included in the estimation (not reported here).

Source: RAIS, 10 percent random sample, 1996-2001.

spillover effect and the accompanying *F-statistic* and *p-value* for the null hypothesis of a zero difference, as well as the separate γ_M and γ_D coefficients. All other independent variables that are included in the analysis are listed in the previous section. In order to precisely estimate both γ_M and γ_D , I cluster the robust standard errors at the establishment-level.²⁸

In column (1), I present the cross-sectional analysis for the year 2000. The results are consistent with multinational spillovers though without establishment and individual fixed effects, the result is difficult to interpret. In column (2), I bring in the full panel of data and allow for time series variation. The large, positive effects in columns (1) and (2) resemble the early generations of work on knowledge spillovers from multinational enterprises (e.g., Blomstrom and Kokko (1998) and the references therein). I include establishment fixed effects in column (3), which control for any fixed factor that may affect an establishment's decision to hire former multinational-establishment workers, such as management style. As was found in the third generation of studies on multinational spillovers (e.g., Aitken and

²⁸Moulton (1990) points out that because observations are at the worker-level, yet the main variable of interest varies by establishment, standard errors may be underestimated. Furthermore, Bertrand, Duflo and Mullainathan (2004) find that serial correlation of the errors can also be a problem.

Harrison (1999)), the differential effect of hiring former multinational-establishment workers over other domestic hires no longer has a positive effect on incumbent workers' wages. This is the only specification for which the precisely-estimated γ_M is less than γ_D . That the coefficient on γ_M falls between columns (2) and (3) suggests that omitting the establishment fixed effect (what might be considered to be the omitted variable bias for the establishment fixed effect) has a large and positive effect. This is consistent with the evidence presented in the descriptive statistics section—on average, establishments with higher shares of former multinational-establishment workers are also higher-wage establishments.

Column (4) also includes individual fixed effects, in order to control for any unobservable individual characteristics, such as motivation or ability that may determine an individual's wages. It is clear that incumbent domestic workers are not randomly assigned to the establishments in which they work. Even after considering individual fixed effects, workers' wages increase with the proportion of co-workers in their establishment who have experience in foreign-owned establishments ($\gamma_M - \gamma_D$ is significantly different from zero). The increase in the coefficient on γ_M between columns (3) and (4) suggests that the omitted variable bias for the worker fixed effect is large, but negative. This result foreshadows those to come—lower-earning individuals learn more.

In the final column, I test the inclusion of an additional time-varying establishment-level variable, average establishment wages. Ideally, my specification would include all possible time-varying, establishment-level variables so as to capture all possible establishment-level shocks. I test the inclusion of this variable separately given the so-called reflection problem discussed in Manski (1993)—in this setting, that the individual's wage may influence the average establishment wage. The main result in column (5) shows that including average establishment wages changes the result minimally and only serves to increase the explanatory power of the regression.²⁹

In my most preferred and robust specification in column (4), a one percentage-point increase in the share of former multinational-establishment workers in a domestic-owned establishment, holding the share of non-MNE switcher workers constant, increases an

²⁹The Manski (1993) criticism is less-pronounced in the current set-up as average establishment wages are generated for all workers in establishment j in year t , while the analysis focuses solely on a subset of workers in the establishment.

incumbent worker’s wages by approximately 0.1 percent. To help interpret the magnitude of the coefficient, consider that the average change in the share of former multinational-establishment workers between 1996 and 2001 was about one percentage-point per year.

At the wage for the national average worker discussed in the descriptive statistics section 4.3, this is an increase of approximately \$2 per year per worker—an admittedly small impact. However, I will argue that while small, it is also an appropriately-sized impact. First, the estimates are at the worker-level, and not at the firm-level as in previous studies (for instance, Keller and Yeaple (forthcoming)). For this reason, the impact is spread over a wider population. Considering the approximate 80 million formal-sector workers in Brazil, the transfer of knowledge may potentially reach \$160 million per year—0.025% of Brazil’s GDP in the year 2000. Second, as noted previously, the estimates should be considered lower-bounds. I focus the estimation on MNE-switcher workers displaced from the multinational establishment. These are presumably lower productivity workers, less able to transfer knowledge and technology to the domestic firm.³⁰

5.2 Multinational spillovers by sector

In the previous section, I presented evidence consistent with the existence of positive multinational spillovers through worker turnover for the economy. In this section, I ask which sectors account for the multinational spillovers. The theory of social interactions considers the transfer of information between individuals as an important element. So, we may expect that higher-skilled individuals are better suited to transfer information. As such, high-skill intensive sectors, as defined by the share of the workforce with a minimum high school diploma, may be expected to experience larger multinational spillovers.

Tables 5.2 and 5.3 present results from the estimation of worker-level multinational spillovers with individual, establishment, and annual fixed effects. Each row represents a unique individual-level regression as in equation (3.2) by 2-digit CNAE sector. I report

³⁰Similarly, many of Brazil’s foreign investment inflows were in the form of privatizations, for which there is no reason to believe workers have special skills to transfer. Also, as mentioned in the section describing the FDI data, misclassifying partially foreign-owned enterprises as domestically-owned may also bias results against my favor.

the coefficient for $\gamma_M - \gamma_D$, as well as the individual coefficients.³¹ All other independent variables that are included in the analysis are listed in the introduction to this section. As in the previous analysis, robust standard errors are clustered at the establishment-level. I report the skill-intensity of the sector and the average share of former multinational-establishment workers across domestic-owned establishments in the sector alongside the regression results. I sort the results by the skill-intensity of the sector.

In general, the results present strong evidence for the existence of wage gains as a result of increased multinational presence in the establishment, even after controlling for the general hiring trends of the establishment. In 6 of the 51 2-digit CNAE sectors analyzed, the differential effect of the share of MNE-switcher workers in the establishment beyond the effect of non-MNE switcher workers in the establishment is positively and statistically significantly associated with an incumbent domestic worker's wages.

There is considerable variation in the magnitude of the wage spillovers from multinational establishments depending on the sector under consideration. Among the highest skill quintile, only the education sector exhibits a statistically significant positive correlation between the multinational presence in the establishment and incumbent workers' wages. For incumbent workers in this sector, a one percentage-point increase in the share of former multinational-establishment workers, all else equal, increases wages by 0.2 percent. Positive multinational spillovers, however, are not specific to the services sector where much of the foreign investment flowed since 1996. Workers in the radio and television equipment manufacturing sector also experience wage increases of 0.4 percent with an increase of one percentage-point in the proportion of former MNE workers in the establishment, all else equal.

Though multinational spillovers are not economy-wide, and in fact, most sectors and most workers do not receive spillover benefits, the results are consistent with the idea that local conditions, such as the level of education and industry characteristics, may play an important role in the ability of a country to absorb the positive effects of foreign investment. This result runs parallel to the results in Keller and Yeaple (forthcoming) which finds the

³¹To conserve space, the accompanying robust standard errors, *F-statistics* and *p-values* are not reported, but are available in an appendix by request.

Table 5.2: Multinational Spillovers by 2-digit CNAE Sector, 1996-2001

| Dep. Variable: Log Annual Wages | | | | | | | | | | | | |
|---------------------------------|--|-----------------------|------------|------------|------------------------|--------|-----------------|------------------------|--|--|--|--|
| 2-digit CNAE | Description | $\gamma_M - \gamma_D$ | γ_M | γ_D | Number of Observations | R^2 | Skill Intensity | Foreign Presence Share | | | | |
| <i>Highest Quintile</i> | | | | | | | | | | | | |
| 65 | Financial intermediation | 0.179 | 0.085 | -0.094 | 275,330 | 0.1704 | 0.919 | 0.022 | | | | |
| 66 | Insurance and pension funding | 0.138 | 0.062 | -0.076 | 101,803 | 0.1403 | 0.897 | 0.025 | | | | |
| 72 | Computer and related activities | 0.041 | 0.003 | -0.039 | 236,321 | 0.1295 | 0.865 | 0.045 | | | | |
| 67 | Activities auxiliary to financial intermediation | 0.121 | 0.068 | -0.053 | 54,342 | 0.2457 | 0.813 | 0.028 | | | | |
| 62 | Air transport | 0.945 | 0.500* | -0.445 | 63,312 | 0.2264 | 0.793 | 0.021 | | | | |
| 11 | Extraction of crude petroleum and natural gas | 0.758 | 0.486* | -0.272 | 19,370 | 0.0831 | 0.742 | 0.049 | | | | |
| 64 | Post and telecommunications | 0.073 | 0.114 | 0.041 | 301,280 | 0.1554 | 0.731 | 0.033 | | | | |
| 40 | Electricity, gas, steam and hot water supply | 0.146 | 0.052 | -0.095 | 200,086 | 0.0172 | 0.729 | 0.028 | | | | |
| 73 | Research and development | 0.939 | 1.165** | 0.226 | 61,726 | 0.0212 | 0.714 | 0.013 | | | | |
| 30 | Manufacture of office machinery and computers | -0.343 | 0.055 | 0.398 | 28,314 | 0.2723 | 0.695 | 0.045 | | | | |
| 80 | Education | 0.168* | 0.203* | 0.035 | 1,089,814 | 0.3420 | 0.689 | 0.006 | | | | |
| <i>4th-Quintile</i> | | | | | | | | | | | | |
| 32 | Manufacture of radio, television and communication equipment | 0.350* | 0.103** | -0.247 | 93,135 | 0.3022 | 0.570 | 0.045 | | | | |
| 85 | Health and social work | 0.011 | 0.047 | 0.037* | 1,530,229 | 0.2050 | 0.561 | 0.006 | | | | |
| 22 | Publishing, printing and reproduction of recorded media | 0.121 | 0.148* | 0.027 | 335,598 | 0.2717 | 0.534 | 0.014 | | | | |
| 63 | Supporting and auxiliary transport activities; travel agencies | 0.062 | 0.121** | 0.060 | 237,425 | 0.2103 | 0.521 | 0.023 | | | | |
| 33 | Manufacture of medical, precision and optical instruments | 0.115 | 0.107 | -0.008 | 77,995 | 0.2107 | 0.510 | 0.027 | | | | |
| 13 | Mining of metal ores | 0.650 | 0.477** | -0.173 | 64,470 | 0.1878 | 0.495 | 0.036 | | | | |
| 52 | Retail trade; repair of personal and household goods | 0.047** | 0.046** | -0.001 | 2,950,440 | 0.1785 | 0.487 | 0.011 | | | | |
| 24 | Manufacture of chemicals and chemical products | 0.007 | 0.020 | 0.013 | 526,063 | 0.2239 | 0.486 | 0.030 | | | | |
| 35 | Manufacture of other transport equipment | -0.188 | 0.039 | 0.226 | 53,986 | 0.4757 | 0.459 | 0.027 | | | | |
| 41 | Collection, purification and distribution of water | -0.852 | -0.236 | 0.616 | 259,179 | 0.0941 | 0.449 | 0.008 | | | | |
| <i>3rd-Quintile</i> | | | | | | | | | | | | |
| 51 | Wholesale trade and commission trade | 0.105** | 0.137** | 0.032 | 989,641 | 0.2394 | 0.447 | 0.017 | | | | |
| 50 | Sale, repair of motor vehicles; retail sale of fuel | 0.041 | 0.025 | -0.016 | 749,516 | 0.2484 | 0.441 | 0.011 | | | | |
| 61 | Water transport | 0.438 | 0.081 | -0.357* | 32,266 | 0.2575 | 0.433 | 0.023 | | | | |
| 71 | Renting of machinery and equipment | 0.075 | 0.072 | -0.003 | 62,894 | 0.2337 | 0.430 | 0.020 | | | | |
| 31 | Manufacture of electrical machinery n.e.c. | -0.110 | -0.078 | 0.032 | 251,180 | 0.2591 | 0.397 | 0.028 | | | | |
| 34 | Manufacture of motor vehicles, trailers and semi-trailers | 0.075 | 0.028** | -0.047 | 601,943 | 0.4892 | 0.390 | 0.035 | | | | |
| 29 | Manufacture of machinery and equipment n.e.c. | 0.083 | 0.124** | 0.041 | 558,131 | 0.2584 | 0.379 | 0.037 | | | | |
| 27 | Manufacture of basic metals | 0.145 | 0.123* | -0.022 | 397,222 | 0.4109 | 0.377 | 0.021 | | | | |
| 21 | Manufacture of pulp, paper and paper products | -0.107 | 0.026* | 0.133 | 260,331 | 0.3326 | 0.368 | 0.020 | | | | |
| 16 | Manufacture of tobacco products | -0.737 | 0.035 | 0.772 | 40,415 | 0.0689 | 0.302 | 0.109 | | | | |

Note: Each row represents a unique individual-level regression as in equation (3.2) for each sector. All specifications include annual time dummies, individual, and establishment fixed effects. ** denotes significance at 1 percent level; * denotes significance at 5 percent level. Robust standard errors are clustered at the establishment-level. See section 5 for other independent variables included in the estimation (not reported here). The skill-intensity of the sector is defined as the share of the workforce with a high school or college education. The foreign presence share in an establishment is defined as the number of MNE-to-non-MNE switchers as a share of the establishment workforce. Source: RAIS, 1996-2001.

Table 5.3: Multinational Spillovers by 2-digit CNAE Sector, 1996-2001: Continued

| Dep. Variable: Log Annual Wages | | | | | | | | |
|---------------------------------|--|-----------------------|------------|------------|------------------------|--------|-----------------|------------------------|
| 2-digit CNAE | Description | $\gamma_M - \gamma_D$ | γ_M | γ_D | Number of Observations | R^2 | Skill Intensity | Foreign Presence Share |
| <i>2nd-Quintile</i> | | | | | | | | |
| 25 | Manufacture of rubber and plastic products | 0.124 | 0.047 | -0.076 | 602,046 | 0.3360 | 0.290 | 0.021 |
| 10 | Coal Mining | -0.824 | -0.053 | 0.771 | 6,802 | 0.0159 | 0.287 | 0.007 |
| 28 | Manufacture of fabricated metal products | 0.109* | 0.077** | -0.032 | 619,341 | 0.2490 | 0.287 | 0.024 |
| 18 | Manufacture of apparel | 0.042 | 0.101** | 0.059* | 678,200 | 0.2425 | 0.272 | 0.010 |
| 17 | Manufacture of textiles | 0.032 | -0.033 | -0.066 | 713,747 | 0.1915 | 0.262 | 0.015 |
| 55 | Hotels and restaurants | -0.038** | -0.008 | 0.029* | 1,011,209 | 0.1455 | 0.250 | 0.010 |
| 15 | Manufacture of food products and beverages | 0.262* | 0.254** | -0.008 | 1,963,912 | 0.0618 | 0.241 | 0.011 |
| 70 | Real estate activities | -0.002 | -0.018 | -0.017 | 446,905 | 0.1632 | 0.239 | 0.010 |
| 19 | Manufacture of luggage, handbags, saddlery, harness and footwear | 0.124 | 0.120* | -0.004 | 655,803 | 0.1290 | 0.227 | 0.015 |
| 60 | Land transport; transport via pipelines | 0.222** | 0.141** | -0.081 | 2,311,445 | 0.3069 | 0.223 | 0.012 |
| <i>Lowest Quintile</i> | | | | | | | | |
| 26 | Manufacture of other non-metallic mineral products | -0.044 | 0.003 | 0.048 | 499,193 | 0.3431 | 0.220 | 0.011 |
| 23 | Manufacture of coke, refined petroleum products and nuclear fuel | -0.686 | -0.213 | 0.473 | 143,481 | 0.2300 | 0.209 | 0.008 |
| 14 | Other mining and quarrying | 0.060 | 0.157** | 0.098 | 99,726 | 0.1990 | 0.188 | 0.007 |
| 45 | Construction | -0.033 | 0.021* | 0.054** | 2,277,089 | 0.2219 | 0.185 | 0.023 |
| 37 | Recycling | 0.223 | 0.292** | 0.069 | 15,015 | 0.4281 | 0.178 | 0.018 |
| 90 | Sewage and refuse disposal, sanitation and similar activities | 0.073 | -0.038 | -0.111 | 211,355 | 0.0496 | 0.147 | 0.022 |
| 20 | Manufacture of wood and wood products | -0.126 | -0.058 | 0.069 | 364,452 | 0.1939 | 0.133 | 0.009 |
| 5 | Fishing | -0.182 | -0.177** | 0.004 | 20,840 | 0.0578 | 0.122 | 0.036 |
| 1 | Agriculture | 0.004 | 0.045* | 0.042** | 1,347,357 | 0.1391 | 0.103 | 0.008 |
| 2 | Forestry | 0.034 | 0.033 | -0.001 | 122,164 | 0.0409 | 0.082 | 0.018 |

Note: Each row represents a unique individual-level regression as in equation (3.2) for each sector. All specifications include annual time dummies, individual, and establishment fixed effects. ** denotes significance at 1 percent level; * denotes significance at 5 percent level. Robust standard errors are clustered at the establishment-level. See section 5 for other independent variables included in the estimation (not reported here). The skill-intensity of the sector is defined as the share of the workforce with a high school or college education. The foreign presence share in an establishment is defined as the number of MNE-to-non-MNE switchers as a share of the establishment workforce. Source: RAIS, 1996-2001.

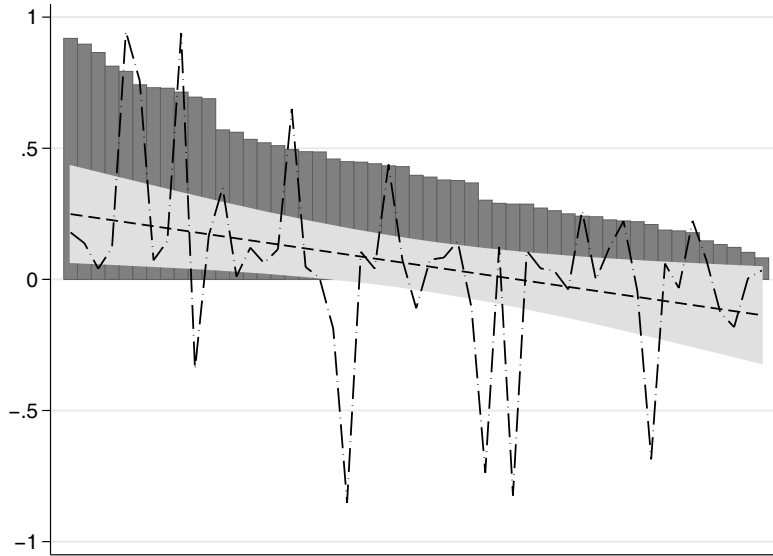


Figure 5.1: Multinational Spillovers, by Sector Skill-Intensity, 1996-2001

strongest productivity spillovers among high-tech sectors in the United States. A possible explanation, therefore, for the strong productivity spillovers in high-tech sectors in Keller and Yeaple (forthcoming) is worker mobility.

Figure 5.1 offers an illustration of the results from tables 5.2 and 5.3. Each bar represents a single sector, ranked from left to right in order of decreasing skill-intensity, as defined by the share of workers with at least a high-school education. Furthest to the left is the financial intermediation sector where 91.9 percent of the workforce is, at a minimum, high-school educated. At the right end, by contrast, is the forestry sector, where only 8.2 percent of workers hold a high-school degree. The figure also displays the multinational spillover effect ($\gamma_M - \gamma_D$) for each sector and demonstrates that multinational spillovers decline with sector skill-intensity. Though all sectors do not benefit from multinational knowledge spillovers, high-skilled sectors, on average, benefit more from the presence of former multinational-establishment workers.

Table 5.4 reinforces the idea that workers in high-skilled sectors receive larger spillovers from the presence of former multinational-establishment workers in the sector than do low-skilled sectors. Columns (1)-(4) replicate the results from table 5.1. In column (5), I report coefficients from the regression in which the share of workers with experience at a multinational-establishment (S_{jt}^M) and the share of workers hired from another domestic-

Table 5.4: Multinational Spillovers, 1996-2001

| Dep. Variable: Log Annual Wages | (1) | (2) | (3) | (4) | (5) |
|------------------------------------|---------|-----------|-----------|-----------|-------------------|
| $\gamma_M - \gamma_D$ | 0.977** | 1.071** | -0.025 | 0.075** | -0.043 |
| <i>F-statistic</i> | 15.29 | 75.87 | 1.00 | 10.38 | 0.87 |
| <i>p-value</i> | 0.0001 | 0.0000 | 0.3183 | 0.0013 | 0.3506 |
| Sector Skill-Intensity Interaction | | | | | 0.332** |
| <i>F-statistic</i> | | | | | 7.56 |
| <i>p-value</i> | | | | | 0.0060 |
| Sector Skill-Intensity | | | | | -0.024 (0.016) |
| Individual Fixed Effects | NO | NO | NO | YES | YES |
| Establishment Fixed Effects | NO | NO | YES | YES | YES |
| Time Fixed Effects | NO | YES | YES | YES | YES |
| Sector Skill-Intensity Interaction | NO | NO | NO | NO | YES |
| Number of Observations | 450,842 | 2,634,947 | 2,634,947 | 2,634,947 | 2,629,404 |
| Overall R-squared | 0.5483 | 0.5403 | 0.3948 | 0.2658 | 0.5181 |

Note: Robust standard errors, clustered at the establishment-level, are in parentheses. ** denotes significance at 1 percent level; * denotes significance at 5 percent level. See section 5 for other independent variables included in the estimation (not reported here).

Source: RAIS, 10 percent random sample, 1996-2001.

owned establishment (S_{jt}^D) are interacted with the skill-intensity of the establishment's sector. The results fail to reject that the marginal effect of the share of former multinational-establishment workers in the domestic-owned establishment, controlling for periods of establishment hiring, increases when the sector skill-intensity is higher.

6 Multinational Spillovers By Worker Skill-Level

Results in the previous sections suggest that skill-levels and the absorptive capacity of a sector play a role in a sector's ability to absorb a multinational's technological capital. In this section, I ask: are higher-skilled switcher workers better able to *convey* the MNE's technology to other workers, just as higher-skilled incumbent domestic workers may be better able to *absorb* the MNE's technology from the switchers? I define the skill-level of the worker along two separate dimensions: the worker's educational attainment and the worker's skill-intensity of occupation. The analysis returns to the ten percent random sample of the

incumbent domestic workforce drawn across all sectors from section 5.1.³²

6.1 Switcher skill-level

I augment equation (3.2) to include the share of the domestic establishment’s workforce trained and displaced from a foreign-owned establishment *and* of a specific skill-level as follows:

$$\begin{aligned} \ln y_{ijt} = & \gamma_{M_{prim}} S_{jt}^{M_{prim}} + \gamma_{M_{high}} S_{jt}^{M_{high}} + \gamma_{M_{grad}} S_{jt}^{M_{grad}} \\ & + \gamma_{D_{prim}} S_{jt}^{D_{prim}} + \gamma_{D_{high}} S_{jt}^{D_{high}} + \gamma_{D_{grad}} S_{jt}^{D_{grad}} \\ & + \psi_i + \lambda_{j(i)} + \delta_t + \beta_1 X_{it} + \beta_2 Z_{jt} + \epsilon_{ijt}, \end{aligned} \quad (6.1)$$

where the subscripts (*prim, high, grad*) signify primary school, high school, and college graduate, respectively. To be clear that it is the skill-level of the former multinational-establishment workers and not simply that these workers are disproportionately higher-skilled than the non-MNE switcher workers, I also include the share of non-MNE switchers by skill-level.

The top panel of table 6.1 reports the results by the education level of the switcher worker. The results are consistent with the hypothesis that higher-skilled former multinational-establishment workers are better able to transfer information to the incumbent domestic workforce. A one percentage-point increase in the share of former multinational-establishment workers with a college education increases wages of the incumbent domestic workforce by 0.3 percent. Though the results for MNE-switcher workers with a high school and primary school education are not statistically different from the results for non-MNE switcher workers with similar education levels, the point estimates are increasing with education.

The bottom panel of table 6.1 reports results by the MNE and non-MNE switcher worker’s

³²In an appendix available by request, I explore in greater detail how spillovers are transferred and absorbed in the sectors where spillovers exist. I define the sectors with positive and significant multinational knowledge spillovers from section 5.2 to be the “high absorptive capacity sectors.”

Table 6.1: Multinational Spillovers, By Switcher Skill-Level, 1996-2001

| Dep. Variable: Log Annual Wages | |
|--|----------------|
| Education | |
| Primary School ($\gamma_{M_{prim}} - \gamma_{D_{prim}}$) | 0.039 |
| <i>F-statistic</i> | 2.10 |
| <i>p-value</i> | 0.1476 |
| High School ($\gamma_{M_{high}} - \gamma_{D_{high}}$) | 0.046 |
| <i>F-statistic</i> | 1.15 |
| <i>p-value</i> | 0.2845 |
| College Graduate ($\gamma_{M_{grad}} - \gamma_{D_{grad}}$) | 0.303** |
| <i>F-statistic</i> | 14.78 |
| <i>p-value</i> | 0.0001 |
| Number of Observations | 2,634,947 |
| Overall R-squared | 0.2663 |
| Occupation | |
| Unskilled Blue Collar ($\gamma_{M_{unskb}} - \gamma_{D_{unskb}}$) | -0.092 |
| <i>F-statistic</i> | 2.77 |
| <i>p-value</i> | 0.0963 |
| Skilled Blue Collar ($\gamma_{M_{skb}} - \gamma_{D_{skb}}$) | 0.025 |
| <i>F-statistic</i> | 0.59 |
| <i>p-value</i> | 0.4429 |
| Other White Collar ($\gamma_{M_{whit}} - \gamma_{D_{whit}}$) | 0.071 |
| <i>F-statistic</i> | 1.11 |
| <i>p-value</i> | 0.2927 |
| Professional & Technical ($\gamma_{M_{prof}} - \gamma_{D_{prof}}$) | 0.243** |
| <i>F-statistic</i> | 30.55 |
| <i>p-value</i> | 0.0000 |
| Number of Observations | 2,634,947 |
| Overall R-squared | 0.2662 |

Note: All specifications include annual time dummies, individual, and establishment fixed effects. Robust standard errors are clustered at the establishment-level. ** denotes significance at 1 percent level; * denotes significance at 5 percent level. See section 5 for other independent variables included in the estimation (not reported here). Source: RAIS, 10 percent random sample, 1996-2001.

skill-level, as defined by the skill-intensity of occupation according to the following regression:

$$\begin{aligned}
 \ln y_{ijt} = & \gamma_{M_{unskb}} S_{jt}^{M_{unskb}} + \gamma_{M_{skb}} S_{jt}^{M_{skb}} + \gamma_{M_{whit}} S_{jt}^{M_{whit}} + \gamma_{M_{prof}} S_{jt}^{M_{prof}} \\
 & + \gamma_{D_{unskb}} S_{jt}^{D_{unskb}} + \gamma_{D_{skb}} S_{jt}^{D_{skb}} + \gamma_{D_{whit}} S_{jt}^{D_{whit}} + \gamma_{D_{prof}} S_{jt}^{D_{prof}} \\
 & + \psi_i + \lambda_{j(i)} + \delta_t + \beta_1 X_{it} + \beta_2 Z_{jt} + \epsilon_{ijt},
 \end{aligned} \tag{6.2}$$

where the subscripts (*unskb*, *skb*, *whit*, *prof*) signify unskilled blue collar, skilled blue collar, other white collar, and professional worker, respectively. The results follow the same pattern as the results for skill as measured by educational attainment. A one percentage-point

increase in the share of former multinational-establishment workers in a professional or technical occupation increases wages of the incumbent domestic workforce by 0.2 percent. The coefficient estimates for the lower skilled occupations are statistically insignificant.

Together, the results from table 6.1 offer evidence that higher skilled former multinational-establishment workers are better able to transfer information to the incumbent domestic workforce. An increase in the share of MNE-switchers with a college education or in a professional occupation increases wages of incumbent domestic workers at domestic-owned establishments.³³

6.2 Incumbent skill-level

Tables 6.2 and 6.3 report results from augmented equations (3.2) in which I restrict the set of observations for analysis to only those incumbent domestic workers with a given skill-level, as defined by the incumbent worker's educational attainment or skill-intensity of occupation.

Table 6.2 reports results from these regressions when educational attainment is used to measure the skill-level of the incumbent domestic worker. The results fail to reject the hypothesis that higher-skilled incumbent domestic workers are better able to absorb information from MNE-switchers. A one percentage-point increase in the share of former multinational-establishment workers in the domestic-owned establishment increases wages for incumbents with a high school education by 0.1 percent. Though the estimate for college-educated workers is only weakly significant, the point estimates increase with education, as would be expected.

The results for incumbent skill-levels measured by the skill-intensity of occupation, reported in table 6.3, also present weak evidence in favor of the hypothesis that higher-skilled incumbent domestic workers are better able to absorb information from former multinational-establishment workers. There is no statistical evidence that increasing the share of former multinational-establishment workers increases the wages of unskilled blue collar workers. However, skilled blue collar workers benefit from the increased presence of former multinational-establishment workers—a one percentage-point increase in the share of

³³Iranzo and Peri (forthcoming) offer that skill-biased technologies may be a reason why positive wage externalities are found only for highly-educated workers.

Table 6.2: Multinational Spillovers, By Incumbent Skill-Level, 1996-2001

| Dep. Variable: Log Annual Wages | |
|---------------------------------------|---------------|
| Education | |
| <i>Incumbents with Primary School</i> | |
| $\gamma_M - \gamma_D$ | 0.027 |
| <i>F-statistic</i> | 1.14 |
| <i>p-value</i> | 0.2858 |
| Number of Observations | 1,690,010 |
| Overall R-squared | 0.2087 |
| <i>Incumbents with High School</i> | |
| $\gamma_M - \gamma_D$ | 0.098* |
| <i>F-statistic</i> | 5.48 |
| <i>p-value</i> | 0.0192 |
| Number of Observations | 701,222 |
| Overall R-squared | 0.2417 |
| <i>Incumbents with College Degree</i> | |
| $\gamma_M - \gamma_D$ | 0.162 |
| <i>F-statistic</i> | 2.44 |
| <i>p-value</i> | 0.1183 |
| Number of Observations | 243,715 |
| Overall R-squared | 0.2773 |

Note: All specifications include annual time dummies, individual, and establishment fixed effects. Robust standard errors are clustered at the establishment-level. ** denotes significance at 1 percent level; * denotes significance at 5 percent level. See section 5 for other independent variables included in the estimation (not reported here). Source: RAIS, 10 percent random sample, 1996-2001.

former multinational-establishment workers increases wages for skilled blue collar incumbents by 0.1 percent. Similarly, with weak significance, the highest skilled workers (those with other white collar and professional occupations) benefit from an increased presence of former multinational-establishment workers.

6.3 Knowledge matching and knowledge spillovers

Jovanovic and Rob (1989) argue that informational spillovers will be greater the larger the *knowledge distance* between the agents, that is the greater the informational asymmetry between the agents, while Moretti (2004) finds human capital spillovers are greater for industries that are *economically close* than for industries that are *economically distant*. In this section, I use these two contrasting ideas to test the hypothesis that spillovers occur

Table 6.3: Multinational Spillovers, By Incumbent Skill-Level, 1996-2001

| Dep. Variable: Log Annual Wages | |
|--|---------------|
| Occupation | |
| <i>Unskilled Blue Collar Incumbents</i> | |
| $\gamma_M - \gamma_D$ | 0.007 |
| <i>F-statistic</i> | 0.01 |
| <i>p-value</i> | 0.9070 |
| Number of Observations | 323,866 |
| Overall R-squared | 0.0982 |
| <i>Skilled Blue Collar Incumbents</i> | |
| $\gamma_M - \gamma_D$ | 0.073* |
| <i>F-statistic</i> | 4.41 |
| <i>p-value</i> | 0.0356 |
| Number of Observations | 1,119,308 |
| Overall R-squared | 0.2064 |
| <i>Other White Collar Incumbents</i> | |
| $\gamma_M - \gamma_D$ | 0.083 |
| <i>F-statistic</i> | 2.62 |
| <i>p-value</i> | 0.1056 |
| Number of Observations | 433,308 |
| Overall R-squared | 0.2494 |
| <i>Professional & Technical Incumbents</i> | |
| $\gamma_M - \gamma_D$ | 0.069 |
| <i>F-statistic</i> | 3.00 |
| <i>p-value</i> | 0.0832 |
| Number of Observations | 714,862 |
| Overall R-squared | 0.3238 |

Note: All specifications include annual time dummies, individual, and establishment fixed effects. Robust standard errors are clustered at the establishment-level. ** denotes significance at 1 percent level; * denotes significance at 5 percent level. See section 5 for other independent variables included in the estimation (not reported here). Source: RAIS, 10 percent random sample, 1996-2001.

between *like* workers versus the hypotheses that spillovers occur between *unlike* workers. I ask the following question: does the magnitude of spillovers increase as the likelihood increases that the entering displaced multinational-establishment worker is similar in his skill set to the incumbent domestic worker? Do managers learn from managers and production workers learn from production workers? Or do production workers learn best from managers?

Table 6.4 reports results for the analysis of equation (6.1), where observations are restricted by the skill-level of the incumbent domestic worker for the three educational

Table 6.4: Multinational Spillovers, By Switcher*Incumbent Skill-Level, 1996-2001

| Dep. Variable: Log Annual Wages | |
|--|----------------|
| Incumbent with Primary School | |
| Primary School ($\gamma_{M_{prim}} - \gamma_{D_{prim}}$) | 0.047 |
| <i>F-statistic</i> | 2.28 |
| <i>p-value</i> | 0.1307 |
| High School ($\gamma_{M_{high}} - \gamma_{D_{prim}}$) | -0.018 |
| <i>F-statistic</i> | 0.10 |
| <i>p-value</i> | 0.7566 |
| College Graduate ($\gamma_{M_{grad}} - \gamma_{D_{grad}}$) | 0.022 |
| <i>F-statistic</i> | 0.03 |
| <i>p-value</i> | 0.8696 |
| Number of Observations | 1,690,010 |
| Overall R-squared | 0.2087 |
| Incumbent with High School | |
| Primary School ($\gamma_{M_{prim}} - \gamma_{D_{prim}}$) | 0.043 |
| <i>F-statistic</i> | 0.55 |
| <i>p-value</i> | 0.4580 |
| High School ($\gamma_{M_{high}} - \gamma_{D_{high}}$) | 0.062 |
| <i>F-statistic</i> | 0.90 |
| <i>p-value</i> | 0.3417 |
| College Graduate ($\gamma_{M_{grad}} - \gamma_{D_{grad}}$) | 0.283** |
| <i>F-statistic</i> | 6.80 |
| <i>p-value</i> | 0.0091 |
| Number of Observations | 701,222 |
| Overall R-squared | 0.2422 |
| Incumbent with College Degree | |
| Primary School ($\gamma_{M_{prim}} - \gamma_{D_{prim}}$) | 0.263 |
| <i>F-statistic</i> | 2.08 |
| <i>p-value</i> | 0.1496 |
| High School ($\gamma_{M_{high}} - \gamma_{D_{high}}$) | -0.146 |
| <i>F-statistic</i> | 0.52 |
| <i>p-value</i> | 0.4698 |
| College Graduate ($\gamma_{M_{grad}} - \gamma_{D_{grad}}$) | 0.307* |
| <i>F-statistic</i> | 3.99 |
| <i>p-value</i> | 0.0459 |
| Number of Observations | 243,715 |
| Overall R-squared | 0.2787 |

Note: All specifications include annual time dummies, individual, and establishment fixed effects. Robust standard errors are clustered at the establishment-level. ** denotes significance at 1 percent level; * denotes significance at 5 percent level. See section 5 for other independent variables included in the estimation (not reported here).

Source: RAIS, 10 percent random sample, 1996-2001.

attainment groupings. If information is best transferred between *like*-groups of workers, I expect to see the largest positive and significant coefficients in the top row for the first panel (the effects of switcher workers with primary school on incumbents with primary school), the second row in the middle panel (the effects of switcher workers with high school on incumbents with high school), and the third row (the effects of switcher workers with a college degree on incumbents with a college degree). If information is best transferred between *different* workers, the data would show positive and significant coefficients for college graduate switchers when interacting with primary school incumbents, and vice versa. For the middle panel, high school incumbents should benefit most when interacting with college graduate switchers.

The data suggest that information is best transferred between similarly-skilled groups of high-skilled workers and from higher skilled former multinational-establishment workers to lower-skilled incumbent domestic workers. A one percentage-point increase in the share of former multinational-establishment workers with a college degree increases wages for incumbent domestic workers with a high school education by 0.28 percent. A similar increase in the share of former multinational-establishment workers with a college degree would increase wages for incumbent domestic workers with a college degree by 0.30 percent.

Results for skill-intensity of occupation groupings are available from the author by request. Largely consistent with the evidence presented in table 6.4, results for the occupational groupings suggest that skilled blue collar, other white collar, and professional incumbents learn from professional former-multinational establishment workers. Skilled blue collar workers also benefit from an increased presence of skilled blue collar MNE-switchers.

7 Robustness Checks

The key identifying assumption in equation (3.2), after controlling for individual, establishment, and time fixed effects, time-varying, individual-specific characteristics and time-varying, establishment-specific characteristics, and general hiring trends, is that ϵ_{ijt} is uncorrelated with the main variable of interest, S_{jt}^M . Any positive correlation between the share of former multinational-establishment workers in the domestic-owned establishment and the error term

will lead to upwardly biased estimates. Potential threats to this identification are: 1) time-varying, productivity shocks to establishments that cause establishments to seek out former multinational-establishment workers in the unemployed labor pool and 2) switcher workers who sort into high wage establishments. I assess the plausibility of each of these concerns in turn.

7.1 Time-varying, establishment-level, productivity shocks

Suppose domestic-owned establishment j experiences a positive productivity shock in time t . Suppose further this positive productivity shock causes the establishment to disproportionately seek out former multinational-establishment workers, as opposed to non-MNE switcher workers, in the unemployed labor pool (perhaps with the intention of upgrading the skill-level of the workforce). This would violate the exogeneity assumption that $(E(S_{jt}^M * \epsilon_{ijt}) = 0)$.

Ideally, the econometrician would have access to data on establishment-level investment or intermediate inputs to proxy for shocks to productivity in order to test for such time-varying, establishment-level heterogeneity. In the absence of such data, I rely on incomplete information from the Brazilian manufacturing survey, *Pesquisa Industrial Anual*, on firm-level total factor productivity and labor productivity³⁴ for the partial sample of manufacturing firms in the years 1996-1998 as defined in Muendler (2003a) and Muendler (2004).³⁵

As table 7.1 demonstrates, the share of former multinational-establishment workers in the establishment workforce is positively-correlated with firm-level total factor productivity and labor productivity, but to a limited degree—the correlation coefficient on the MNE-switcher share and firm-level TFP is only 0.041, while the correlation coefficient on the MNE-switcher share and firm-level labor productivity is only 0.033. This should reduce the main concerns that a large positive correlation between the error term and the main variable of interest is

³⁴The data are based on three-firm random aggregates.

³⁵The results from the estimation of equation (3.2) for the partial sample of manufacturing firms for the years 1996-1998 report an insignificant multinational spillover effect $(\gamma_M - \gamma_D)$. This is not unexpected, considering only 2 of the 6 sectors reporting significant knowledge transfers in section 5.2 are manufacturing sectors.

Table 7.1: Correlation Coefficients

| | S_{jt}^M | S_{jt+1}^M |
|-----------------|------------|--------------|
| $\ln(TFP)$ | 0.041 | 0.044 |
| $\ln(LP)$ | 0.033 | 0.036 |
| Exporter in t | 0.087 | 0.122 |

Sources: RAIS, 10 percent random sample, 1996-2001; PIA, 1996-1998; & SECEX, 1996-2001.

biasing the estimates.

Table 7.1 also points to a now well-established finding in the international economics literature—that even within narrowly-defined industrial categories, globally-engaged firms and domestically-oriented firms are substantially different in terms of their productivity, size, employment composition, and wages (Bernard and Jensen 1995). Since Brazilian establishment tax numbers are common across many databases, I match the information from RAIS to a complementary establishment-level data source from the Brazilian Customs Office (SECEX) to determine whether the establishment is globally-engaged in time t . SECEX records all legally-registered establishments in Brazil with at least one export transaction in any given year. This is my definition of an exporter.

As a more robust test for time-varying, establishment-level productivity shocks, I include a control for the global engagement of the firm into the main estimating equation (3.2). Firms which become exporters in time t may also hire disproportionately more former-MNE workers from the unemployed pool with the purpose of upgrading the skill-composition of the workforce in anticipation of exporting.³⁶ Table 7.2 reports results from equation (3.2) with this additional time-varying, firm-level control—the exporter status of the firm, defined to be an indicator variable equal to one if the firm exported any positive value in year t and zero otherwise. Since the estimation includes establishment fixed effects, the exporter status effect is identified off the firms which switch status over time—it is exactly this shock to productivity that I wish to control for in this analysis.

Column (1) replicates the results from column (4) in table 5.1 for the reader’s reference. Column (2) confirms that the main results are unaffected by the inclusion of the time-varying,

³⁶See Yeaple (2005), Verhoogen (2008), and Kugler and Verhoogen (2008) for theory and evidence to support the quality-upgrading hypothesis.

Table 7.2: Robustness Checks: Control for Exporter Status, 1996-2001

| Dep. Variable: Log Annual Wages | (1) | (2) |
|---------------------------------|--------------------|--------------------|
| $\gamma_M - \gamma_D$ | 0.075** | 0.075** |
| <i>F-statistic</i> | 10.38 | 14.50 |
| <i>p-value</i> | 0.0013 | 0.0001 |
| γ_M | 0.085** (0.016) | 0.085** (0.010) |
| γ_D | 0.010 (0.017) | 0.010 (0.017) |
| Exporter Status at t | | 0.001 (0.001) |
| Number of Observations | 2,634,947 | 2,634,947 |
| Overall R-squared | 0.2658 | 0.2659 |

Note: Robust standard errors, clustered at the establishment-level, are in parentheses. ** denotes significance at 1 percent level; * denotes significance at 5 percent level. See section 5 for other independent variables included in the estimation (not reported here).

Source: RAIS, 10 percent random sample, 1996-2001; SECEX, 1996-2001.

firm-level exporter status dummy to control for shocks to productivity. I fail to find support for the hypothesis that time-varying, establishment-level shocks to productivity are driving the technology transfers from multinational to domestic firms.

In the absence of better productivity data, as a final test for the existence of this plausible unobservable establishment-level, time-varying shock correlated with S_{jt}^M , I include the future value of the foreign presence share into the analysis. More precisely, if S_{jt}^M is correlated with ϵ_{ijt} due to time-varying, establishment-level shocks to productivity, and moreover, these shocks to productivity lead the establishment to skill-upgrade by hiring former multinational-establishment workers, controlling for S_{jt+1}^M in equation (3.2) should capture this shock. Again, table 7.1 reinforces this possibility—a shock to productivity in time t induces firms to upgrade the level of skill in $t+1$ by disproportionately hiring former-MNE workers from the unemployed pool of workers—the correlation between total factor productivity and the share of former multinational-establishment workers in the establishment workforce is stronger for future values, though still small at 0.044. Therefore, controlling for future values of former-MNE hires should help to control for time-varying, unobserved firm-heterogeneity.

However, it is the differential increase in former multinational-establishment worker hiring that is important to the estimation, so I also include the future value of S_{jt}^D . I augment

equation (3.2) as follows:

$$\begin{aligned} \ln y_{ijt} = & \gamma_{M_t} S_{jt}^M + \gamma_{M_{t+1}} S_{jt+1}^M + \gamma_{D_t} S_{jt}^D + \gamma_{D_{t+1}} S_{jt+1}^D \\ & + \psi_i + \lambda_{j(i)} + \delta_t + \beta_1 X_{it} + \beta_2 Z_{jt} + \epsilon_{ijt}. \end{aligned} \quad (7.1)$$

Establishment-level skill-upgrading productivity shocks will overturn my results if $\gamma_{M_{t+1}} - \gamma_{D_{t+1}}$ is positive and significant, meanwhile $\gamma_{M_t} - \gamma_{D_t}$ is statistically insignificant.

Switcher Worker Sorting Suppose the unemployed stock of former multinational-establishment workers in their decision where to accept reemployment choose establishments with higher expected future wages. In this case, S_{jt}^M is endogenous to the worker's wage and there is a simultaneous equations feedback problem. If all unemployed workers, former multinational-establishment and domestic-owned establishment alike, equally sort to high expected wage establishments, then my control, S_{jt}^D , for the non-MNE switcher share should account for this problem. However, if former multinational-establishment workers are better at distinguishing high wage establishments, then the results may again be upwardly biased.

I consider this issue by including as an additional control the future value of establishment-average wages into equation (7.1) as follows:

$$\begin{aligned} \ln y_{ijt} = & \gamma_{M_t} S_{jt}^M + \gamma_{M_{t+1}} S_{jt+1}^M + \gamma_{D_t} S_{jt}^D + \gamma_{D_{t+1}} S_{jt+1}^D + \beta_{\bar{y}.jt} \ln \bar{y}.jt + \beta_{\bar{y}.jt+1} \ln \bar{y}.jt+1 \\ & + \psi_i + \lambda_{j(i)} + \delta_t + \beta_1 X_{it} + \beta_2 Z_{jt} + \epsilon_{ijt}. \end{aligned} \quad (7.2)$$

If former multinational-establishment workers sort for expected future wages in establishments, $\gamma_{M_t} - \gamma_{D_t}$ will be statistically indistinguishable from zero.

Table 7.3 presents results from equation (7.2) with the future values for the share of former multinational-establishment workers, non-MNE switcher workers, and establishment-average wages included in the regression, in order to test the robustness of the multinational spillovers results to both unobservable, establishment-level, time-varying productivity shocks and MNE switcher worker sorting. I restrict the sample of incumbent domestic workers to be the same throughout the analysis. Column (1) provides the baseline result for comparison.³⁷

³⁷While directly comparable to column (5) in table 5.1, the differences in the coefficients reflect the

Table 7.3: Robustness Checks, 1996-2001

| Dep. Variable: Log Annual Wages | (1) | (2) | (3) |
|---------------------------------------|---------------|---------------|---------------|
| $\gamma_{M_{t-1}} - \gamma_{D_{t-1}}$ | | | 0.041 |
| F-statistic | | | 2.01 |
| p-value | | | 0.1561 |
| $\gamma_{M_t} - \gamma_{D_t}$ | 0.051* | 0.045 | 0.052* |
| F-statistic | 4.56 | 3.03 | 3.87 |
| p-value | 0.0327 | 0.0817 | 0.0492 |
| $\gamma_{M_{t+1}} - \gamma_{D_{t+1}}$ | | -0.006 | |
| F-statistic | | 0.07 | |
| p-value | | 0.7875 | |
| Number of Observations | 608,057 | 608,057 | 608,057 |
| Overall R-squared | 0.4584 | 0.5072 | 0.5217 |

Note: All specifications include annual time dummies, individual, and establishment fixed effects. Robust standard errors are clustered at the establishment-level. ** denotes significance at 1 percent level; * denotes significance at 5 percent level. See section 5 for other independent variables included in the estimation (not reported here).

Source: RAIS, 1996-2001.

In Column (2), I present results from equation (7.2). The coefficient of interest on $\gamma_{M_t} - \gamma_{D_t}$ remains weakly significant, while $\gamma_{M_{t+1}} - \gamma_{D_{t+1}}$ is strongly insignificant and negative. In general, including additional controls for future values fails to find evidence of time-varying, establishment-level productivity shocks or switcher worker sorting.

7.2 Learning or technology?

In a related issue, I consider briefly how knowledge spillovers may change over time. Until now, the implicit assumption in the analysis has been that increases in an establishment's foreign presence share are reflected instantaneously in an incumbent worker's wages. While this assumption is compelling (e.g., if an MNE-switcher worker employs a new piece of technological capital or a new production process which increases the establishment's profits and through rent-sharing increases wages), there is also reason to believe that some period of time may elapse before knowledge transfers can translate into earnings through learning (e.g., if an MNE-switcher worker transfers individual-specific human capital to an incumbent domestic worker).

Column (3) of table 7.3 reports the results from an equation relating contemporaneous

restricted sample.

and lagged values of the foreign presence share, as well as establishment-average wages, to incumbent workers' wages. Under the hypothesis that learning occurs over time, the share of MNE-switchers in the establishment last period should be positively-associated with incumbent domestic workers' wages this period. While the point estimate on the lagged multinational spillover effect, controlling for other domestic hiring, is comparable to the contemporaneous multinational spillover effect, the results fail to find significant support for learning over time in favor of technological adoption. This result corroborates evidence from Iranzo and Peri (forthcoming) in which the introduction of new and advanced technologies which are complementary to highly-educated workers has a positive effect on total factor productivity.

7.3 Multinational screening

The argument in this paper rests on former multinational-establishment workers learning while employed at the multinational establishment and having the ability to transfer this knowledge to workers at the domestic-owned establishment. As an alternative explanation, suppose multinational establishments are simply better at screening potential job applicant quality than are domestic-owned establishments. If this is the case, the findings in this paper do not support a transfer of technological capital from foreign-owned to domestic-owned establishments through worker turnover, but rather that workers with some unobservable attribute—an attribute better identified by managers at MNEs—offer human capital spillovers.

As a test for this alternative explanation, I augment equation (6.1) to include the MNE-switcher worker's tenure at the multinational establishment. The longer a worker is employed at the multinational establishment, the greater the potential information to be absorbed and transferred. By contrast, if a worker is not employed at an MNE for an appropriate length of time and multinational knowledge spillovers exist, the argument that former multinational-establishment workers are able to transfer technology acquired while employed at the foreign-owned establishment does not hold and the result captures only a signal of the quality of the former multinational-establishment worker.³⁸

³⁸The average duration of employment at a multinational establishment for MNE switchers in the sample of

Table 7.4: Robustness Check: MNE Screening, 1996-2001

| Dep. Variable: Log Annual Wages | |
|---|----------------|
| Tenure | |
| Lowest Quartile Tenure ($\gamma_{M_{tenlow}} - \gamma_{D_{tenlow}}$) | 0.073 |
| <i>F-statistic</i> | 3.15 |
| <i>p-value</i> | 0.0759 |
| Second Quartile Tenure ($\gamma_{M_{tenmlow}} - \gamma_{D_{tenmlow}}$) | 0.073 |
| <i>F-statistic</i> | 2.78 |
| <i>p-value</i> | 0.0957 |
| Third Quartile Tenure ($\gamma_{M_{tenmhigh}} - \gamma_{D_{tenmhigh}}$) | 0.125** |
| <i>F-statistic</i> | 8.56 |
| <i>p-value</i> | 0.0034 |
| Highest Quartile Tenure ($\gamma_{M_{tenhigh}} - \gamma_{D_{tenhigh}}$) | 0.028 |
| <i>F-statistic</i> | 0.32 |
| <i>p-value</i> | 0.5694 |
| Number of Observations | 2,634,947 |
| Overall R-squared | 0.2659 |

Note: All specifications include annual time dummies, individual, and establishment fixed effects. Robust standard errors are clustered at the establishment-level. ** denotes significance at 1 percent level; * denotes significance at 5 percent level. See section 5 for other independent variables included in the estimation (not reported here). Source: RAIS, 10 percent random sample, 1996-2001.

Table 7.4 reports results by the MNE and non-MNE switcher worker's tenure at the previous establishment according to the following regression:

$$\begin{aligned}
\ln y_{ijt} = & \gamma_{M_{tenlow}} S_{jt}^{M_{tenlow}} + \gamma_{M_{tenmlow}} S_{jt}^{M_{tenmlow}} + \gamma_{M_{tenmhigh}} S_{jt}^{M_{tenmhigh}} + \gamma_{M_{tenhigh}} S_{jt}^{M_{tenhigh}} \\
& + \gamma_{D_{tenlow}} S_{jt}^{D_{tenlow}} + \gamma_{D_{tenmlow}} S_{jt}^{D_{tenmlow}} + \gamma_{D_{tenmhigh}} S_{jt}^{D_{tenmhigh}} + \gamma_{D_{tenhigh}} S_{jt}^{D_{tenhigh}} \\
& + \psi_i + \lambda_{j(i)} + \delta_t + \beta_1 X_{it} + \beta_2 Z_{jt} + \epsilon_{ijt},
\end{aligned} \tag{7.3}$$

where the subscripts (*tenlow*, *tenmlow*, *tenmhigh*, *tenhigh*) signify switcher workers with experience at the previous establishment in the lowest quartile, second quartile, third quartile, and highest quartile, respectively.³⁹ The results largely confirm the hypothesis that the longer the MNE-switcher worker is employed at the multinational establishment, the better able is the worker to transfer information to the incumbent domestic workforce in the form of higher wages. An increase in the share of workers with at least a year of experience at a multinational establishment significantly increases incumbent domestic

data is 3.4 years. Meanwhile, the average duration of employment for non-MNE switchers and for incumbent domestic workers is 2.2 years and 4.7 years, respectively.

³⁹The median tenure is approximately 1 year.

workers' wages. More importantly, however, we note that the share of former multinational-establishment workers with less than a year experience at the multinational establishment do not significantly impact incumbent domestic-establishment workers' wages. These results fail to find significant evidence that multinational enterprises are simply better able to screen for high-quality workers.

8 Conclusion

The goal of this paper was to investigate the impact of foreign direct investment in Brazil on the local labor market through worker mobility and knowledge transmission. Though anecdotal evidence suggests informational externalities may be created by the movement of workers who have been trained by multinational establishments into jobs outside those establishments, thus allowing the benefits of the training to spill to agents outside the MNE, empirically identifying these effects has been difficult. This paper offers the first direct evidence from a large database on a developing country for positive multinational wage spillovers through worker turnover.

The main results are consistent with the existence of positive multinational spillovers defined to be the effects of the share of former multinational-establishment workers in the domestic-owned establishment on incumbent domestic workers' wages. The results are robust to individual and establishment fixed effects, and to different specifications controlling for time-varying, establishment-specific productivity shocks, worker sorting, and multinational screening. The magnitude of wage spillovers from multinational establishments depends on the sector under consideration. Though multinational spillovers are not economy-wide, and in fact, most sectors and most workers do not receive spillover benefits, the results are consistent with the idea that local conditions, such as the level of education, may play an important role in the ability of a country to absorb the positive effects of foreign investment.

This paper also distinguishes the multinational spillover effect by the skill-level of the displaced former multinational-establishment worker and the incumbent domestic worker. The results are consistent with the hypothesis that higher-skilled switcher workers are better able to convey the MNE's technology to incumbent domestic workers and higher-skilled

incumbent domestic workers are better able to absorb the MNE's technology from switchers. Large spillover effects occur when the skill sets of the incumbent domestic worker are lower than the skill sets of the former multinational-establishment worker, suggesting incumbent production workers learn from former multinational managers or technicians.

Interesting avenues for future work may exploit more fully the depth of the data to uncover the explicit timing of multinational spillovers through labor mobility to be able to answer better questions about the learning process and the transfer of technology within the firm, as well as the dynamics of wages for multinational switcher workers themselves as they relate to the literature on on-the-job training.

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A Constructing the Sample

For the purpose of this study, I identify workers displaced from multinational establishments and subsequently rehired at domestic-owned establishments using the complete sample of approximately 80 million formal-sector workers employed in approximately 600,000 formally-registered firms in all 28 Brazilian states. Using the common establishment tax identification codes in both the RAIS and RDE-IED data sets, I identify foreign-owned establishments and domestic-owned establishments as described in the data section 4.2. In this section, I describe my efforts to identify workers displaced from multinational establishments, the domestic-owned establishments at which they were rehired, and the incumbent domestic workers at the hiring domestic establishments.⁴⁰ For some parts of the analysis, I draw a 10 percent random sample of the incumbent domestic workforce.

Step 1: Identify Displaced Multinational Workers Matching the establishment tax identification code in RAIS and RDE-IED, I identify all employees of multinational establishments. The RAIS database includes an indicator for employment on December 31. To identify workers displaced from multinational establishments, I keep workers employed in multinational establishments at some time in year t , but no longer employed on December 31 of that year. Furthermore, with information on the reason for job separation, I keep only those workers who left the job involuntarily.

Step 2: Identify Domestic Establishments The full employment history in RAIS allows me to trace the worker beyond employment at the multinational establishment. Once an employee has received training from a multinational establishment in year t , he may transfer it to *any* establishment j hiring the worker in year $\tau \geq t$. I collect the set of establishments j in each year t and generate the share of the workforce with any previous employment spell in a multinational establishment.^{41,42}

⁴⁰As part of my empirical strategy, I also control for other domestic workers entering the establishment to control for general hiring trends. Therefore, these steps also apply to displaced domestic-owned establishment workers.

⁴¹If the worker was hired by another multinational establishment, the observation is excluded from the analysis (as are all multinational establishments).

⁴²The assumption that MNE switchers may take knowledge to all subsequent establishments is not used for domestic switchers. A worker is a domestic switcher only for the first establishment he enters subsequent

Step 3: Identify Incumbent Domestic Workers With the complete set of hiring domestic-owned establishments, I identify the set of incumbent domestic workers in the domestic establishments in each time period. I include only workers who remain in the same establishment over the sample period.⁴³ I focus on the retained worker to ensure pure spillover effects and not compositional effects.⁴⁴

B Supplemental Tables

Table B.1: ISCO Skill-Intensity of Occupation, By Major Group

| Major Group | Description | Skill Level | Definition |
|-------------|---|-------------|----------------------------|
| 1 | Legislators, senior officials, and managers | 4 | Professional and Technical |
| 2 | Professionals | 4 | Professional and Technical |
| 3 | Technicians and associate professionals | 4 | Professional and Technical |
| 4 | Clerks | 3 | Other White Collar |
| 5 | Service workers and shop and market sales workers | 3 | Other White Collar |
| 6 | Skilled agricultural and fishery workers | 2 | Skilled Blue Collar |
| 7 | Craft and related workers | 2 | Skilled Blue Collar |
| 8 | Plant and machine operators and assemblers | 2 | Skilled Blue Collar |
| 9 | Elementary occupations | 1 | Unskilled Blue Collar |

Source: International Standard Classification of Occupations.

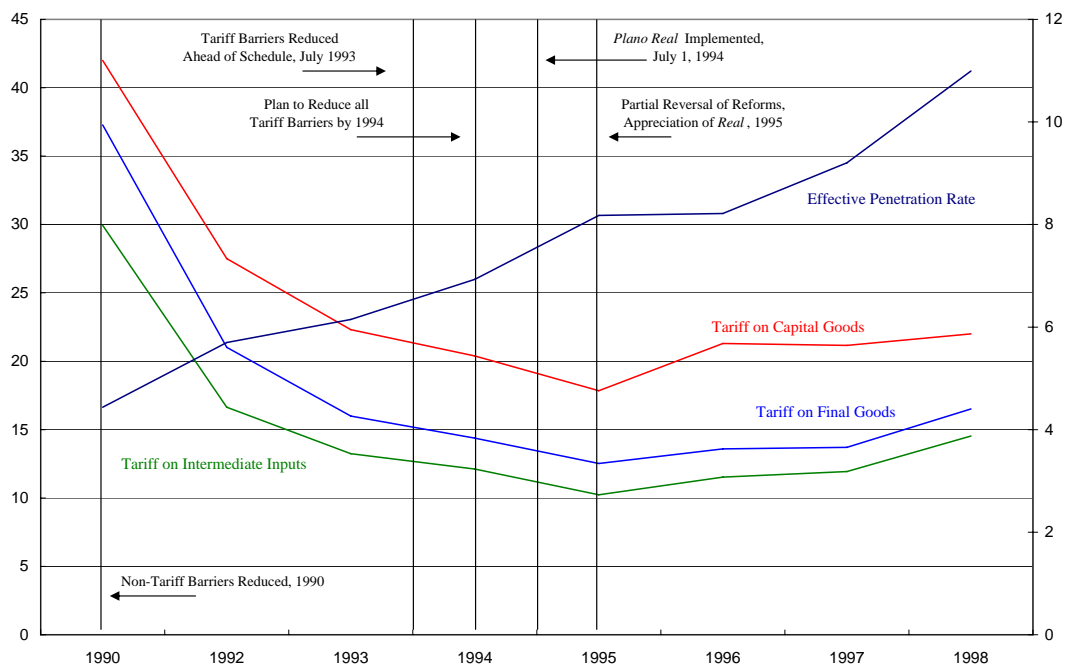
C Brazilian Policy Reforms

The marked increases in foreign investment inflows were largely a result of macroeconomic stabilization policies which brought down inflation levels, trade liberalization policies which encouraged foreign firms to locate in Brazil, a national privatization program, and a federal deregulation program.

to his initial displacement.

⁴³In principle, the sample selection was implemented as follows: only workers who are employed at the same establishment for every year in which they show up in the data are included in the sample.

⁴⁴Admittedly, the sample selection introduces a potential bias into the results, but simultaneously helps to correct for any bias resulting from compositional effects.



Source: Muendler (2003b)

Figure C.1: Brazilian Protection Rates and Foreign Competition, 1990-1998

Macroeconomic Stabilization After a decade of rising inflation and a number of attempts to stabilize the economy, on July 1, 1994, the Brazilian government implemented the *Plano Real* to end years of hyperinflation. In the twelve months that preceded the introduction of the new currency, inflation had reached 5,154 percent per annum. By 1998, annual inflation was only 1.7 percent. Castelar-Pineiro, Giambiagi and Moreira (2001) remark that Brazil had the same inflation rate for a year that it had in a single day prior to the Real Plan. The drop in inflation allowed for increased efficiency and competition and attracted significant foreign direct investment.

Trade Liberalization The late 1980s and early 1990s witnessed sweeping changes in Brazilian trade policy. Figure C.1 charts the decline in Brazil's average tariff rates and rise

in effective rates of penetration over the 1990s, alongside major policy reforms over the 1990s. Beginning with the Collor de Mello administration and continuing with President Cardoso, Brazil began extensive policies of trade liberalization which paved the way for bilateral trade agreements and multilateral free trade areas with the Southern Cone countries of South America. Brazil's entry into MERCOSUL in 1991 was instrumental in beginning to attract greater inflows of FDI to the country as a regional export base for multinational firms (Castelar-Pineiro and Moreira (2000)).

Privatization Program In March 1990, President Fernando Collor de Mello launched the National Privatization Program (PND) under the auspices of Law No. 8,031, but it was the Cardoso administration which placed a high priority on the privatization of public services ending the discrimination against subsidiaries of foreign companies. Purchases by foreign investors reached 53 percent of the total privatization sales between 1995-2001 (BNDES (2003)).

Federal Deregulation Program With the intention of increasing competition among domestic producers, the Collor de Mello administration instituted the Federal Deregulation Program. Among other reforms were the elimination of legal restrictions limiting market entry into specific non-tradeable sectors by foreigners. At this time, foreign firms were also given national treatment in access to domestic preferential public credit markets.