The Structure of Worker Compensation in Brazil, With a Comparison to France and the United States*

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Abstract

We employ a comprehensive linked employer-employee data set for Brazil to analyze wage determinants and compare results to Abowd, Kramarz, Margolis and Troske (2001) for French and U.S. manufacturing. While returns to human capital variables in Brazilian manufacturing exceed those of the other countries, occupation and gender differentials are similar. The worker characteristics component of individual compensation accounts for much of the greater wage inequality in Brazil, but the establishment-fixed component has scant explanatory power. Thus, firm- or industry-level factors have little scope for explaining wage inequality. Brazil's wage structure closely resembles that of France, a country with some similarity in labor-market institutions.

Keywords: Wage structure; wage inequality; linked employer-employee data; formal and informal employment; selectivity; Brazil

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The structure of wages is a topic of central importance in labor and development economics. Empirical research has tied wages closely to individual worker characteristics, including human capital and gender, and shown that industry- and firm-level characteristics play important roles. Earnings inequality has been broadly linked to these factors.

To avoid potentially serious omitted variable bias, recent work on wage structure has utilized linked employer-employee panel data, which admit a full range of worker- and firm-level controls. Considerable progress has been made in exploiting such data sets to assess aspects of wage structure in industrialized countries.[1] Due to data limitations, however, far less attention has been paid to developing countries.[2] This has restricted the evaluation of wage determination theories beyond the context of industrialized economies. Moreover, many issues in labor market policy relate to the wage structure. In particular, the relatively high wage inequality in developing countries is difficult to evaluate in the absence of cross-country information on wage structure determinants.

This paper examines the relationship between earnings, worker characteristics and firm characteristics in a developing country. We employ an extensive linked employer-employee data set for Brazil that is directly comparable to data sets for France and the U.S., as studied by Abowd et al. (2001). The data quality enables us to analyze compensation determinants, controlling for employer-fixed effects and detailed firm and worker characteristics. As far as we are aware, we report the first direct comparison of this kind between developing and industrialized countries.

We draw on Brazil's establishment-worker data set *Relação Anual de Informações Sociais*, or *RAIS*. This is an annual record of workers formally employed in any sector (agriculture, commerce, construction, manufacturing, utilities, services and public), with demographic information for individual workers, along with establishment identifiers. Beyond prior studies for developing countries, we estimate composite establishment-level fixed effects for a cross section of formally employed workers, and thereby capture unobserved establishment-average worker characteristics along with unobserved establishment characteristics. This allows us to evaluate

[1] Abowd, Kramarz and Margolis (1999) and Arai (2003) show for France and Sweden that substantial person-fixed and, to a lesser degree, employer-fixed effects account for wage dispersion. Postel Vinay and Robin (2002) decompose wage variation across workers further by occupation and find that the portion of cross-sectional wage variance explained by person-fixed effects is close to 40 percent for high-skilled white collar workers but quickly drops to zero with decreasing skill intensity of the job. Abowd and Kramarz (1999) survey other recent work in this area.

[2] Linked employer-employee data sets exist for Algeria (Chennouf, Levy and Montmarquette 1997), Zimbabwe (Velenchik 1997), Guatemala (Funkhouser 1998), Peru (Schaffner 1998), Morocco and Tunisia (Nordman and Destre 2002), Slovenia (Haltiwanger and Vodopivec 2003), Colombia (as mentioned in Abowd, Haltiwanger and Lane 2004), Bulgaria (Dobbelaere 2004), and Mexico (Kaplan, Mártinez González and Robertson 2004). Few data exhibit as rich a set of variables and as comprehensive employer and employee coverage as does *RAIS* in Brazil. Using *RAIS*, Mizala and Romaguera (1998) draw a random sample of 12,580 workers from 172 São Paulo state manufacturing firms in 1987.

the relationships between wages and observable worker characteristics, controlling for otherwise unmeasured effects.

Our primary purpose is to contrast the wage structure in Brazilian manufacturing in 1990 with that of France in 1992 and the U.S. in 1990, as evaluated by Abowd et al. (2001). Our data permit the adoption of those authors' exact statistical specification. The chosen reference year predates the implementation of Brazil's extensive pre-competitive reforms in the early 1990s, thus limiting the role of transition effects. To assess robustness, we also provide a set of results for 1997, a year that follows the transition period.[3]

We restrict our analysis to São Paulo state, the most economically advanced Brazilian state, as well as the manufacturing center of the country. Given its similarity to mid-income developing countries, São Paulo state provides a useful comparison of industrialized- versus developing-country wage determinants.[4] Our data capture the wage structure in the formal labor market. As a robustness check, we assess potential selectivity bias by predicting worker selection into our sample using complementary household data.

While past studies have compared returns to human capital in developing versus industrialized countries, ours is the first to provide a direct comparison based on linked employer-employee data. In line with traditional studies, we find that wage premia associated with human capital measures are far higher in Brazil than in France and the U.S. A typical male manufacturing worker in Brazil with at least some college attendance receives wages that are 180 percent higher than a comparable worker with at least some high-school education. This premium stands at 70 percent in the U.S., and in France it is only 60 percent. We also find that returns to experience among men are considerably greater in Brazil. Because we include establishment effects, these comparisons are robust to workforce sorting based on human capital and to unmeasured workforce characteristics (such as average ability) at the establishment level. On the other hand, we find that wage differentials based on occupation and gender are strikingly similar across the three countries.

Brazilian earnings inequality, as measured by the standard deviation of log wages, is 44 percent higher than in the U.S., and 90 percent higher than in France. Our estimated worker characteristics and establishment-fixed components of individual wages shed light on the overall importance of individual- versus establishment-level factors

[3]In 1990, the Collor administration initiated trade reforms, which involved the removal of widespread non-tariff barriers and the imposition of a new tariff structure. Implementation of these policies was largely completed by 1993. During the Franco administration in 1994, drastic anti-inflation measures succeeded for the first time in decades. A privatization program for public utilities was started in 1991 and accelerated in the mid 1990s.

[4]Brazil exhibits considerable economic diversity across states so that it can be problematic to consider average labor-market outcomes for the country as a whole. 41% of Brazil's manufacturing value added in the 1990s originates in São Paulo state, making the state highly representative of Brazilian manufacturing overall. São Paulo state is home to 22% of the Brazilian population and a third of all formal sector workers.

in explaining this difference. In all three countries, the predicted wages of manufacturing workers based on their observable characteristics play a dominant role in total compensation—amounting to between one-half and three-quarters of overall manufacturing wage variability. Establishment-fixed effects, in contrast, have relatively little importance in explaining Brazilian wages, compared to the other countries. Correspondingly, the variability of residual earnings, after controlling for worker and establishment characteristics, is much greater in Brazilian manufacturing.[5]

It follows that Brazil's relatively high wage inequality cannot be traced to establishment-level factors, including industry- and firm-level variables. To the contrary, worker-level factors, both measurable and unmeasurable, account for the observed cross-country differences in earnings inequality. This finding has direct implications for theoretical models of wage determination and renders employer-related explanations of wage dispersion relatively less important.

We further consider the relationships between firm characteristics and wages, using the manufacturing survey *PIA* (*Pesquisa Industrial Anual*), which provides firm-level input, output and performance measures. Firm identifiers in the *RAIS* and *PIA* data sets permit the linking of firm- and worker-level observations. We show that firm-average predicted worker characteristics and establishment-fixed components of wages, based on our estimates, each relate positively and significantly to firm size, capital intensity, occupational skill intensity, and workforce productivity in Brazilian manufacturing. Both workforce composition and unmeasured establishment-specific factors are important in explaining the higher wages paid by large, capital- and skill-intensive, and highly productive firms. The relationships between wages and firm characteristics are similar for Brazil and France, while the U.S. differs in important respects.

To assess the robustness of our results to the choice of sector, we replicate our analysis for three non-manufacturing sectors—services, commerce and agriculture—in 1990. Broadly speaking, the services and commerce sectors are similar to manufacturing regarding the relation between wages and individual characteristics, and the relative importance of the worker-characteristics and establishment-fixed components. In agriculture, however, the returns to human capital are smaller, and the establishment-fixed component is significantly more important. Thus, the agriculture sector, while small, demonstrates important differences with respect to wage determination.

The paper proceeds as follows. We discuss our main data sources *RAIS* (for worker and establishment information) and *PIA* (for manufacturing firm information) in Section 1, along with a complementary but not linkable household survey used for selection correction. Section 2 describes the statistical models. Section 3 presents results on Brazil's manufacturing wage structure in 1990 and 1997, and compares

[5]We inspect whether selection of Brazilian workers into formal employment induces a detectable bias in the log wage component estimates for Brazil. Under the assumption of jointly normally distributed formality selection disturbances and log wage residuals, we find no such evidence.

Table 1: Mean Log Wages and Employment Shares

	Mean Log Wage				Employment Shares			
	Manuf	Servcs	Comm	Agric	Manuf	Servcs	Comm	Agric
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Sector				
Year:								
1990	8.016	7.953	7.461	7.352	.398	.433	.151	.018
1997	8.872	8.797	8.406	8.056	.288	.500	.171	.041
				Education				
1990:								
Some college or more	9.014	8.589	8.261	8.146	.093	.217	.070	.027
High school or less	7.913	7.776	7.400	7.330	.907	.783	.930	.973
1997:								
Some college or more	9.891	9.462	9.202	9.128	.103	.225	.069	.022
High school or less	8.754	8.604	8.347	8.032	.897	.775	.931	.978
				Occupation				
1990:								
White collar	8.469	8.124	7.503	7.718	.292	.660	.679	.131
Blue collar	7.829	7.620	7.372	7.297	.708	.340	.321	.869
1997:								
White collar	9.288	8.923	8.420	8.727	.293	.720	.685	.092
Blue collar	8.699	8.475	8.377	7.988	.707	.280	.315	.908
				Gender				
1990:								
Male	8.174	8.040	7.549	7.421	.728	.558	.648	.802
Female	7.593	7.842	7.299	7.073	.272	.442	.352	.198
1997:								
Male	8.987	8.881	8.469	8.094	.744	.520	.625	.844
Female	8.536	8.706	8.301	7.854	.256	.480	.375	.156

Source: *RAIS* São Paulo state 1990 and 1997 (prime age workers in their highest-paying job). Wages in current USD (1990 and 1997 exchange rates). The log U.S. CPI change between 1990 and 1997 is .187.

findings to France in 1992 and the U.S. in 1990. Section 4 reports a re-estimation of Brazil's manufacturing wage structure controlling for formal-job selectivity, verifying the robustness of results. Connections between firm characteristics and wage components are investigated in Section 5. For the year 1990, Section 6 provides a comparison between manufacturing and non-manufacturing sectors. An extended discussion is offered in Section 7, and Section 8 concludes.

1 Data

We use comprehensive individual worker data with information on earnings, demographic characteristics and occupations, along with establishment ID codes for the place of work. From a separate source we obtain data on manufacturing firms that describe numerous firm-level characteristics. Firm-identifying establishment IDs from the worker data set make it possible to link the worker and firm observations. To verify that our results are not affected by worker selectivity into formal employment, we obtain out-of-sample predictions of employment status from a separate household survey.

Worker data. Our individual worker data derive from the labor force records *RAIS* (*Relação Anual de Informações Sociais* of the Brazilian labor ministry *MTE*). By Brazilian law, every private or public-sector employer must report detailed worker and job information to *RAIS* every year.[6]

A job observation in *RAIS* is uniquely identified by worker ID, the employer's establishment ID, and dates of job accession and separation. The establishment ID makes it possible to control for unobservable establishment and average-workforce effects in explaining the wage structure. For every worker, we keep the observation with the highest paying job on December 31st. In the available version of *RAIS*, workers' ages are reported in terms of eight age ranges. We exclude workers in the two highest ranges (50 years and older) to avoid potential confounding effects stemming from workers who leave the labor force prior to the official retirement age. We restrict attention to workers employed in São Paulo state in four private sectors (agriculture, commerce, manufacturing and services) for the years 1990 and 1997. The resulting samples consist of 5.89 million workers in 1990 and 6.37 million in 1997.

RAIS reports compensation as the monthly average wage, expressed in multiples of the current minimum wage. We use the log of annual wages as our earnings measure, defined as the reported monthly wage times the December U.S. dollar equivalent of the current minimum wage times 12. See Appendix A for further details concerning the compensation measure.

We use the reported age ranges jointly with the nine reported education categories to obtain a proxy for potential labor force experience. For example, a typical Early Career worker (34.5 years of age) who is also a Middle School Dropout (left school at 11 years of age) is assigned 23.5 years of potential labor force experience. Our education variable regroups the nine education categories included in *RAIS* to cor-

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

respond to the categories considered by Abowd et al. (2001).[7] Appendix A provides further details on the construction of our education and experience variables.

Occupational classifications in *RAIS* follow the *CBO* (*Classificação Brasileira de Ocupações*). To make this system comparable to standard international classifications, we mapped the *CBO* for 1994 into the commonly-used *ISCO-88* (*International Standard Classification of Occupations*, Muendler, Poole, Ramey and Wajnberg (2004)). The *ISCO-88* reclassifications are in turn mapped into five broad occupational categories (professional and managerial, technical and supervisory, other white collar, skill-intensive blue collar, and other blue collar). These correspond to the categories that Abowd et al. (2001) use.[8]

Table 1 indicates the sectoral employment shares within the 1990 and 1997 samples. Agriculture represents less than five percent of the totals in both years, while manufacturing and services each account for about 40 percent of the sample in 1990. For manufacturing, the employment share falls to less than 30 percent in 1997, while rising to 50 percent for services.

Table 1 also reports mean annual wages for selected demographic groups by sector and year, along with employment shares within sector. On average, manufacturing provides the highest level of earnings for males, and services provides the highest level for females. Males earn an unconditional wage premium in all sectors and years. Table 1 also indicates that workers with some college education earn a substantial unconditional premium in all sectors and years. The same holds true for workers in white collar occupations (professional and managerial, technical and supervisory, and other white collar), except for commerce in 1997, where wages across the two occupation groupings are nearly equal. Males make up the bulk of workers in agriculture and manufacturing, while females account for a substantial proportion of employment in commerce and services. Outside of services, the vast majority of workers have no college education. Blue collar occupations predominate in agriculture and manufacturing, and white collar occupations comprise most of employment in commerce and services. Appendix D provides complete lists with summary statistics of *RAIS* variables used in the paper.

Firm data. For the firm-level data, we use the manufacturing survey *PIA* (*Pesquisa Industrial Anual* from *IBGE*, the Brazilian census bureau) for 1990 and 1997. The

[7]The correspondence is imprecise in only one respect: the French and U.S. data allow Abowd et al. (2001) to distinguish between undergraduate and graduate degree attainment, while the *RAIS* combines these two categories. Our education indicator variables therefore distinguish four levels of schooling. "College Graduate" corresponds to the "Completed College" and "Completed Post-Graduate Degree" levels in Abowd et al. (2001).

[8]Brazil's *CBO-94* generally provides classifications at a finer level of detail than does *ISCO-88*. The level of detail in the Brazilian system permits the reclassifications needed for transforming the more profession-based Brazilian classifications into the more skill-based international classifications. For a small number of 1990 observations, *RAIS* includes *CBO* codes that are not used in *CBO-94*. We set these to "Miscellaneous" within the relevant subcategory.

data are a random sample of all but the smallest manufacturing firms. *PIA* includes a wide range of input, output and performance measures.[9]

IBGE's publication rules allow data from *PIA* to be withdrawn in the form of tabulations of cells having at least three firms. We construct cells using three-firm random combinations drawn from within each *Nível 50* sector, calendar year and location (metropolitan São Paulo city or rural). The *Nível 50* sectors consist of 31 manufacturing sectors, corresponding roughly to the two-digit *SIC* sectors in the U.S. A single four- or five-firm cell is defined within a sector when the number of firms in the sector is not divisible by three. For each three-to-five-firm cell, we calculate the number of firms as well as the sum, mean, and standard deviation of the relevant *PIA* variables. While the observations are aggregated, we retain the firm identifiers behind each newly-created composite observation, permitting the linking of *RAIS* workers to the composite observations. This procedure yields samples of 1,169 and 679 linked cells for 1990 and 1997, respectively. We provide details on the linking in Appendix B.

Complementary household survey data. The widely used Brazilian household survey *PNAD* (*Pesquisa Nacional por Amostra de Domicílios*) provides separate and complementary information on informal and formal employment. We relegate a discussion of *PNAD* variable definitions, and a brief comparison with *RAIS*, to Appendix C.

2 Statistical Models

Individual wages. The availability of establishment information in our worker data set allows us to include an establishment variable in our wage regressions. Following Abowd et al. (2001), we model individual compensation in a given year as

$$\ln w_i = x_i\beta + \psi_{J(i)} + \varepsilon_i, \tag{1}$$

[9] In *PIA* (*Pesquisa Industrial Anual*), the Brazilian statistical bureau *IBGE* surveys mining and manufacturing firms for the years 1986 to 1990, and from 1992 to present. We use observations for the years 1990 and 1997. In 1986, a firm qualified for *PIA* if at least half of its revenues stemmed from mining or manufacturing activity, and the starting sample was taken from three strata: (1) The population of the roughly 800 largest Brazilian manufacturers with sales in 1985 corresponding to at least 200 million 1995-BRL (1995-USD). (2) A random sample of medium-size firms with annual output in 1985 above 100,000 1995-BRL. More than 6,900 firms make it into *PIA* this way. (3) The non-random selection of newly founded firms with annual average employment of at least 100 persons. Around 1,800 such entrants are included in *PIA* until 1993. A firm that enters *PIA* through one of these three strata remains in the sample until legal extinction. Any affiliate, spin-off, or firm otherwise related to a sample firm enters *PIA*. Sampling changes in 1996 to represent all mining and manufacturing firms with more than 10 employees, but no capital stock figures are reported since. Therefore, the data set of this paper only includes firms in 1997 that are also present in *PIA* in at least one year prior to 1996. Their capital stock is inferred with a perpetual inventory method.

where w_i is worker i's annual wage, x_i is a vector of observable worker characteristics including gender, experience, education and occupation, β is a vector of parameters to be estimated, $\psi_{J(i)}$ is an establishment effect ($j = J(i)$ being the establishment that employs worker i), and ε_i is an error term. The establishment effect combines a pure establishment effect with the establishment average of pure worker effects:

$$\psi_j = \phi_j + \overline{\alpha}_j, \tag{2}$$

where ϕ_j is the pure establishment effect and $\overline{\alpha}_j$ is the average of pure worker effects α_i over workers employed at establishment j. The establishment effect controls for unobservable worker and establishment characteristics. Abowd and Kramarz (1999) show that omitting this effect leads to bias in the estimation of β in general.

Selectivity. Informal employment is not covered in *RAIS*. To remove potential bias from formal work status selectivity in (1), we assess work status selection based on identical worker characteristics x_i in the household data. We model selection as

$$h(x_i, \theta) + \eta_i > 0 \quad \text{iff worker } i \text{ is formally employed,} \tag{3}$$

where θ is a parameter vector. The coefficient vectors β and θ are estimated under two sets of structural assumptions. First, we assume joint normality of the errors ε_i and η_i. Second, under the assumption that $h(x_i, \theta)$ is a nonlinear function of x_i, contrary to $x_i\beta$, we estimate an analog to the nonparametric Das, Newey and Vella (2003) model.

Firm characteristics. For the firm-level analysis, the predicted wage component due to worker characteristics, $x_i\widehat{\beta}$, as well as the predicted establishment-fixed component, $\widehat{\psi}_j$, are linked to firms and aggregated to firm-level averages $\overline{\widehat{\psi}}_k$ and $\overline{x}_k\widehat{\beta}$. We then relate these firm-level components of individual compensation to firm-level variables q_k according to

$$q_k = \overline{\widehat{\psi}}_k\gamma_1 + (\overline{x}_k\widehat{\beta})\gamma_2 + \omega_{S(k)} + \nu_k, \tag{4}$$

where γ_1 and γ_2 are parameters to be estimated, ω_s is a sector effect, $s = S(k)$ is the *Nível 50* manufacturing sector in which firm k operates, and ν_k is an error term.

3 Individual Wage Structure in Manufacturing

Our specification of the individual compensation model (1) uses potential worker experience and indicator variables for gender, education and occupation as measures of individual characteristics. Quadratic, cubic and quartic terms for potential experience are included. Gender is interacted with all other variables. Table 2 presents

Table 2: MANUFACTURING WAGES IN BRAZIL, FRANCE AND THE U.S.

	Brazil 1990	Brazil 1997	France 1992	U.S. 1990
	(1)	(2)	(3)	(4)
Primary School Education (or less)	-1.075	-1.000	-.338	-.526
	(.002)	(.002)	(.009)	(.008)
Some High School Education	-.923	-.881	-.256	-.404
	(.002)	(.002)	(.009)	(.007)
Some College Education	-.339	-.316	-.200	-.334
	(.003)	(.003)	(.009)	(.007)
College Graduate			-.064	-.123
			(.016)	(.007)
Professional or Managerial Occupation	.856	.912	.760	.359
	(.002)	(.002)	(.009)	(.004)
Technical or Supervisory Occupation	.600	.632	.401	.206
	(.002)	(.002)	(.007)	(.004)
Other White Collar Occupation	.262	.249	.169	-.039
	(.002)	(.002)	(.011)	(.005)
Skill Intensive Blue Collar Occupation	.239	.225	.155	.083
	(.001)	(.001)	(.007)	(.003)
Potential Labor Force Experience	.095	.082	.069	.083
	(.0005)	(.0007)	(.003)	(.002)
Quadratic Experience Term	-.003	-.003	-.004	-.003
	(.00005)	(.00007)	(.0002)	(.0001)
Cubic Experience Term	.00005	.00008	.0001	.00007
	(2.29e-06)	(2.86e-06)	(1.00e-05)	
Quartic Experience Term	-3.01e-07	-7.64e-07	-1.20e-06	-4.70e-07
	(3.24e-08)	(3.89e-08)	(1.00e-07)	(3.00e-08)
Female	.060	.070	.052	-.078
	(.005)	(.006)	(.024)	(.019)
Female × Primary School Education (or less)	.106	.051	*-.0006*	.041
	(.004)	(.004)	(.021)	(.016)
Female × Some High School Education	-.016	-.058	*-.016*	*-.009*
	(.004)	(.004)	(.021)	(.015)
Female × Some College Education	.018	*-.005*	*.025*	*-.019*
	(.005)	(.005)	(.021)	(.015)
Female × College Graduate			-.062	*-.022*
			(.029)	(.015)
Female × Professional or Managerial Occupation	-.101	-.058	-.049	-.086
	(.004)	(.005)	(.016)	(.007)
Female × Technical or Supervisory Occupation	-.173	-.250	*-.006*	.037
	(.003)	(.004)	(.011)	(.008)
Female × Other White Collar Occupation	.088	.071	.033	.046
	(.003)	(.003)	(.013)	(.006)
Female × Skill Intensive Blue Collar Occupation	-.208	-.167	-.045	-.043
	(.002)	(.003)	(.010)	(.008)
Female × Potential Labor Force Experience	-.056	-.036	-.047	-.016
	(.0008)	(.001)	(.004)	(.003)
Female × Quadratic Experience Term	.002	.002	.004	*.0003*
	(.0001)	(.0001)	(.0003)	(.0002)
Female × Cubic Experience Term	-.00006	-.00005	-.0001	.00000
	(4.35e-06)	(5.63e-06)	(1.00e-05)	
Female × Quartic Experience Term	7.06e-07	5.40e-07	1.20e-06	*1.80e-08*
	(6.32e-08)	(7.78e-08)	(1.10e-07)	(4.00e-08)
R^2 (within)	.508	.468	.817	.617
Residual degrees of freedom	2,326,428	1,828,049	23,920	148,992

Sources: *RAIS* São Paulo state manufacturing 1990 and 1997 (prime age workers in their highest-paying job), Abowd et al. (2001) for France and the U.S., controlling for establishment fixed effects. Estimates for Brazil relative to college graduates, for France and the U.S. relative to workers with post-graduate degree. Standard errors in parentheses (insignificant point estimates at the five percent level in *italics*).

Table 3: Relative Manufacturing Wages in Brazil, France and the U.S.

	Brazil 1990	Brazil 1997	France 1992	U.S. 1990
	(1)	(2)	(3)	(4)
		Education[a]		
Male worker:				
College Degree	2.516	2.412	1.376	1.693
Some College	1.793	1.758	1.057	1.073
Primary School (or less)	.859	.888	.920	.885
Female worker:				
College Degree	2.556	2.556	1.488	1.746
Some College	1.855	1.854	1.101	1.062
Primary School (or less)	.970	.990	.935	.930
		Occupation[b]		
Male worker:				
Professional or Managerial	2.355	2.488	2.139	1.432
Technical or Supervisory	1.821	1.882	1.493	1.228
Other White Collar	1.299	1.283	1.184	.962
Skill-intensive Blue Collar	1.270	1.252	1.168	1.087
Female worker:				
Professional or Managerial	2.128	2.348	2.037	1.313
Technical or Supervisory	1.532	1.466	1.484	1.275
Other White Collar	1.419	1.377	1.224	1.006
Skill-intensive Blue Collar	1.031	1.059	1.116	1.041
		Gender[c]		
Female worker	.893	.915	.803	.899

[a]Relative to worker with some or complete high school education, controlling for occupation.
[b]Relative to non-skill-intensive blue collar occupations, controlling for education.
[c]Female relative to male workers, controlling for education and occupation.

Sources: *RAIS* São Paulo state manufacturing 1990 and 1997 (prime age workers in their highest-paying job), Abowd et al. (2001) for France 1992 and the U.S. 1990. Wage levels relative to comparison-group wage levels from component estimates (Table 2). For France and the U.S., wage prediction of college graduates reassigned to predicted fixed effects component.

results for the manufacturing sector in 1990 and 1997. Comparable estimates for manufacturing workers in France in 1992 and the U.S. in 1990, drawn from Abowd et al. (2001), are also reported.[10]

Wages and worker characteristics in Brazil. To facilitate the interpretation of earnings components, Table 3 summarizes the wage differentials for education,

[10]Data for France derive from the *Enquête sur la Structure des Salaires* (*ESS*), which samples responses to an annual administrative census of business enterprises. Data for the U.S. derive from the *Worker-Establishment Characteristic Database* (*WECD*), which links individual census responses to manufacturing establishments surveyed in the *Longitudinal Research Database* (*LRD*). See Abowd et al. (2001) for further details.

occupation and gender implied by Table 2 estimates. As regards education, Brazilian manufacturing workers with some college education earn almost twice as much on average as high school graduates, and college graduates earn two-and-a-half times as much. The profiles of education differentials for men and women display striking similarity, and change little between 1990 and 1997.

With respect to occupations, relative wages in Brazil rise for both men and women as occupations increase in skill intensity. Professional and managerial workers, for example, earn over twice as much as non-skill-intensive blue collar workers. The profile is steeper for men. Male skill-intensive blue collar workers earn a premium of nearly 30 percent relative to their non-skill-intensive blue collar counterparts, while among women the wages of all blue collar workers are roughly similar. Differences in the occupational returns between 1990 and 1997 are very small.

Figure 1 displays average wages by years of experience for male and female workers, as derived from the Table 2 estimates. For both sexes, wages in Brazilian manufacturing rise with experience throughout the range of years considered, with returns to experience being much higher for males but relatively less steep in 1997 than in 1990.[11]

Comparison with France and the U.S. Our wage structure estimates for Brazil can be directly contrasted with the findings of Abowd et al. (2001) for France and the U.S., given the comparability of our variable definitions and econometric specification. Figure 1 and Table 3 report the estimated experience-wage profiles and education, occupation and gender differentials for all three countries. For men, the experience profile is steeper in Brazil than in the U.S., and much steeper than in France. A similar pattern holds with respect to education premia, where the returns to college for Brazilian men are dramatically higher than for either French or American men. In general, measured returns to human capital acquisition by men are highest in Brazil and lowest in France.

Women present a different picture. As Figure 1 shows, the experience profile for Brazilian women is much flatter than for men. Returns to experience for women in Brazil are below those in the U.S., while still being above those in France. Thus, while women earn lower compensation for experience relative to men in all three countries, the gap is far larger in Brazil. Similar to France and the U.S., women receive higher college premia in Brazil than men. Excepting the relatively small earnings increase from primary school to high school education for women in manufacturing, women realize higher returns to human capital acquisition relative to men in all three countries.

The results also reveal a striking similarity between occupation differentials in Brazil and France for both sexes. For Brazil, the male occupation profile by skill is

[11] Arbache (2001) stresses the stability of Brazilian wage structure in micro data despite a series of policy reforms. We confirm stability of manufacturing wages between 1990 and 1997 for returns to education and for occupation premia, but not for returns to experience.

Sources: *RAIS* São Paulo state manufacturing 1990 and 1997 (prime age workers in their highest-paying job), Abowd et al. (2001) for France 1992 and the U.S. 1990. Wage levels relative to zero experience wage levels from wage component estimates (Table 2). Calculations for France 1992 and the U.S. 1990 based on Abowd et al.'s (2001) estimates and summary statistics.

Figure 1: **Potential experience profiles in Brazil, France and the U.S.**

slightly steeper than for France, while the female occupation profiles in Brazil and France are very similar in 1990 and close in 1997. U.S. occupation premia are much lower and exhibit a larger wage premium for skill-intensive blue-collar occupations than for other (non-skill-intensive) white collar occupations.

The remaining gender gap in wages—conditional on experience, education and occupation differences between genders—is less pronounced in Brazil than in France and closer to U.S. manufacturing. The overall Brazilian female/male wage ratio of around 90 percent lies very near the U.S. figure and markedly above the level of 80 percent in France.

In summary, Brazil's earnings pattern in manufacturing resembles that of the U.S. more closely in experience, education and gender, while occupational premia in Brazil and France are quite similar.

Components of individual wages. We next assess the overall explanatory power of the estimated worker characteristics and establishment-fixed components of individual wages, given by $x_i\widehat{\beta}$ and $\widehat{\psi}_j$, respectively. The worker characteristics component represents the predicted wages of a worker with observed characteristics x_i, conditioning on his or her place of work. As discussed above, the establishment-fixed component captures both establishment-average pure worker effects and pure establishment effects, so it reflects predicted wages based on the establishment mean of unobserved worker characteristics together with unobserved establishment characteristics. Finally, the residual component of wages captures worker-level wage determinants that remain after controlling for worker characteristics and establishment-fixed effects. To ensure comparability with Abowd et al. (2001), we exclude education variables and compute wage components from a re-estimated model.[12] As a consequence, the effect of education on wages is subsumed into the residual component.

Table 4 assesses the importance of the two components in explaining wages. Column (1) of the table reports the means of log wages and the two wage components for the three countries expressed in 1990 U.S. dollars, and for Brazil in 1997 expressed in 1997 U.S. dollars. Standard deviations are given in column (2), and the remaining columns indicate simple correlations between log wages, the wage components and the regression residuals. Observe that the standard deviation of log wages for Brazil in 1990 exceeds that of France and the U.S. by 90 percent and 44 percent, respectively, indicating substantially greater earnings inequality in Brazil.

In all three countries, the predicted wages of workers based on their observable characteristics play an important role in determining total compensation. For Brazil, the variability of the worker characteristics components in 1990 and 1997, measured

[12]The samples for France in 1990 and the U.S. used by Abowd et al. (2001) distinguish college and post graduate education, while our Brazilian data combine all college graduates into a single category. So we cannot directly compare estimated individual characteristics components across the samples unless education is excluded. For France and the U.S., we report the results from Abowd et al. (2001) that use the specifications excluding education.

Table 4: Variability of Manufacturing Wages in Brazil, France and the U.S.

	Mean	St.Dev.	Correlation with $\ln w_i$	$x_i\widehat{\beta}$	$\widehat{\psi}_j$	$\widehat{\varepsilon}_i$
	(1)	(2)	(3)	(4)	(5)	(6)
Brazil 1990						
Log Annual Wage ($\ln w_i$)	8.019	.785	1.000			
Worker Characteristics ($x_i\widehat{\beta}$)	.962	.491	.667	1.000		
Establishment-Fixed ($\widehat{\psi}_j$)	7.056	.203	.358	.160	1.000	
Residual ($\widehat{\varepsilon}_i$)	.000	.550	.700	.000	-.000	1.000
Brazil 1997						
Log Annual Wage ($\ln w_i$)	8.872	.778	1.000			
Worker Characteristics ($x_i\widehat{\beta}$)	.878	.441	.622	1.000		
Establishment-Fixed ($\widehat{\psi}_j$)	7.994	.267	.435	.161	1.000	
Residual ($\widehat{\varepsilon}_i$)	-.000	.549	.705	-.000	-.000	1.000
France 1992[a]						
Log Annual Wage ($\ln w_i$)	10.158	.414	1.000			
Worker Characteristics ($x_i\widehat{\beta}$)	.637	.287	.791	1.000		
Establishment-Fixed ($\widehat{\psi}_j$)	9.521	.172	.581	.237	1.000	
Residual ($\widehat{\varepsilon}_i$)	.000	.190	.457	-.003	.000	1.000
U.S. 1990						
Log Annual Wage ($\ln w_i$)	10.174	.544	1.000			
Worker Characteristics ($x_i\widehat{\beta}$)	.672	.271	.598	1.000		
Establishment-Fixed ($\widehat{\psi}_j$)	9.502	.266	.610	.242	1.000	
Residual ($\widehat{\varepsilon}_i$)	.000	.350	.627	-.029	.000	1.000

[a]Means converted to USD (December 31st, 1990).

Sources: *RAIS* São Paulo state manufacturing 1990 and 1997 (prime age workers in their highest-paying job), Abowd et al. (2001) for France 1992 and the U.S. 1990. Estimates for all three countries from establishment-fixed effects wage regressions relative to other blue-collar occupations, *not* controlling for education to achieve comparability (not reported). Statistics based on estimation sample. The log U.S. CPI change between 1990 and 1997 is .187.

by standard deviation, amounts to 62.5 percent and 56.7 percent, respectively, of the variability of log wages. Comparable figures for France and the U.S. are 65.1 percent and 49.8 percent. Moreover, worker characteristics have high explanatory power, as exhibited by the high correlations between the worker characteristics components and log wages across the four cases. Arguably, these figures understate the importance of worker characteristics, since education has been subsumed into the residual component.

In contrast, the establishment-fixed component is much less important for Brazil. The variability of this component amounts to 25.9 percent of total wage variability in 1990, and 34.3 percent in 1997. The corresponding percentages for France and the U.S. are 41.6 and 48.9, respectively. The establishment-fixed component also has lower explanatory power in Brazil, as indicated by the relatively low correlations between the components and log wages in Brazil (.358 and .435) versus France and the U.S. (.581 and .610). Unmeasured characteristics at the establishment level appear to explain substantially less of the variation in log wages in Brazil relative to France and the U.S.[13]

Comparing the establishment-fixed components shows the extent to which establishment-level factors can explain the relatively greater earnings inequality in Brazil. Importantly, the standard deviations of the Brazilian establishment-fixed components in 1990 and 1997 (.203 and .267) are closely comparable in magnitude to the corresponding values for France and the U.S. (.172 and .266). Thus, explanatory variables based on establishment cannot account for the differences in overall wage variability. We return to the importance of this finding in the discussion in Section 7.

Finally, the two wage components considered jointly have lower explanatory power in Brazil. Comparing the goodness of fit R^2 (within) values in Table 2 relative to France and the U.S., Brazilian wages display much greater unexplained variability.

Decomposition of wage inequality. We inquire further as to how the establishment-fixed and worker characteristics components contribute to log wage inequality in Brazilian manufacturing.[14] The individual earnings model (1) decomposes log wages into mutually exclusive additive components. Shorrocks (1982) shows that, under plausible invariance axioms, the unique decomposition of any inequality index is proportional to the additive decomposition of the squared coefficient of variation.[15]

Table 5 reports the Shorrocks (1982) decomposition of log annual wage inequality into its components. For this purpose, we include education in the wage regressions. Worker characteristics account for around half of wage inequality in both years. The unexplained residual in log wages, however, accounts for almost as much of log wage inequality as do observed worker characteristics.

Recall that the estimated establishment-fixed effect combines a pure establishment effect with the establishment average of pure worker effects. This combined establishment-fixed effect accounts for only about 10 percent of total log wage inequality. Omitting the establishment-fixed effect in straight OLS regressions induces a slight increase in the contribution of worker characteristics to log wage inequality of around three percentage points. This effect is tiny, and the estimates of returns to experience and eduction, the premia on occupations, and the gender differential hardly change when establishment-fixed effects are removed.[16] The establishment-

[13]These results are broadly consistent with the general finding that worker effects dominate firm effects in explaining wages. Abowd and Kramarz (1999) provide a review of the numerous studies establishing the relative importance of worker effects.

[14]Fishlow (1972) and subsequent studies investigate sources of income inequality in Brazil by demographic group; our focus lies on the estimated earnings components.

[15]The squared coefficient of variation is an inequality index in the generalized entropy family and equals two times the generalized entropy measure of degree two.

[16]Velenchik (1997) for Zimbabwe and Funkhouser (1998) for Guatemala also report only a small bias when employer-fixed effects are omitted.

Table 5: Components of Manufacturing Log Wage Inequality

	1990		1997	
	FE[a]	OLS[b]	FE[a]	OLS[b]
	(1)	(2)	(3)	(4)
Worker Characteristics ($x_i\widehat{\beta}$)	.501	.529	.445	.484
Experience	.158	.170	.110	.121
Occupation	.137	.139	.139	.141
Education	.134	.140	.145	.161
Gender	.072	.080	.051	.061
Establishment-Fixed Effect ($\widehat{\psi}_j$)[c]	.081		.131	
Residual ($\widehat{\varepsilon}_i$)	.418	.471	.424	.516

[a]Component estimates from log wage regressions in Table 2, columns 1 and 2.

[b]Component estimates from log wage estimates of model (1), but omitting the fixed effect.

[c]Regression constant for OLS.

Source: *RAIS* São Paulo state manufacturing 1990 and 1997 (prime age workers in their highest-paying job). Underlying inequality index: squared coefficient of deviation (Shorrocks 1982), based on estimation samples.

fixed effect reduces the residual component in log wage inequality, and accounts for no more than a fifth of otherwise unexplained residual variability. So, unobserved worker heterogeneity is behind the bulk of unexplained earnings inequality in Brazil.

4 Formal Work Status Selectivity

Selection into formality. In the Brazilian manufacturing sector, informal workers constitute 22 and 35 percent of the workforce in 1990 and 1997, respectively. We inspect whether selection of workers into formal work status affects estimates of the individual earnings model (1) for Brazil. For this purpose, we make use of the *PNAD* household data. Occupational reporting is less reliable in the household data, so we only discern between blue and white-collar jobs. To improve fit, we distinguish nine levels of educational attainment. The categories are identically defined in the *PNAD* household and the *RAIS* labor force data.

Let selection into formal employment be modelled as in (3): worker i is formally employed iff $h(x_i, \theta) + \eta_i > 0$. Conditional on presence in the *RAIS* census, expected compensation (1) becomes

$$\mathbb{E}\left[\ln w_i \,|\mathcal{I}_i = 1, x_i\right] = x_i\beta \,+\, \psi_{J(i)} \,+\, \mathbb{E}\left[\varepsilon_i \,|h(x_i, \theta) > -\eta_i\right], \tag{5}$$

where $\mathcal{I}_i = 1$ indicates formal status. We use regressors x_i common to both the household and *RAIS* data sets for prediction of $h(x_i, \theta)$ in *RAIS*, based on household-data estimates of θ. Two sets of structural assumptions are considered.[17]

[17]The regressor sets x_i in (1) and in the selection condition $h(x_i, \theta) + \eta_i > 0$ coincide unless there

First, in the spirit of Heckman's (1979) two-stage parametric procedure, we estimate formality selection using a probit model on the household data. The errors ε_i and η_i are assumed to be jointly normally distributed, and we adopt the simplification $h(x_i, \theta) = x_i\theta$. The selection probability is given by the cumulative normal distribution at $x_i\theta$, $P(\mathcal{I}_i = 1|x_i) = \Phi(x_i\theta)$. It follows that β in (5) is identified, and the least squares estimator is unbiased, after inclusion of the predicted inverse of Mills' ratio as regressor (Heckman 1979).

To implement the parametric procedure, we first obtain estimates of the selection coefficients θ for 1990 and 1997 from *PNAD*, using *PNAD* variables that coincide with *RAIS* variables. We find that the probability of formal work status significantly increases with education and experience, while occupation and gender have no statistically significant effect. We take the coefficient estimates for an out-of-sample prediction of the inverse of Mills' ratio for every worker in the *RAIS* census of formal employment. Finally, we include the predicted inverse of Mills' ratio in our individual compensation model (5) to gauge the bearing of formality selection on the compensation estimates.

Table 6 reveals that returns to education, occupation premia, and gender differences, for both 1990 and 1997, are essentially unaffected by the parametric correction (columns 1 and 2, as well as 4 and 5).[18] Findings are similar for experience premia and components of individual wages.

Second, as a further robustness check, we make the alternative assumption that $h(x_i, \theta)$ is a nonlinear function of x_i, whereas $x_i\beta$ involves no higher-order interactions, and estimate the so-restricted semiparametric analog to the nonparametric Das et al. (2003) model.[19] In particular, we estimate the propensity score of formality status with a polynomial expansion of continuous variables up to fourth order and the full set of indicator variable interactions (excluding the blue-collar indicator from higher-order interactions).[20] In the compensation equation, we use the propensity score and its square (which are both statistically significant) to approximate the non-zero disturbance expectation.

As seen in Table 6, the semiparametric correction has only a tiny effect on esti-

are worker characteristics that predict formality, but do not correlate with compensation. We have no evidence for the existence of such instruments.

[18]In a similar vein, Carneiro and Henley (1998) find no significant bearing of the informal sector's size on Brazilian real wages in a short-term model of wage determination.

[19]In our application, identification requires restricting the parametric part of the compensation equation to lower-order interactions. This introduces potential specification error. We thus view our semiparametric version of the Das et al. (2003) model merely as a robustness check of Heckman (1979) correction.

[20]Leave-one-out cross validation shows this polynomial expansion to exhibit superior fit with an average squared prediction error up to six percent below lower-order approximations and four percent below the minimum-error specification with blue-collar indicators. We choose polynomial estimation after finding the semiparametric Klein and Spady (1993) estimator to exhibit problematic convergence behavior.

Table 6: Relative Manufacturing Wages in Brazil under Selectivity

	RAIS 1990 (FE)			*RAIS* 1997 (FE)		
	No corr.	Param.	Semip.	No corr.	Param.	Semip.
	(1)	(2)	(3)	(4)	(5)	(6)
			Education[a]			
Male worker:						
College Degree	2.516	2.494	2.516	2.412	2.386	2.412
Some College	1.793	1.795	1.793	1.758	1.766	1.758
Primary School (or less)	.859	.881	.859	.888	.901	.888
Female worker:						
College Degree	2.556	2.504	2.555	2.556	2.488	2.547
Some College	1.855	1.794	1.854	1.854	1.812	1.848
Primary School (or less)	.970	.974	.969	.990	.996	.984
			Occupation[b]			
Male worker:						
Profess'l or Managerial	2.355	2.370	2.355	2.488	2.493	2.488
Technical or Superv.	1.821	1.836	1.821	1.882	1.887	1.882
Other White Collar	1.299	1.310	1.299	1.283	1.285	1.283
Skill-int. Blue Collar	1.270	1.269	1.270	1.252	1.252	1.252
Female worker:						
Profess'l or Managerial	2.128	2.065	2.129	2.348	2.341	2.349
Technical or Superv.	1.532	1.486	1.533	1.466	1.460	1.467
Other White Collar	1.419	1.376	1.419	1.377	1.372	1.378
Skill-int. Blue Collar	1.031	1.029	1.031	1.059	1.059	1.059
			Gender[c]			
Female worker	.893	.901	.893	.915	.917	.915

[a]Relative to worker with some or complete high school education, controlling for occupation.
[b]Relative to other blue collar occupations, controlling for education.
[c]Female relative to male workers, controlling for education and occupation.

Source: *RAIS* (prime age workers in their highest-paying job) São Paulo state manufacturing, 1990 and 1997. Out-of-sample selectivity predictions of formality status from *PNAD* (prime age household members in September) coefficient estimates. Wage levels relative to comparison-group wage levels from component estimates.

mated returns to education, occupation premia, and gender differences for both years. The experience premia and wage components are similarly unaffected. We conclude that our findings are robust to formal-sector selectivity.

Wage effects of formality selection. Under parametric Heckman (1979) correction, the coefficients on the inverse Mills' ratio capture the covariance between the error term in the selection equation and the error term in the individual compensation model. Our *RAIS* estimates are −.259 in 1990 and −.137 in 1997, with standard errors of .122 and .037, respectively. These negative and statistically significant correlations between the two error terms indicate that workers whose unobserved characteristics raise the probability of informal employment receive *higher* wage compensation in their formal jobs, all else equal. In other words, the informal sector exerts a slight upward pressure on formal-job wages for workers who are more likely to find employment in the informal sector.

5 Wage Components and Firm Characteristics

We draw on the linked *RAIS-PIA* sample to relate the firm-average worker characteristics and establishment-fixed components of individual wages to the characteristics of manufacturing firms. The firm characteristics model (4) estimates partial correlations between selected firm characteristics and the two wage components. This allows us to assess what may be predicted about firm characteristics from one wage component, controlling for the other component. We consider five measures of inputs and three measures of productivity at the firm level, corresponding to the variables analyzed by Abowd et al. (2001). Results for Brazil in 1990 and 1997, along with France in 1992 and the U.S. in 1990, are reported in Table 7.

As seen in column (1) of Table 7, the size of Brazilian manufacturing firms, measured in terms of total employment, exhibits a mild positive correlation with both of the wage components in 1990. An increase of one percent in the characteristics-predicted wage levels of a firm's workers, holding constant the predicted wages of its establishments, is associated with a nearly 1.2 percent increase in firm size, while a one percent increase in the predicted wage levels of a firm's establishments, holding constant its characteristics-predicted worker wages, implies an increase in size that approaches 1.5 percent. Both firm-average wage components relate positively with total capital stock, with the wage elasticities of capital stock being in excess of two percent. Correspondingly, high-wage manufacturing firms, measured with respect to either of the wage components, tend to be more capital intensive.

Comparing Brazil to France, the correlations of employment and capital stock with the worker characteristics component of wages are quite similar, but employment and capital stock have much stronger positive correlations with the establishment-fixed component in France. Controlling for predicted wages due to average worker characteristics, firms with high-wage establishments are much more likely to be large and capital intensive in France. For the U.S., in contrast, high predicted worker wages are associated with smaller firms, and the relationship with capital intensity is only slightly positive. The establishment-fixed component relates positively to firm size and capital stock in the U.S., but the partial correlations are much smaller than in Brazil and France. Thus, the link between input characteristics and the wage structure of firms, particularly as predicted by average worker characteristics, differs sharply between Brazil and France, on one hand, and the U.S., on the other.

The link between wage components and occupational structure is considered in two ways, consistent with the differing French and U.S. measures used by Abowd et al. (2001). The variable "High-Skill Occupation Ratio" (corresponding to the French

Table 7: MANUFACTURING FIRM CHARACTERISTICS AND WAGES IN BRAZIL, FRANCE AND THE U.S.

	Brazil 1990	Brazil 1997	France 1992	U.S. 1990
	(1)	(2)	(3)	(4)
Log Employment[a]				
Mean Worker Characteristics ($\overline{x}_k\widehat{\beta}$)	1.111	.783	1.103	-.486
	(.141)	(.144)	(.402)	(.130)
Mean Establishment-Fixed ($\overline{\widehat{\psi}}_k$)	1.496	1.716	4.588	.223
	(.187)	(.172)	(.495)	(.073)
Log Capital Stock				
Mean Worker Characteristics ($\overline{x}_k\widehat{\beta}$)	2.336	.841	2.290	*-.183*
	(.207)	(.185)	(.510)	(.154)
Mean Establishment-Fixed ($\overline{\widehat{\psi}}_k$)	2.403	1.703	6.751	.838
	(.274)	(.219)	(.628)	(.086)
Log Capital-Labor Ratio				
Mean Worker Characteristics ($\overline{x}_k\widehat{\beta}$)	1.244	.337	1.187	.303
	(.121)	(.149)	(.200)	(.060)
Mean Establishment-Fixed ($\overline{\widehat{\psi}}_k$)	.920	*.104*	2.163	.615
	(.160)	(.177)	(.247)	(.034)
Non-Production Worker Ratio[a]				
Mean Worker Characteristics ($\overline{x}_k\widehat{\beta}$)	.052	.055		.124
	(.016)	(.019)		(.014)
Mean Establishment-Fixed ($\overline{\widehat{\psi}}_k$)	.091	*.020*		-.036
	(.021)	(.022)		(.008)
High-Skill Occupation Ratio[b]				
Mean Worker Characteristics ($\overline{x}_k\widehat{\beta}$)	.441	.507	.572	
	(.021)	(.025)	(.031)	
Mean Establishment-Fixed ($\overline{\widehat{\psi}}_k$)	.279	.121	*.041*	
	(.028)	(.030)	(.036)	
Log Value Added per Employee				
Mean Worker Characteristics ($\overline{x}_k\widehat{\beta}$)	6.556	*-.183*	.818	.252
	(1.260)	(1.578)	(.084)	(.036)
Mean Establishment-Fixed ($\overline{\widehat{\psi}}_k$)	4.485	5.449	1.157	.453
	(1.668)	(1.889)	(.103)	(.020)
Log Sales per Employee				
Mean Worker Characteristics ($\overline{x}_k\widehat{\beta}$)	.488	.547	.930	.343
	(.069)	(.095)	(.152)	(.044)
Mean Establishment-Fixed ($\overline{\widehat{\psi}}_k$)	.264	.354	1.428	.505
	(.092)	(.113)	(.186)	(.025)
Return on Capital				
Mean Worker Characteristics ($\overline{x}_k\widehat{\beta}$)	*-1.329*	*.170*	-.084	*-.003*
	(1.107)	(.105)	(.020)	(.048)
Mean Establishment-Fixed ($\overline{\widehat{\psi}}_k$)	*-1.124*	*.003*	.098	-.205
	(1.462)	(.125)	(.025)	(.027)

[a]From *PIA* data.

[b]From *RAIS* data.

Sources: São Paulo state manufacturing firms in *PIA* and *RAIS* on December 31, 1990 and 1997. Abowd et al. (2001) for France 1992 and the U.S. 1990. Partial correlations from individual regressions on mean worker characteristics ($\overline{x}_k\widehat{\beta}$) and mean establishment effects ($\overline{\widehat{\psi}}_k$), controlling for sector-fixed effects. Standard errors in parentheses (insignificant point estimates at the five percent level in *italics*).

measure) is defined as professional and managerial plus technical and supervisory employment, divided by total employment, using the skill categories from *RAIS*. The "Non-Production Worker Ratio," in contrast, divides the ratio of white collar workers by the sum of white and blue collar workers, where the data are drawn from *PIA*. Across occupation variables and countries, occupational skill intensity relates positively to predicted worker wages, as expected. The association between skill intensity and predicted establishment wages is positive for Brazil, but much smaller for the other countries, suggesting that the establishment-fixed earnings component in Brazil is more responsive to work force composition.

Worker productivity, based on either value added per employee or sales per employee, exhibits positive correlation with both wage components in all three countries. In Brazil, firms with high values of either wage component are especially likely to have highly productive workers, as measured by value added. The relationship is much weaker with respect to the sales measure, however. The two productivity measures produce nearly identical results for France and the U.S., with the relationship being more strongly positive in France. The results do not establish any significant relationship between return on capital and the wage components in any of the countries. Productivity gains for firms with high-wage workers or high-wage establishments appear to offset the higher wage costs.

Finally, the estimated relationships for 1997 are broadly consistent with those of 1990, with the exception that the relationships between wage components and the capital stock variables become significantly smaller in 1997.

6 Sectoral Comparisons

The sectoral scope of *RAIS* permits a wage analysis beyond manufacturing. Table 8 presents regression results for four sectors in 1990 (note that column (1) of Table 8 reproduces the results for Brazilian manufacturing reported in Table 2). We use the complete regression specification, including the education variable, in computing the wage components. We choose the year 1990 for sectoral comparisons.[21]

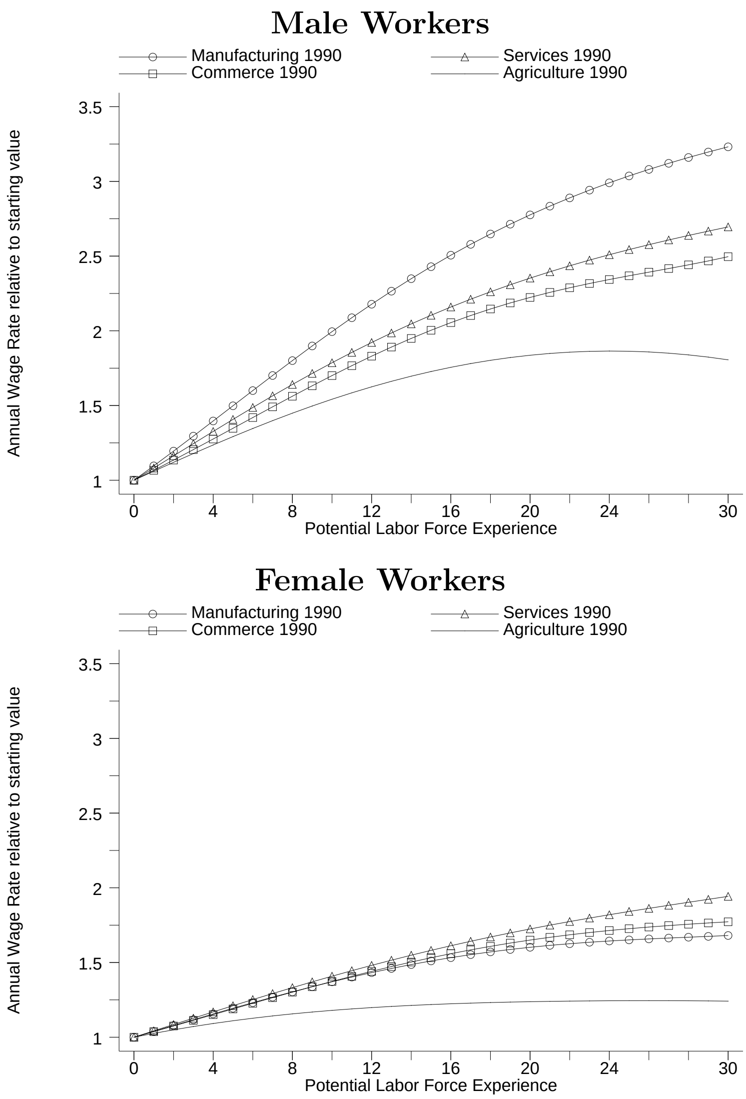
Wages and worker characteristics. The profiles of experience premia for men and women in 1990 are shown in Figure 2. Experience profiles in services and commerce for both sexes are close to each other, but below those in manufacturing for males while above those in manufacturing for females. The experience profiles are the lowest in agriculture for both sexes. Table 9 does not reveal major discrepencies in education, occupation and gender differentials across sectors. Thus, our basic findings concerning the relation between wages and worker characteristics hold across

[21] Results do not markedly differ between 1990 and 1997, except for declining returns to experience in the manufacturing sector, which we discussed in section 3, and a widening gender gap in the services sector between 1990 and 1997.

Table 8: Wage Structure in Brazil 1990, by Sector

	Manufact. (1)	Services (2)	Commerce (3)	Agriculture (4)
Primary School Education (or less)	-1.075	-.948	-1.229	-1.247
	(.002)	(.002)	(.005)	(.014)
Some High School Education	-.923	-.848	-1.115	-1.061
	(.002)	(.002)	(.005)	(.014)
Some College Education	-.339	-.303	-.374	-.518
	(.003)	(.003)	(.007)	(.022)
Professional or Managerial Occupation	.856	.623	.654	.467
	(.002)	(.002)	(.004)	(.008)
Technical or Supervisory Occupation	.600	.497	.221	.343
	(.002)	(.002)	(.002)	(.011)
Other White Collar Occupation	.262	.237	.090	.130
	(.002)	(.002)	(.002)	(.008)
Skill Intensive Blue Collar Occupation	.239	.314	.171	-.065
	(.001)	(.002)	(.002)	(.004)
Potential Labor Force Experience	.095	.081	.065	.060
	(.0005)	(.0006)	(.0006)	(.002)
Quadratic Experience Term	-.003	-.003	-.001	-.002
	(.00005)	(.00007)	(.00008)	(.0002)
Cubic Experience Term	.00005	.00005	-.00003	.00003
	(2.29e-06)	(2.92e-06)	(3.89e-06)	(8.60e-06)
Quartic Experience Term	-3.01e-07	-3.17e-07	7.35e-07	-3.31e-07
	(3.24e-08)	(4.06e-08)	(5.83e-08)	(1.21e-07)
Female	.060	-.255	-.388	-.438
	(.005)	(.004)	(.009)	(.031)
Female × Primary School Education (or less)	.106	.215	.397	.394
	(.004)	(.003)	(.008)	(.029)
Female × Some High School Education	-.016	.130	.326	.256
	(.004)	(.003)	(.008)	(.030)
Female × Some College Education	.018	.080	.175	.099
	(.005)	(.004)	(.010)	(.041)
Female × Professional or Managerial Occupation	-.101	.116	-.062	.147
	(.004)	(.003)	(.007)	(.026)
Female × Technical or Supervisory Occupation	-.173	.053	-.028	.092
	(.003)	(.003)	(.004)	(.021)
Female × Other White Collar Occupation	.088	.151	.122	.193
	(.003)	(.002)	(.004)	(.015)
Female × Skill Intensive Blue Collar Occupation	-.208	-.160	-.083	.044
	(.002)	(.004)	(.006)	(.009)
Female × Potential Labor Force Experience	-.056	-.038	-.029	-.034
	(.0008)	(.001)	(.001)	(.004)
Female × Quadratic Experience Term	.002	.002	.0007	.0007
	(.0001)	(.0001)	(.0001)	(.0004)
Female × Cubic Experience Term	-.00006	-.00004	*7.72e-06*	*-1.15e-06*
	(4.35e-06)	(4.66e-06)	(6.72e-06)	(.00002)
Female × Quartic Experience Term	7.06e-07	4.10e-07	-3.75e-07	*3.39e-08*
	(6.32e-08)	(6.43e-08)	(1.01e-07)	(2.52e-07)
Observations	2,330,883	2,530,777	876,164	107,641
R^2 (within)	.508	.367	.320	.322

Source: *RAIS* São Paulo state 1990 (prime age workers in their highest-paying job), controlling for establishment-worker fixed effects (manufacturing Table 2). Standard errors in parentheses (insignificant point estimates at the five percent level in *italics*).



Source: *RAIS* São Paulo state 1990 (prime age workers in their highest-paying job). Wage levels relative to zero experience wage levels from wage component estimates (Table 8).

Figure 2: **Potential experience in Brazil 1990, by sector**

Table 9: Relative Wages in Brazil by Sector

	Manufact. (1)	Services (2)	Commerce (3)	Agriculture (4)
		Education[a]		
Male worker:				
College Degree	2.516	2.334	3.049	2.890
Some College	1.793	1.724	2.097	1.721
Primary School	.859	.905	.892	.830
Female worker:				
College Degree	2.556	2.051	2.201	2.237
Some College	1.855	1.641	1.803	1.470
Primary School	.970	.986	.957	.953
		Occupation[b]		
Male worker:				
Profess'l or Managerial	2.355	1.864	1.923	1.596
Technical or Supervisory	1.821	1.643	1.247	1.409
Other White Collar	1.299	1.267	1.094	1.139
Skill-intensive Blue Collar	1.270	1.370	1.187	.938
Female worker:				
Profess'l or Managerial	2.128	2.094	1.807	1.848
Technical or Supervisory	1.532	1.733	1.212	1.545
Other White Collar	1.419	1.474	1.235	1.382
Skill-intensive Blue Collar	1.031	1.167	1.092	.979
		Gender[c]		
Female worker	.893	.879	.925	.941

[a]Relative to worker with some or complete high school education, controlling for occupation.

[b]Relative to non-skill-intensive blue collar occupations, controlling for education.

[c]Female relative to male workers, controlling for education and occupation.

Source: *Source*: *RAIS* São Paulo state 1990s (prime age workers in their highest-paying job). Wage levels relative to comparison-group wage levels from component estimates (Table 8).

the four sectors. There are, however, some differences worth noting. Table 9 shows that returns to education are somewhat lower in the non-manufacturing sectors, save for college-educated men in commerce and agriculture.

Occupational premia exhibit interesting cross-sectoral differences. For services, the technical and supervisory occupations receive wages that are closer to professional and managerial levels than in other sectors. For commerce, in contrast, the occupation profile is relatively flat up to the professional and managerial level, where it takes a sharp upward jump. At the other end of the scale, skill-intensive blue collar occupations receive substantial premia for men in manufacturing and commerce, and for women in services.

Components of individual wages. Table 10 evaluates the explanatory power of the predicted worker characteristics and establishment-fixed components of wages

Table 10: Wage Variability in Brazil 1990, by Sector

	Mean	St.Dev.	Correlation with $\ln w_i$	Correlation with $x_i\widehat{\beta}$	Correlation with $\widehat{\psi}_j$	Correlation with $\widehat{\varepsilon}_i$
	(1)	(2)	(3)	(4)	(5)	(6)
Manufacturing 1990						
Log Annual Wage ($\ln w_i$)	8.019	.785	1.000			
Worker Characteristics ($x_i\widehat{\beta}$)	.056	.541	.727	1.000		
Establishment-Fixed ($\widehat{\psi}_j$)	7.963	.183	.346	.163	1.000	
Residual ($\widehat{\varepsilon}_i$)	.000	.508	.647	.000	-.000	1.000
Services 1990						
Log Annual Wage ($\ln w_i$)	7.956	.830	1.000			
Worker Characteristics ($x_i\widehat{\beta}$)	.177	.480	.600	1.000		
Establishment-Fixed ($\widehat{\psi}_j$)	7.779	.335	.436	.054	1.000	
Residual ($\widehat{\varepsilon}_i$)	-.000	.573	.691	.000	.000	1.000
Commerce 1990						
Log Annual Wage ($\ln w_i$)	7.464	.742	1.000			
Worker Characteristics ($x_i\widehat{\beta}$)	-.476	.403	.573	1.000		
Establishment-Fixed ($\widehat{\psi}_j$)	7.939	.214	.345	.105	1.000	
Residual ($\widehat{\varepsilon}_i$)	.000	.571	.768	-.000	-.000	1.000
Agriculture 1990						
Log Annual Wage ($\ln w_i$)	7.355	.584	1.000			
Worker Characteristics ($x_i\widehat{\beta}$)	-.795	.300	.507	1.000		
Establishment-Fixed ($\widehat{\psi}_j$)	8.150	.295	.499	-.012	1.000	
Residual ($\widehat{\varepsilon}_i$)	.000	.407	.698	-.000	.000	1.000

Source: *RAIS* São Paulo state 1990 (prime age workers in their highest-paying job). Estimates from establishment-fixed effects wage regressions in Table 8. Statistics based on estimation sample.

across sectors. Total wage variability in manufacturing and services exceeds that in commerce and especially in agriculture. Except for agriculture, the sectors remain highly unequal relative to the manufacturing sectors in France and the U.S. The standard deviations of the worker characteristics and establishment-fixed components relative to the standard deviation of log wages are roughly comparable in manufacturing, services, and commerce, as are the correlations between the two components and log wages. Thus, for these three sectors, worker characteristics play a much greater role in explaining wages than do establishment-fixed components. This finding does not extend to agriculture, where the establishment-fixed component is equally important in terms of both relative variability and correlation with wages.

Decomposition of wage inequality. Table 11 reports components of log annual wage inequality in 1990 across sectors. Worker characteristics account for 50 percent of log wage variation in manufacturing but predict a considerably smaller portion of the variability in non-manufacturing sectors, ranging from 35 percent in services to

Table 11: COMPONENTS OF LOG WAGE INEQUALITY 1990, BY SECTOR

	Manufacturing		Services		Commerce		Agriculture	
	FE	OLS	FE	OLS	FE	OLS	FE	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Worker Char. ($x_i\widehat{\beta}$)	.501	.529	.347	.374	.311	.329	.261	.264
Experience	.158	.170	.059	.066	.138	.148	.067	.072
Occupation	.137	.139	.104	.105	.064	.064	.065	.057
Education	.134	.140	.174	.193	.105	.115	.085	.089
Gender	.072	.080	.010	.011	.003	.002	.043	.046
Establishm.-Fixed ($\widehat{\psi}_j$)[a]	.081		.176		.099		.252	
Residual ($\widehat{\varepsilon}_i$)	.418	.471	.477	.626	.590	.671	.487	.736

[a]Regression const. for OLS.

Source: *RAIS* São Paulo state 1990 (prime age workers in their highest-paying job). Inequality index: squared coefficient of deviation (Shorrocks 1982), based on estimation samples.

26 percent in agriculture. Individual components among the worker characteristics matter to different degrees across sectors. Most notably, the commerce sector exhibits only negligible gender inequality.

In parallel with our findings on wage components, the establishment-fixed components in manufacturing, services and commerce account for comparably small proportions of wage inequality, while this component is much more important in agriculture. For services and commerce, the smaller role of the worker-characteristics component is tied to the greater importance of the residual component. Note that the overall explanatory power of observed worker characteristics and the establishment fixed effect, as measured by the goodness of fit R^2, is considerably lower in services, commerce, and agriculture than in manufacturing (Table 8). This corresponds to the lower overall explanatory power of the individual compensation model (1) for these sectors.

7 Discussion

Broad comparisons. Our analysis uncovers a rich pattern of differences and similarities between the wage structures of Brazil, France and the U.S. The most noticable differences are the familiar ones: both wage inequality and returns to education are much greater in Brazil. More surprising are the similarities. Brazil and France exhibit closely comparable occupational premia, and the compensation of workers based on their observable characteristics relates in a similar way to firm size, capital intensity and skill intensity. In the U.S., occupational premia are considerably smaller, and the relationship between wages and firm attributes are weaker. On the other hand, returns to human capital are lowest in France, and the gender gap is greatest.

High levels of wage inequality in developing versus industrialized countries are of great concern to economists and policymakers. These differences are especially pronounced for the case of Brazil. Our results offer insights into the factors underlying high Brazilian wage inequality. Wage variability based on observable worker characteristics, as a percentage of overall wage variability, is roughly equivalent across the three countries. Moreover, the correlation of log wages with the worker characteristics component of wages is highest in Brazil. These findings indicate that much of the difference in wage inequality can be traced to compensation of workers based on their observable characteristics.

The picture is strikingly different with respect to the establishment-specific component of wages, controlling for worker characteristics. Variability of wages at the establishment level, in *absolute* terms, is roughly equal across the three countries, meaning that establishment-level factors explain a much smaller percentage of Brazilian inequality compared with the other countries. Thus, factors operating at the establishment level cannot account for the greater wage inequality observed in Brazil. The relatively weak correlation between log wages and the establishment component of wages in Brazil further highlight the low explanatory power of establishment-level influences.

Institutional factors. Institutional comparisons across the three countries offer a measure of insight into these findings. Labor markets are heavily regulated in Brazil and France, and much less regulated in the U.S. Botero, Djankov, La Porta, Lopez de Silanes and Shleifer (2004), for example, place France among the countries with the highest index of employment regulation, while Brazil occupies an intermediate position, and the U.S. belongs to the group of countries with few laws governing the cost of working times, dismissal procedures, and similar labor-market characteristics. The countries are equivalently ordered with respect to collective relations legislation, with French laws greatly influencing the negotiations between firms and unions, and the U.S. relegating the bargaining process to the private sector.

As Botero et al. (2004) argue, similarities between Brazil and France might be traceable to the fact that the Brazilian legislation derives from the French Civil law, which spread to the rest of Europe through the Napoleonic conquest, and was then brought to Brazil via Portuguese colonization. In addition, Brazil's 1988 Constitution introduced a series of reforms to labor market institutions that aimed to increase workers' benefits and the right to organize, significantly raising labor costs.[22]

Our results are suggestive as to the effects of labor-market regulation on wages.

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

Regulatory similarities between Brazil and France are paralleled by similarities in compensation tied to workers' occupations and characteristics of establishments. Thus, the regulatory environment may be an important determinant of cross-country differences in the terms of occupational and establishment-level compensation. Disparities in returns to human capital between Brazil and France, as well as wage gaps based on gender, may be less sensitive to regulation. Similarly, regulation may matter less for overall wage variability based on worker characteristics and residual factors, where Brazil stands closer to the U.S. than to France.

Theoretical implications. Our decomposition of wage variability into worker characteristics and establishment-fixed components captures the relative explanatory power of worker-based as opposed to establishment-based explanatory factors. Notably, observable worker characteristics account for about half of earnings inequality in Brazilian manufacturing, whereas factors operating at the establishment level, including those tied directly to the establishment and those related to establishment averages of unmeasured workforce characteristics, explain roughly ten percent. The remaining forty percent are associated with unmeasured worker attributes.

These findings have direct implications for theoretical approaches to wage determination. A wide range of theories predicts that features of the industry or firm may exert strong influences on wage structure, after taking account of worker characteristics. Such features include compensating differentials, efficiency wages, rent sharing, unionization, and trade exposure. Theories have also tied firm size and factor intensity, including worker skill intensity, to the wage structure.[23]

Since differences in wages across industries and firms derive from wage variability among constituent establishments, our decomposition implies that these employer-related theories can account for at most a tenth of overall wage variability. In addition, since Brazil, France and the U.S. exhibit roughly equivalent establishment-level wage variability in absolute terms, employer-based theories cannot account for the high degree of inequality in Brazil relative to the other countries.

Competitive labor-market theories predict that worker attributes command equal compensation across establishments. Observed attributes, including human capital, occupation and gender, explain roughly half of Brazilian wage inequality, while unobserved attributes account for two-fifths. These unobserved attributes may include intrinsic ability, school quality, family background, geographic mobility, and unmeasured determinants of health and education investment.[24] Cross-country differences in residual wage inequality may be quite sensitive to such worker-related factors.

[23]Rosen (1986) discusses compensating differentials. Links between trade and wage structure in Brazil are assessed in Gonzaga, Menezes Filho and Terra (2006). Arbache (2001) and Velenchik (1997) provide brief overviews of the literature on other industry- and firm-based explanatory factors.

[24]Willis (1986) surveys competitive theories of wage determination based on worker attributes. On school quality and family background, see Behrman and Birdsall (1983) and Lam and Schoeni (1993), respectively. Other factors are discussed in Behrman (1999).

In summary, our findings suggest that labor-supply factors warrant the most attention among the explanations for high wage inequality. Labor-demand factors deserve less attention, since their potential explanatory power is limited. For future research into compensation variation, expanded information about worker attributes, including social and geographic factors, would appear to have great potential for enhancing the understanding of wage structure.

8 Conclusion

Using a comprehensive linked employer-employee data set for a developing country, we provide estimates for key elements of the Brazilian wage structure that permit direct comparisons with estimates of Abowd et al. (2001) for France and the U.S. We confirm some familiar differences, but notably uncover numerous important similarities, particularly for Brazil and France. Our most important finding is that Brazil's high wage inequality cannot be explained by factors operating at the firm or industry level. Explanations must be sought in the characteristics of workers, both measured and unmeasured.

Beyond the purpose of contrasting Brazil's wage structure with other countries in this paper, an extension of our data and method to periods before and after Brazil's pro-competitive reforms may prove useful for understanding effects of Brazil's policy shifts. Numerous studies have tracked the effects of Brazil's trade reform on wages, for instance.[25] The availability of linked *RAIS* data allows wage effects to be separated into worker and establishment influences and to trace workers across jobs. Menezes and Muendler (2005) consider implications of trade for employment flows using *RAIS* and find that Brazil's tariff reductions significantly accelerate worker transitions out of the formal sector, while exporting firms and comparative-advantage sectors fail to absorb displaced workers for several years. Extending this investigation to wage effects of trade would be of interest. Evidence in this paper suggests that impacts of reforms on the wage dispersion may be especially pronounced if they affect the compensation of worker characteristics.

[25] In 1990, the Brazilian government broke with the country's import substitution strategy and embarked on drastic trade liberalization. Gonzaga et al. (2006), for example, show that the decline in education premia in the early 1990s was consistent with predictions of the classic Heckscher-Ohlin model. Arbache, Dickerson and Green (2004) do not detect a statistically significant effect of trade liberalization on the inter-industry wage differentials in manufacturing, which remain remarkably stable over the 1980s and 1990s. Both papers use household data.

Appendix

A Worker data

Screening. Workers in *RAIS* are identified by the individual-specific *PIS* number (*Programa de Integração Social).* A given establishment may report the same *PIS* multiple times within a single year so that the worker can withdraw from the employer-funded severance pay account ($FGTS$) through spurious layoffs and rehires. Bad compliance can cause certain *PIS* numbers to be recorded incorrectly or repeatedly. To handle these issues, we screen the sample as follows. (1) Observations with faulty *PIS* numbers (having fewer than 11 digits) are eliminated. We suspect short *PIS* numbers to be due to faulty bookkeeping. (2) As mentioned in the text, observations with workers not employed on December 31st are removed; only the worker's job observation on December 31st with the highest annual average wage level is retained (in cases of ties, we randomly drop all but one job observation per worker on Dec 31st). This makes our sample comparable to Abowd et al. (2001), who consider full-time and full-year employees. (3) Observations of workers older than 50 years are dropped to avoid potential confounding effects stemming from workers who leave the labor force prior to official retirement age.

Compensation. *RAIS* defines the average monthly wage as the arithmetic mean of all monthly remunerations for a given worker, divided by the value of the minimum wage that prevails during the respective month. In this conversion, *RAIS* counts only the months, or parts thereof, during which the workers are employed, excluding the "thirteenth salary," which is a special December payment made in some sectors. Months with missing wage information are disregarded in the calculation of this mean.

The *RAIS* manual for respondents states explicitly the forms of payment that are considered valid components of the monthly wage rate. Among other components, these include: salaries; extraordinary additions, supplements and bonuses; tips and gratuities; commissions and fees; contracted premia; overtime compensation for contracted extra hours; hazard compensation; executive compensation; cost reimbursement components if they exceed 50 percent of the base salary and are for travel or transfers necessary for the execution of the job; payments for periods of vacation, holidays and parental leave; vacation gratuities if they exceed 20 days of salary; piece wages; and in-kind remunerations such as room and board. As a rule, components are considered part of salary if they are taxable income or are subject to Brazilian social security contributions.

Payments that are not considered wage components include: severance payments for layoffs; indemnity payments for permanent maternal leave and any other indemnity payments; so-called "family payments" under Brazilian labor law; vacation gratuities if they do not exceed 20 days of salary; additional social security compensation due to a worker's illness; moving expenses; travel cost reimbursements if they do not exceed 50 percent of the base salary; scholarships for interns; meals, equipment and clothing for execution of the job; and participation in the employer's profits.

Experience, education and occupation. The following tables present age and education classifications from *RAIS*, along with the imputed ages used in construction of the potential experience variable. We use the age range information in our version of *RAIS* to infer the "typical" age of a worker in the age range as follows:

	RAIS Age Category	Imputed Age
1.	Child (10-14)	12
2.	Youth (15-17)	16
3.	Adolescent (18-24)	21
4.	Nascent Career (25-29)	27
5.	Early Career (30-39)	34.5
6.	Peak Career (40-49)	44.5
7.	Late Career (50-64)	*excluded*
8.	Post Retirement (65-)	*excluded*

We group age information in *PNAD* into the same categories and also ignore workers of age 50 and older.

To calculate potential labor force experience, we use the following inference schedule to impute the worker's age at the completion of his/her education for both *RAIS* and *PNAD* data:

	RAIS Education Category	Imputed Age at completion
1.	Illiterate	6
2.	Primary School Dropout	7
3.	Primary School Graduate	10
4.	Middle School Dropout	11
5.	Middle School Graduate	14
6.	High School Dropout	15
7.	High School Graduate	18
8.	College Dropout	19
9.	College Graduate	22

The preceding table also shows how we translate years of education in *PNAD* into the *RAIS* education categories.

Following Abowd et al. (2001), we define potential labor market experience for a worker as the imputed age for his/her age category minus the imputed age for his/her education category.

The occupation indicator variables are obtained from the *CBO* classification codes in the *RAIS*, as reclassified to conform with the *ISCO-88* categories (Muendler et al. 2004). Before we convert *CBO* to *ISCO-88*, we reset unknown *CBO* codes in *RAIS* at the four-digit level to the nearest applicable miscellaneous occupation category at the four-digit level. The mapping between *ISCO-88* categories and occupation levels is given as follows:

	ISCO-88 Category	Occupation Level
1.	Legislators, senior officials, and managers	Professional & Managerial
2.	Professionals	Professional & Managerial
3.	Technicians and associate professionals	Technical & Supervisory
4.	Clerks	Other White Collar
5.	Service workers and shop and market sales workers	Other White Collar
6.	Skilled agricultural and fishery workers	Skill Intensive Blue Collar
7.	Craft and related workers	Skill Intensive Blue Collar
8.	Plant and machine operators and assemblers	Skill Intensive Blue Collar
9.	Elementary occupations	Other Blue Collar

Finally, we define the education indicator variables as follows:

	Education Level	*RAIS* Education Categories
1.	Primary School (or less)[a]	1-3
2.	Some High School	4-7
3.	Some College	8
4.	College	9

[a]Including illiterates.

B Firm data

Table 12 describes the link between *RAIS* establishments and *PIA* firms. For the year 1990, we can link 2,864 out of 58,192 establishments in São Paulo state to the *PIA* firm sample. In 1997, only 1,689 out of 62,969 establishments in São Paulo state can be identified in the *PIA* firm sample. In order to withdraw micro-level data from *PIA* at the Brazilian census bureau *IBGE*, we randomly tabulate cells of three (to five) firms. Some so-created cells contain firms for which do not have *RAIS* observations or for which we cannot predict establishment-level information within *RAIS*. Our random aggregation routine leaves some *PIA* firms unassigned to cells in certain years in order to create random cells of three firms that appear possibly many consecutive years during other periods between 1990 and 1998. For both reasons, we lose further firms.

C Complementary household survey data

We use *Pesquisa Nacional por Amostra de Domicílios* (*PNAD*) to observe formally and informally employed workers in São Paulo state in September 1990 and September

Table 12: MATCHES BETWEEN *RAIS* AND *PIA* RANDOM FIRM TABULATIONS

Data Source	Frequency	Percent	Cumulated
1990:			
RAIS and PIA firms			
RAIS-SP establishments but no *PIA* firm	281,685	97.69	97.69
PIA firms but no *RAIS*-SP establishment	3,056	1.06	98.75
RAIS-SP establishments in *PIA* firms	3,616	1.25	100.00
Total	288,357	100.00	
Randomly tabulated three-firm cells			
RAIS & *PIA* firms but no cell match	724	37.05	37.05
Cells but no *RAIS* & *PIA* match	61	3.12	40.17
Cells matched with *RAIS* & *PIA*	1,169	59.83	100.00
Total	1,954	100.00	
1997:			
RAIS and PIA firms			
RAIS-SP establishments but no *PIA* firm	376,719	99.04	99.04
PIA firms but no *RAIS*-SP establishment	1,511	0.40	99.43
RAIS-SP establishments in *PIA* firms	2,158	0.57	100.00
Total	380,388	100.00	
Randomly tabulated three-firm cells			
RAIS & *PIA* firms but no cell match	305	28.21	28.21
Cells but no *RAIS* & *PIA* match	97	8.97	37.19
Cells matched with *RAIS* & *PIA*	679	62.81	100.00
Total	1,081	100.00	

Sources: São Paulo state manufacturing firms in *PIA* and *RAIS* on December 31, 1990 and 1997.

1997. We exclude both unemployed persons and employers, and obtain 13,665 *PNAD* household-level observations of workers in 1990 and 14,414 observations in 1997. Similar to our procedure for December wages in *RAIS*, we convert September wages in *PNAD* first to December values in Brazilian currency (using the Brazilian CPI *Índice Nacional de Preços ao Consumidor*, *INPC*) and then into current U.S. dollars.[26]

The *PNAD* household data permit the distinction between formal employment (with a labor ID card *carteira*) and informal employment (without labor ID card). Informal employment is recorded in *PNAD* if it entails at least four paid hours per week. The labor ID card entitles workers to employment protection and social benefits, largely borne by the employer.

[26]While *INPC* inflation was 59.4 percent between September and December 1990, the exchange rate devalued by 101.9 percent over the same period. To avoid distortions from exchange rate fluctuations in our comparisons, we first transform *PNAD* September wages to December values using the Brazilian CPI *INPC*.

D Summary Statistics

Tables 13 and 14 provide sample means and standard deviations of worker-sample variables.

Table 13: SUMMARY STATISTICS, *RAIS* MANUFACTURING 1990 AND 1997

	Manufact. 1990		Manufact. 1997	
	Mean	St.Dev.	Mean	St.Dev.
	(1)	(2)	(3)	(4)
Log Annual Wage[a]	8.016	.786	8.872	.778
Primary School Education (or less)[b]	.533	.499	.487	.500
Some High School Education	.373	.484	.409	.492
Some College Education	.034	.182	.037	.190
College Graduate	.053	.225	.066	.248
Professional or Managerial Occupation	.079	.270	.072	.259
Technical or Supervisory Occupation	.096	.294	.081	.273
Other White Collar Occupation	.117	.321	.140	.347
Skill Intensive Blue Collar Occupation	.551	.497	.589	.492
Low-skill Intensive Blue Collar Occupation	.157	.364	.117	.322
Potential Labor Force Experience	16.079	9.458	17.252	9.144
Quadratic Experience Term	3.480	3.374	3.813	3.406
Cubic Experience Term	8.653	11.352	9.575	11.696
Quartic Experience Term	23.492	38.335	26.140	40.007
Tenure at establishment	.923	1.106	1.012	1.176
Female	.272	.445	.256	.436
Female × Log Annual Wage	2.062	3.393	2.181	3.738
Female × Primary School Education (or less)	.140	.347	.123	.328
Female × Some High School Education	.106	.308	.102	.303
Female × Some College Education	.010	.101	.011	.105
Female × College Graduate	.013	.114	.019	.137
Female × Professional or Managerial Occupation	.014	.118	.015	.122
Female × Technical or Supervisory Occupation	.027	.163	.022	.147
Female × Other White Collar Occupation	.042	.201	.058	.234
Female × Skill Intensive Blue Collar Occupation	.140	.347	.128	.334
Female × Low-skill Intensive Blue Collar Occupation	.048	.215	.033	.178
Female × Potential Labor Force Experience	3.828	7.904	4.134	8.388
Female × Quadratic Experience Term	.771	2.060	.874	2.216
Female × Cubic Experience Term	1.833	6.110	2.127	6.614
Female × Quartic Experience Term	4.837	19.379	5.677	21.063
Female × Tenure at establishment	.187	.542	.214	.613
Observations	2,364,007		1,837,461	

[a]Log annualized mean monthly wage (in current U.S. dollars on December 31).
[b]Including illiterates.

Table 14: Summary Statistics, *RAIS* 1990

	Manufact. 1990		Services 1990	
	Mean	St.Dev.	Mean	St.Dev.
	(1)	(2)	(3)	(4)
Log Annual Wage[a]	8.016	.786	7.953	.830
Primary School Education (or less)[b]	.533	.499	.545	.498
Some High School Education	.373	.484	.237	.425
Some College Education	.034	.182	.063	.242
College Graduate	.053	.225	.147	.354
Professional or Managerial Occupation	.079	.270	.224	.417
Technical or Supervisory Occupation	.096	.294	.155	.362
Other White Collar Occupation	.117	.321	.279	.448
Skill Intensive Blue Collar Occupation	.551	.497	.140	.346
Low-skill Intensive Blue Collar Occupation	.157	.364	.203	.402
Potential Labor Force Experience	16.079	9.458	17.137	9.283
Quadratic Experience Term (/100)	3.480	3.374	3.798	3.462
Cubic Experience Term (/1,000)	8.653	11.352	9.594	11.987
Quartic Experience Term (/10,000)	23.492	38.335	26.414	41.364
Tenure at establishment	.923	1.106	1.047	1.240
Female	.272	.445	.442	.497
Female × Log Annual Wage	2.062	3.393	3.469	3.930
Female × Primary School Education (or less)[b]	.140	.347	.232	.422
Female × Some High School Education	.106	.308	.086	.280
Female × Some College Education	.010	.101	.033	.179
Female × College Graduate	.013	.114	.088	.283
Female × Professional or Managerial Occupation	.014	.118	.130	.336
Female × Technical or Supervisory Occupation	.027	.163	.088	.283
Female × Other White Collar Occupation	.042	.201	.126	.332
Female × Skill Intensive Blue Collar Occupation	.140	.347	.012	.107
Female × Low-skill Intensive Blue Collar Occupation	.048	.215	.087	.282
Female × Potential Labor Force Experience	3.828	7.904	7.642	10.563
Female × Quadratic Experience Term (/100)	.771	2.060	1.700	3.003
Female × Cubic Experience Term (/1,000)	1.833	6.110	4.307	9.428
Female × Quartic Experience Term (/10,000)	4.837	19.379	11.909	31.123
Female × Tenure at establishment	.187	.542	.496	.987
Observations	2,364,007		2,585,223	

[a]Log annualized mean monthly wage (in current U.S. dollars on December 31).
[b]Including illiterates.

Table 14: Summary Statistics, *RAIS* 1990, cont'd

	Commerce 1990		Agriculture 1990	
	Mean	St.Dev.	Mean	St.Dev.
	(1)	(2)	(3)	(4)
Log Annual Wage[a]	7.461	.742	7.352	.584
Primary School Education (or less)[b]	.479	.500	.802	.399
Some High School Education	.450	.497	.171	.377
Some College Education	.028	.165	.008	.089
College Graduate	.031	.173	.013	.115
Professional or Managerial Occupation	.061	.240	.043	.203
Technical or Supervisory Occupation	.328	.469	.026	.158
Other White Collar Occupation	.288	.453	.062	.240
Skill Intensive Blue Collar Occupation	.166	.372	.689	.463
Low-skill Intensive Blue Collar Occupation	.156	.363	.180	.385
Potential Labor Force Experience	13.206	9.348	16.163	9.833
Quadratic Experience Term (/100)	2.618	3.047	3.579	3.639
Cubic Experience Term (/1,000)	6.153	9.872	9.227	12.568
Quartic Experience Term (/10,000)	16.139	32.721	26.051	43.426
Tenure at establishment	.512	.699	.600	.808
Female	.352	.478	.199	.399
Female × Log Annual Wage	2.569	3.506	1.401	2.826
Female × Primary School Education (or less)[b]	.165	.371	.161	.368
Female × Some High School Education	.160	.366	.030	.170
Female × Some College Education	.012	.107	.003	.055
Female × College Graduate	.012	.108	.003	.057
Female × Professional or Managerial Occupation	.017	.131	.004	.060
Female × Technical or Supervisory Occupation	.139	.346	.008	.091
Female × Other White Collar Occupation	.136	.342	.022	.147
Female × Skill Intensive Blue Collar Occupation	.015	.123	.132	.339
Female × Low-skill Intensive Blue Collar Occupation	.045	.207	.033	.178
Female × Potential Labor Force Experience	4.281	7.873	3.118	7.704
Female × Quadratic Experience Term (/100)	.803	2.006	.691	2.158
Female × Cubic Experience Term (/1,000)	1.819	5.940	1.795	6.811
Female × Quartic Experience Term (/10,000)	4.670	18.965	5.134	22.808
Female × Tenure at establishment	.165	.435	.096	.342
Observations	894,885		109,786	

[a]Log annualized mean monthly wage (in current U.S. dollars on December 31).
[b]Including illiterates.

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