

Multinational Spillovers through Worker Turnover*

Jennifer Pamela Poole[†]

University of California, Santa Cruz

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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 establishments 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.

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[†]Department of Economics, University of California, Santa Cruz, 437 Engineering 2, Santa Cruz, CA 95064, jpoole@ucsc.edu, (831) 459-5397.

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. Motivated by the social interactions model proposed by Manski (1993), I picture the growth of knowledge occurring when pairwise meetings between individual workers take place. Empirically, the transmission of knowledge occurs through interactions between individual 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 individual 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. 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 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 an industrialized country, the United Kingdom.

Local firms may also benefit from increased multinational presence if they are suppliers

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

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 (2008) 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 assumption that this knowledge is not firm-specific, worker mobility can serve as a mechanism

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.

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 Ghanaian 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 Strobl (2005) find that firms whose owners once worked in MNEs in the same industry are

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.

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 An econometric model of multinational spillovers

My estimation procedure derives from social interactions theory and allows an individual's outcome to depend on the characteristics of his environment.⁵ 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.

⁵See Brock and Durlauf (2001b) and Manski (1993).

To account for the fact that periods of establishment hiring tend to coincide with general periods of increased investment, i.e., establishments hiring recently displaced multinational-establishment workers may be hiring displaced workers from other domestic-owned establishments as well, I include a control for the share of recently-hired workers from 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 last period.

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 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.⁶ Because the sample of workers is restricted to remain in the same establishment,

⁶Please see appendix A for more information on the data construction.

individual fixed effects (ψ_i) fully absorb the establishment-specific effects ($\lambda_{j(i)}$). 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.

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 (Brazilian Labor Ministry 2001). The main variables of interest are the worker’s identification code (*Programa de Integração* (PIS)),⁷ 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)).

⁷A 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.

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.⁸ Next, RAIS has a depth of information 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 track 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.⁹ Next, the sample includes only full-time, prime-age workers; that is, workers between the ages of 15 and 64 years¹⁰ who work at least 40 contracted hours per week. Following Abowd, Kramarz and Margolis (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.¹¹

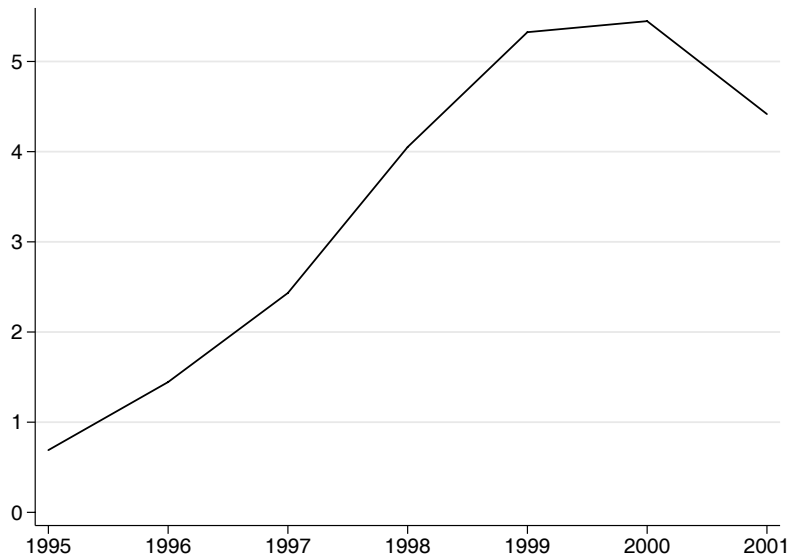
Muendler, Poole, Ramey and Wajenberg (2004) map the CBO to the *International Standard Classification of Occupations* (ISCO-88). The CBO-94 is a detailed, task-

⁸The 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 CNAE codes 40-90.

⁹Eleven 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.

¹⁰The 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.

¹¹There 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.



Source: World Bank, 2005.

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

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.¹² 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.

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 (World Bank (2005)). Direct investments increased significantly beginning in 1996, and more than quadrupled by 2001.¹³ 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,

¹²Created 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.

¹³Appendix 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.

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 direct investment inflows to Brazil are required to be registered with the Central Bank of Brazil (BCB) in the *Registro Declaratório Eletrônico - Investimentos Externos Diretos* (RDE-IED). The RDE-IED is available from the BCB for the years 1996 through 2001 (Brazilian Central Bank 2001). I define an establishment to be 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 foreign relationships in later years. Therefore, establishments are counted as foreign-owned in all years $\tau \geq t$ after the initial inflow in year t . Finally, I consider foreign funds at the holding-company level to affect all establishments of the corporate group. Using BCB information on corporate ownership relations among Brazilian firms, I count an establishment as foreign-owned in year $\tau \geq t$ if it is a subsidiary of a company receiving inflows of foreign capital in year t .¹⁴

¹⁴By my definition, a foreign-owned establishment which did not receive any foreign capital inflows between 1996 and 2001 is considered a domestic-owned establishment. In combination with information on the stock

Table 4.2: Multinational Share, 1996-2001

| | Standard | | | |
|---------------|----------|-----------|---------|---------|
| | Average | 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.

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.

4.3 Descriptive statistics

In this section, I present statistics that describe the MNE-switcher workers, the domestic-owned establishments that hire them, and the incumbent domestic-establishment of foreign investments in 2001, I am confident that I have identified all foreign-owned establishments.

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.

workforce.¹⁵

National Data First, I offer statistics from a nationally-representative sample of workers by major industrial sector.¹⁶ 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

¹⁵Please see appendix A for a complete description of the data construction.

¹⁶Statistics 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 4.4: 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.

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 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. The 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 his sector. The higher wages may reflect the wage premium often paid by MNEs (e.g., Gerschenberg (1987) and Lipsey (2004)). Workers displaced from foreign-owned establishments and rehired by domestic-owned establishments are, on average, in

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.

their early careers, no different from the national average. Switchers are less likely to be female. 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-intensity of MNEs, it is not surprising that workers displaced from MNEs are relatively higher skilled.

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.

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.

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 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.

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.

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 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

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.

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 .¹⁷ Consistent with the evidence presented in table 4.2, workers in the 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

¹⁷A 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.

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 in the previous time period. If positive multinational spillovers through worker mobility exist, I expect $\gamma_M > 0$ and $\gamma_M > \gamma_D$. Identification in this model is based on changes over time in the share of former multinational-establishment workers within an establishment for each worker. The 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 characteristics¹⁸ include age, age-squared, experience, experience-squared, tenure at the establishment, education,¹⁹ and the skill-intensity of occupation.²⁰ The establishment characteristics include log average establishment size, average age of the workforce,²¹ average tenure of the workforce, average experience of the

¹⁸Because I include individual fixed effects, variables that do not change over time such as gender and nationality are not included.

¹⁹Education enters into the equation as 3 dummies; primary school, high school, and college graduate (primary school is the omitted category).

²⁰Skill-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).

²¹Age enters as 7 shares; share of the establishment aged child (10-14 years), youth (15-17 years), adolescent

workforce, share of the establishment female, average education of the workforce,²² and average skill-intensity of occupation.²³

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 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.²⁴

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 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 .

(18-24 years), nascent career (25-29 years), early career (30-39 years), peak career (40-49 years), late career (50-64 years), post retirement age (65 years or older).

²²Education enters as 3 shares; share of the establishment with primary school, high school, and college graduate.

²³Skill-intensity of occupation enters as 4 shares; share of the establishment unskilled blue collar worker, skilled blue collar worker, other white collar worker, and professional worker.

²⁴Moulton (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.

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.

The omitted variable bias for the establishment fixed effect is large and positive. 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 omitted variable bias for the worker fixed effect is large, but negative. This result foreshadows those to come—low-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). 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.

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 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.

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 the coefficient for $\gamma_M - \gamma_D$, as well as the individual coefficients.²⁵ 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.

²⁵To 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.

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 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.

Figure 5.1 offers an illustration of the results from table 5.2. 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.

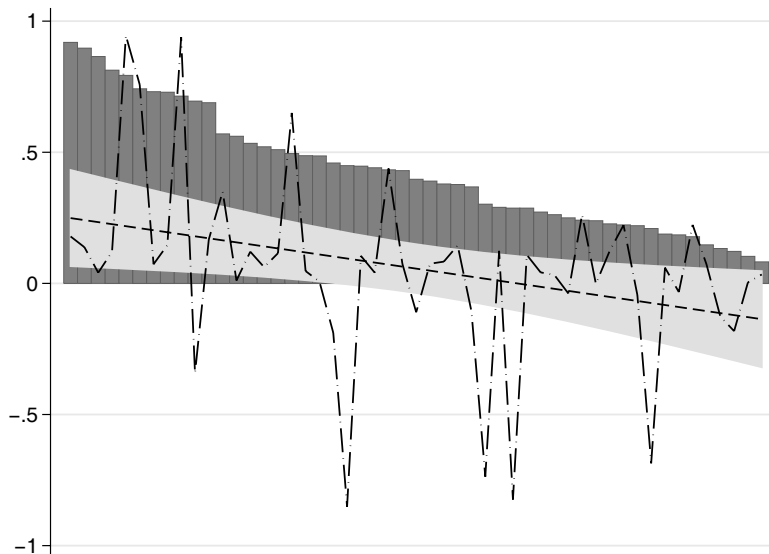


Figure 5.1: Multinational Spillovers, by Sector Skill-Intensity, 1996-2001

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</i> -statistic | 15.29 | 75.87 | 1.00 | 10.38 | 0.87 |
| <i>p</i> -value | 0.0001 | 0.0000 | 0.3183 | 0.0013 | 0.3506 |
| $(\gamma_M - \gamma_D) * \text{Sector Skill-Intensity}$ | | | | | 0.332** |
| <i>F</i> -statistic | | | | | 7.56 |
| <i>p</i> -value | | | | | 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.

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-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.²⁶

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 5.1.²⁷

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:

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

²⁶The individual coefficients on γ_M and γ_D are available by request.

²⁷In 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.

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.²⁸ The results are consistent with the hypothesis that higher-skilled former multinational-establishment workers are better able to transfer information to the incumbent

²⁸The individual coefficients on all γ_M and γ_D are available by request.

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 monotonically increasing with education.

The bottom panel of table 6.1 reports results by the MNE and non-MNE switcher worker's skill-level, as defined by the skill-intensity of occupation according to the following regression:

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

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.²⁹

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

²⁹Iranzo 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.

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-

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.

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 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 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 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

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.

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 (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 force and 2) switcher workers who sort into high wage establishments. I assess the plausibility of each of these concerns in turn.

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 force (perhaps with the intention of upgrading the skill-level of the workforce). This would violate the exogeneity assumption that ($E(S_{jt}^M * \epsilon_{ijt}) = 0$).

As a 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. However, it is the differential increase in former multinational-establishment worker hiring that is important to the estimation, so I 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 are again 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:³⁰

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

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

³⁰In section 5.1, I demonstrated that the inclusion of $\ln \bar{y}.t$ among the vector of regressors in Z_{jt} does not affect the main results.

Table 7.1: 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.

Table 7.1 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.³¹

In Column (2), I present results from equation (7.2).³² 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.

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 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

³¹While directly comparable to column (5) in table 5.1, the differences in the coefficients reflect the restricted sample.

³²Results for average establishment wages are suppressed.

increases the establishment's profits), 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 7.1 reports the results from an equation relating contemporaneous 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 lagged multinational spillover effect, controlling for other domestic hiring, is comparable to the contemporaneous multinational spillover effect, the results fail to support significant 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.

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-

Table 7.2: Robustness Check: MNE Screening, 1996-2001, 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.

owned establishment does not hold and the result captures only a signal of the quality of the former multinational-establishment worker.³³

Table 7.2 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.³⁴ 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

³³The average duration of employment at a multinational establishment for MNE switchers in the sample of 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.

³⁴The median tenure is approximately 1 year.

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 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.

References

- Abowd, John M., Francis Kramarz, and David N. Margolis, “High Wage Workers and High Wage Firms,” *Econometrica*, 1999, 67 (2), 251–333.
- Abowd, John. M., Francis Kramarz, David N. Margolis, and Kenneth R. Troske, “The Relative Importance of Employer and Employee Effects on Compensation: A Comparison of France and the United States,” *Journal of the Japanese and International Economies*, 2001, 15, 419–436.
- Aitken, Brian and Ann E. Harrison, “Do Domestic Firms Benefit from Foreign Direct Investment? Evidence from Venezuela,” *American Economic Review*, 1999, 89 (3), 605–618.
- , Gordon H. Hanson, and Ann E. Harrison, “Spillovers, Foreign Investment, and Export Behavior,” *Journal of International Economics*, 1997, 43, 103–132.
- Alfaro, Laura and Andrés Rodríguez-Clare, “Multinationals and Linkages: An Empirical Investigation,” *Economia*, Spring 2004, pp. 113–169.
- Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan, “How Much Should We Trust Difference-in-Difference Estimates?,” *Quarterly Journal of Economics*, 2004, 119, 249–275.
- Blomstrom, Magnus and Ari Kokko, “Multinational Corporations and Spillovers,” *Journal of Economic Surveys*, 1998, 12 (3), 247–277.
- BNDES, “Privatization in Brazil,” 2003. Banco Nacional de Desenvolvimento Econômico e Social, Unpublished Manuscript.
- Brazilian Central Bank, “Registro Declaratório Eletrônico—Investimentos Externos Diretos,” 2001.
- Brazilian Labor Ministry, “Relação Anual de Informações Sociais,” 2001.
- Brock, William A. and Steven N. Durlauf, “Interactions-Based Models,” in James Heckman and Edward Leamer, eds., *Handbook of Econometrics*, 2001b, 5.
- Brown, Charles and James Medoff, “The Employer Size-Wage Effect,” *Journal of Political Economy*, 1989, 97, 1027–1059.
- Cohen, Wesley M. and Daniel A. Levinthal, “Absorptive Capacity: A New Perspective on Learning and Innovation,” *Administrative Science Quarterly*, 1990, 35, 128–152.
- Cooper, David P., “Innovation and Reciprocal Externalities: Information Transmission via Job Mobility,” *Journal of Economic Behavior and Organization*, 2001, 45, 403–425.
- Elias, Peter and Margaret Birch, “Establishment of Community-Wide Occupational Statistics,” Technical Report, Institute for Employment Research, University of Warwick, February 1994.

- Fosfuri, Andrea, Massimo Motta, and Thomas Ronde**, “Foreign Direct Investment and Spillovers through Workers’ Mobility,” *Journal of International Economics*, 2001, 53 (1), 205–222.
- Gerschenberg, Irving**, “The Training and Spread of Managerial Know-How, A Comparative Analysis of Multinational and Other Firms in Kenya,” *World Development*, 1987, 15 (7), 931–939.
- Glass, Amy and Kamal Saggi**, “Multinational Firms and Technology Transfer,” *Scandinavian Journal of Economics*, 2002, 104, 495–513.
- Gorg, Holger and Eric Strobl**, “Spillovers from Foreign Firms through Worker Mobility: An Empirical Investigation,” *Scandinavian Journal of Economics*, 2005, 107 (4), 693–709.
- Greenaway, David, Nuno Sousa, and Katharine Wakelin**, “Do Domestic Firms Learn to Export From Multinationals?,” *European Journal of Political Economy*, 2004, 20, 1027–1043.
- Hale, Galina and Cheryl Long**, “What Determines Technological Spillovers of Foreign Direct Investment: Evidence from China,” 2006. Economic Growth Center, Yale University, Center Discussion Paper No. 934.
- and —, “Labor Market Imperfections and the Effects of FDI Presence in China,” 2007. Unpublished Manuscript.
- Haskel, Jonathan E., Sonia Pereira, and Matthew J. Slaughter**, “Does Inward Foreign Direct Investment Boost the Productivity of Domestic Firms?,” May 2004. Dartmouth College, Unpublished Manuscript.
- Iranzo, Susana and Giovanni Peri**, “Schooling Externalities, Technology and Productivity: Theory and Evidence from U.S. States,” *Review of Economics and Statistics*, forthcoming.
- Javorcik, Beata Smarzynska**, “Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages,” *American Economic Review*, 2004, 94 (3), 605–627.
- Jovanovic, Boyan and Rafael Rob**, “The Growth and Diffusion of Knowledge,” *The Review of Economic Studies*, 1989, 56 (4), 569–582.
- Keller, Wolfgang**, “Absorptive Capacity: On the creation and acquisition of technology in development,” *Journal of Development Economics*, 1995, 49, 199–227.
- , “International Technology Diffusion,” *Journal of Economic Literature*, 2004.
- and **Stephen Yeaple**, “Multinational Enterprises, International Trade, and Productivity Growth: Firm-Level Evidence from the United States,” 2008. Unpublished Manuscript.

- Lindsey, C. W.**, “Transfer of Technology to the ASEAN Region by U.S. Transnational Corporations,” *ASEAN Economic Bulletin*, 1986, 3, 225–247.
- Lipsey, Robert E.**, “Home- and Host-Country Effects of Foreign Direct Investment,” in *Robert E. Baldwin and L. Alan Winters, eds., Challenges to Globalization*, 2004.
- Malchow-Moller, Nikolaj, James R. Markusen, and Bertil Schjerner**, “Foreign Firms, Domestic Wages,” 2006. CEBR Copenhagen Working Paper.
- Manski, Charles**, “Identification of Endogenous Social Effects: The Reflection Problem,” *Review of Economic Studies*, 1993, 60, 531–542.
- Markusen, James R. and Natalia Trofimenko**, “Teaching Locals New Tricks: Foreign Experts as a Channel of Knowledge Transfers,” 2007. NBER Working Paper 12872.
- Moretti, Enrico**, “Workers’ Education, Spillovers, and Productivity: Evidence from Plant-Level Production Functions,” *American Economic Review*, 2004, 94 (3), 656–690.
- Moulton, Brent R.**, “An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units,” *The Review of Economics and Statistics*, 1990, 72, 334–338.
- Muendler, Marc-Andreas**, “Tariff Series for Brazil, 1986-1999,” 2003. University of California, San Diego, Unpublished Manuscript.
- Muendler, Marc Andreas, Jennifer P. Poole, Garey Ramey, and Tamara Wajnberg**, “Job Concordances for Brazil: Mapping the Classificação Brasileira de Ocupações (CBO) to the International Standard Classification of Occupations (ISCO-88),” 2004. University of California, San Diego, Unpublished manuscript.
- Pineiro, Armando Castelar and Mauricio Mesquita Moreira**, “Perfil dos Exportadores de Manufaturados: quais as implicações de politica?,” 2000. Fundação Centro de Estudios de Comércio, Working Paper.
- , **Fabio Giambiagi, and Mauricio Mesquita Moreira**, “Brazil in the 1990s: A Successful Transition?,” 2001. Banco Nacional de Desenvolvimento Econômico e Social, Unpublished Manuscript.
- Rodrigues, Denise Andrade**, “Investment in Brazil in the 1990s: Sectorial and Regional Views,” 2000. Banco Nacional de Desenvolvimento Econômico e Social, Unpublished Manuscript.
- Saggi, Kamal**, “Trade, Foreign Direct Investment, and International Technology Transfer: A Survey,” *The World Bank Research Observer*, Fall 2002, 17 (2), 191–235.
- World Bank**, *World Development Indicators* 2005.

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 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.³⁵

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 track 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.^{36,37}

³⁵As 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.

³⁶If the worker was hired by another multinational establishment, the observation is excluded from the analysis (as are all multinational establishments).

³⁷The 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 to his initial displacement.

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 establishment over the sample period. I focus on the retained worker to ensure pure spillover effects and not compositional effects.

B Supplemental Tables

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

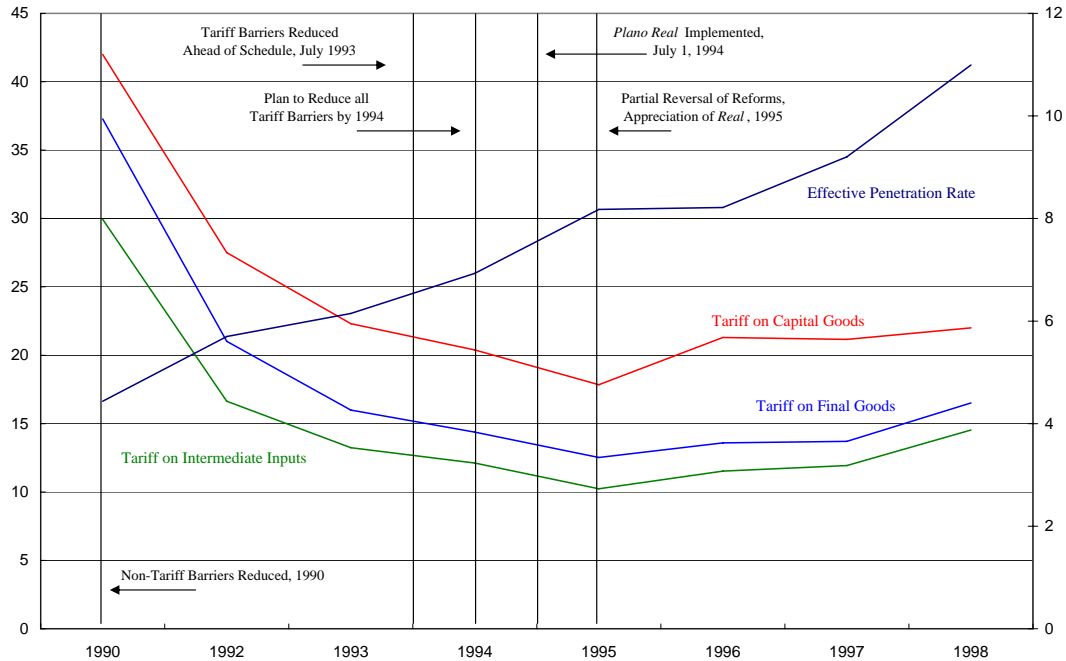
| Major Group | Description | Skill Level | Definition |
|-------------|---|-------------|----------------------------|
| 1 | Legislators, senior officials, and managers | 4 | Professional and Technical |
| 2 | Professionals | 4 | Professional and Technical |
| 3 | Technicians and associate professionals | 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.

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



Source: Muendler (2003)

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

introduction of the new currency, inflation had reached 5,154 percent per annum. By 1998, annual inflation was only 1.7 percent. 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 (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.