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Unions and Economic Performance in Developing Countries: Case Studies from Latin America

by

Fernando Rios-Avila*
Levy Economics Institute of Bard College

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Levy Economics Institute
P.O. Box 5000
Annandale-on-Hudson, NY 12504-5000
<http://www.levyinstitute.org>

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ABSTRACT

This paper analyzes the economic impact of unions on productivity in the manufacturing sector across six Latin American countries: Argentina, Bolivia, Chile, Mexico, Panama, and Uruguay. Using an augmented Cobb-Douglas production function, the paper finds that unions have positive, but mostly small, effects on productivity, with the exception of Argentina, with a large negative effect, and Bolivia, with no effect. An analysis on profitability shows that, in most cases, the positive productivity effects barely offset higher union compensation, and that unions are negatively related to investment in capital and R & D. Different explanations for these effects are discussed.

Keywords: Unions; Productivity; Profitability; Investment; Latin America; Developing Countries

JEL Classifications: J50, L1, O54

INTRODUCTION

One of the most contentious debates in the literature on unions has been on how unions affect a firm's performance. While most of the literature agrees that unions have mostly negative effects on profitability and investment, there is little consensus on the effects that unions have on productivity (Kuhn 1998; Doucouliagos and Laroche 2003, 2009; Aidt and Tzannatos 2002; Hirsch 2004). To some extent, the uncertainty surrounding these issues reflects problems with data limitations, as well as the underlying heterogeneity in union effects across establishments, industries, and countries.

Although there is a reasonably large literature for several developed economies, there is little evidence regarding "what unions do" for establishment productivity in developing economies.¹ Because businesses in developing economies face different types of obstacles, such as restrictions on access to capital, unfavorable institutions, high levels of corruption, less competitive markets, and unstable business environments, compared to those in developed countries, it is not clear how unions affect productivity.

The purpose of this paper is to expand the literature by analyzing the impact of unions on productivity for six countries in Latin America, namely Argentina, Bolivia, Chile, Mexico, Panama, and Uruguay. Differences in their economic settings and adaptation to market reforms provide a mixture of settings which suggests a cross-country study may prove valuable to better understand the relationship between unions and productivity.

Using data from the World Bank Enterprise Survey, modified Cobb-Douglas production functions are estimated to determine the impact of unionization on establishment productivity, controlling for various measures of establishment characteristics. Due to considerable levels of non-reporting in the survey, a "principled" multiple imputation approach is used to improve the completeness and reliability of the data. The preferred model indicates that unions have slightly positive but mostly insignificant effects on productivity, with Chile and Panama showing the largest, but not significant, union-productivity effects. The exception is Argentina, where the estimates are negative and statistically significant across all specifications. Alternative measures

¹ As Freeman (2010) indicates, the research for developing economies is limited because data for this type of research is typically inadequate, and also because unions in developing countries have been weak and unable to fulfill their role as bargaining agents in their economies.

of unionization reveal that the union-productivity relationship is not linear in all countries, which has contributed to the low significance of the results.

The analysis of profitability indicates that in most countries the small gains in productivity are not large enough to offset the higher wage costs faced by unionized establishments. In Bolivia, the profit and productivity evidence is not closely aligned, which seems to be driven by substantial differences on capital intensity. Similarly, the evidence suggests that unions are negatively associated with measures investment and innovation.

The rest of the paper is structured as follows. The first section presents a review of the empirical literature, with emphasis on the research done for Latin America. The second section presents a brief description of the history of unions in Latin America and describes the legal framework under which unions operate in each country. The third and fourth sections describe the data and the empirical strategy. The fifth and sixth sections present results on productivity and performance analysis. Section seven concludes.

I. HOW DO UNIONS AFFECT PRODUCTIVITY?

1.1. Theoretical background

There is a large theoretical literature that has explored the potential costs and benefits of unions in terms of firm performance and productivity. Examples include Brown and Medoff (1978), Addison (1982), Addison and Barnett (1982), Freeman and Medoff (1984), Hirsch and Addison (1986), Turnbull (1991) and, more recently, Hirsch (2004) and Kaufman (2004). This literature has identified various channels through which unions can have positive and negative effects on productivity.

According to the “two faces” approach, popularized in Freeman and Medoff (1984), union’s effects on productivity can be described using the monopoly face – from microeconomic theory – and the collective voice/institutional response framework – from the industrial organization literature. The traditional approach analyzes unions as monopolistic agents, stressing the negative aspects of unions and the distortions they create compared to the perfect competition model. Within this framework, unions extract monopoly gains from the employers by constraining the labor supply. This translates into compensation above competitive levels for their members while potentially causing temporary negative productivity shocks.

It is also possible that unions might impose the adoption of inefficient contractual work rules and generate reductions in managerial discretion that may increase the cost of reacting to economic shocks in dynamic economic environments (Hirsch, 2008).² Furthermore, union rent-seeking behavior can further reduce long run productivity by imposing a pseudo “union tax” on capital returns, limiting the adoption of new technology and investment (Connolly, Hirsch, and Hirschey 1986; Hirsch 1991, 2004).

Constraints in labor supply might also generate wage/price distortions that could force firms to shift toward suboptimal mix of inputs, possibly causing (small) deadweight welfare loss and lower overall labor productivity. These distortions might spuriously increase production per worker if firms shift their input mix toward higher capital intensity and/or higher skilled workers, without generating gains of technical efficiency. This is less likely to be observed to the extent that unions tax the quasi-rents from capital, reducing incentives to increase investment.³ Besides, although high union wages opens the possibility to employ workers with higher skills, such outcome is unlikely, given repeated bargaining (Wessels 1994; Hirsch 2004).

The “collective voice/institutional response” face of unions, as described in Freeman and Medoff (1984), puts more emphasis on the positive aspects of unions and their potential roles enhancing operations and labor relationships within establishments. Legally protected unions can freely express their members’ preferences in the workplace, improving communication between employers and employees, inducing managers to alter methods of production and adopt more efficient personnel policies. In turn they can also reduce potential transaction costs associated with turnover, training and recruiting, monitoring and enforcement in the workplace (Kuhn 1985; Allen 1984). The presence of unionization and pressure for higher wages can increase productivity through shock effects, reducing the so called “X-inefficiency” through improved operations which could have persisted in the absence of unions (Hirsch and Addison 1986; Addison and Hirsch 1989; Kaufman 2004).

As Freeman and Medoff (1984) and Kuhn (1998) emphasize, the positive outcomes from the union's collective voice are constrained to positive and cooperative relationship between management and organized labor. For instance, Kleiner (2002) finds that in the Aircraft industry,

² Although there is anecdotal evidence regarding inefficient union work rules, it seems unlikely that such inefficiencies would be long lived in markets with high levels of competition. There is no systematic evidence relating the interactions between union governance, dynamism, and productivity.

³ For theory on unions and quasi-rents, see Grout (1984) and Baldwin (1983). For the earliest empirical test, see Connolly, Hirsch and Hirschey (1986).

overall productivity was considerably lower during periods of conflicts between management and union leaders. While Black and Lynch (2001) and Bloom and Van Reenen (2011) find that negative union productivity effects are driven by unionized plants with traditional management systems, while positive effects are found among those (few) union establishments that adopt “best-method” human resources practices such as incentive pay.

1.2. Empirical evidence

As in other aspects of the literature on unions, the inherited endogeneity of the unionization process has made the identification of causal effects difficult (Lewis 1963; Freeman and Medoff 1984; Hirsch and Addison 1986; Hirsch 2004). The strategy in most studies has been to compare unionized versus nonunionized firms, using cross-section or panel data, to identify the impact that unions had on productivity and performance. More recent studies, using event study and regression discontinuity approaches, have been able to provide estimates closer to causal effects (DiNardo and Lee 2004; Lee and Mas 2012).

The seminal paper on unions and productivity by Brown and Medoff (1978) is one of the few studies finding a large and positive effect on productivity (22-24%). These results, however, were not supported by subsequent reviews of the literature, which attributed the results to serious data limitations (Freeman and Medoff 1984; Hirsch and Addison 1986; Hirsch 2004). The rough consensus on U.S. studies is that union productivity effects are, on average, small and non-significant and highly variable across different economic settings (Doucouliagos and Laroche 2003). When positive, they are too small to fully offset union wage effects, consistent with the findings of lower profitability among union companies (Fuchs, Krueger and Poterba 1998; Hirsch 2004; Doucouliagos and Laroche 2009). Regression discontinuity analysis of DiNardo and Lee (2004) find unions have an insignificant effect on productivity or wages, although the event study of Lee and Mas (2012) find a negative effect on firm’s stock value.

International evidence for other developed countries likewise finds unions have negative effects on profitability, but also that unions have mostly negative effects on productivity, except for industries with high competition or good relationships between management and unions (Aidt and Tzannatos 2002; Doucouliagos and Laroche 2003).

Beyond the scope of developed countries, the literature on the economic effects of unions is limited, and little is known about how unions affect productivity in developing countries. A brief summary of the relevant literature in developing Latin American countries is provided.⁴

Fairris (2006) finds, for Mexico, that unions have a positive effect on productivity, but not profitability, which is possibly attributed to higher training rates. Menezes-Filho, et al. (2005) finds that unions in the manufacturing sector in Brazil are correlated with lower levels of profitability and investment, but that some level of unionization could have a positive impact on productivity, particularly in larger firms with profit sharing.

Saavedra and Toledo (2005) finds evidence for Peru that union firms earn lower profits and have lower productivity, but that such effects are strongly related to the firm characteristics. The authors partially attribute this to conflicts between labor and management. Cassoni, et al. (2005) finds a positive effect on productivity and productivity growth in the manufacture sector in Uruguay, with mixed evidence regarding profitability. The authors argue that improvements in productivity might be explained by increased labor stability and lower turnover, and to a lesser extent improved cooperation and labor morale. Finally, Urizar and Lee (2005), studying coffee producers in Guatemala, find evidence that becoming unionized decreases productivity, although the estimates seem to be tied to firm characteristics.

2. UNIONS IN LATIN AMERICA: BACKGROUND

There is a substantial literature focused on the development of unions in Latin America, most of which has taken a historical and legal approach describing the evolution of the labor movements in these countries. This section provides a brief overview of important features in the development of unions and legal framework in Argentina, Bolivia, Chile, Mexico, Panama and Uruguay.⁵

⁴ A more comprehensive review of the literature can be found in Freeman (2010)

⁵ This overview does not pretend to be exhaustive. For a more comprehensive analyses see Alexander and Parker (2005), Anner (2008), Carrière, Haworth, and Roddick (1989), Cassoni, Allen, and Labadie (2004), Cassoni, et al., (2005), Hudson (1994), Hudson and Hanratty (1991), Hudson and Meditz (1992), Meditz and Hanratty (1989), Merrill and Miró (1997), Murillo (2000), Murillo and Schrank (2005), O'Connell (1999), OECD (1996) and Ulloa (2003).

2.1. History

Most unions in Latin America have been characterized as playing strong roles in the political arena, both in opposition to and as supporters of the political parties in power (Carrière, Haworth and Roddick 1989). The economic and political development of unions in Latin America is, to no small degree, a story of union alliances and unions strongly influenced by government. Argentina, Bolivia, Chile, Mexico, Panama and Uruguay are no exception.

The alliances between unions and the Peronist Party in Argentina and the Partido Revolucionario Institucional (PRI) in Mexico became long-lasting relationships that benefited the unions for decades. In Bolivia and Chile, alliances between the government and unions were more fragile, with strong unions that played important roles as government allies and opposition. In Panama, during the government of Omar Torrijos (from 1968-1978), the president promoted reforms and encouraged alliances to empower the formation of stronger and more active unions. In Uruguay, where little if any coordination existed between unions and the government, unions played a major role in the democratization process of the 1980s. While the strong alliances between unions and government became the pillar of unions' bargaining power, they weakened their role as collective bargaining in the private sector O'Connell (1999).

The era of dictatorships in Latin America, between the 1970s and late 1980s, produced a major setback for unions. With the exception of Panama, unions were dissolved and persecuted. In Argentina, Bolivia and Mexico, where unions were declared illegal, they remained active opposing the dictatorship. In Chile, while unions were initially disbanded, but following the *Plan Laboral* (late 1970s), the right of association was reestablished, reforming the role of unions as a decentralized unit operating in a newly-adopted neoliberal economy. Finally, in Uruguay, the military regime outlawed union activity and granted rights of dismissal to employers in case of strikes, producing massive layoffs. These actions effectively eliminated substantive union activities until early 1980s, when unions were allowed to resurface, with close control from the government to reduce the politicization of their activities.

With the return of democracy, unions resurfaced throughout the region. The debt crisis that affected Latin America in the 1980s, however, marked a change in the economic system for most of the countries in the region. In an attempt to overcome the crisis, many countries attempted a series of reforms moving from a centralized and protectionist market, to an open and more flexible market environment with smaller governments. These changes greatly reduced the

leverage that unions had on government policies, forcing them to rely on their role in the private sector (O'Connell 1999). Although policies were implemented to favor more flexible labor markets, a series of union-friendly reforms were also adopted during the 1980s and 1990s (Murillo and Schrank 2005). Such reforms were insufficient to strengthen the role of unions as bargaining agents, fragmenting further an already weakened institution (Anner 2008).

2.2. Legal Background

As described by Murillo (2000), Murillo and Schrank (2005), Anner (2008) and O'Connell (1999), the aftermath of the debt crisis, the return to democracy, economic reform and subsequent union friendly reforms transformed the role unions had in the labor market. Unions across the region had to adapt to a more flexible labor market, transitioning from a state-union to a firm-union relationship. The combination of legal responses, coupled with a union's background, brought considerable heterogeneity in the way unions operated. Table 1 summarizes important characteristics that describe the conditions under which unions operate in selected countries.

Similar to the experience worldwide, Bolivia, Mexico and Panama have shown a decline in unionization rates, while Argentina and Uruguay have shown a slight increase in unionization rates. According to Anner (2008), the market-oriented reforms weaken unions by eliminating protectionist policies, reducing the public sector, and contributing to the growth of informal labor.⁶ The union-friendly reforms were limited and unable to counteract the increasing employment flexibility, and were incapable of providing adequate protection and enforcement systems from anti-union discrimination.

The bargaining system in Argentina, Bolivia and Mexico are characterized by substantial state intervention. In Argentina, while unions can be formed freely, only the union with the most members in a specific industry and/or area is recognized. In Bolivia and Mexico, unions can be formed freely, but need to be authorized by the Department of Labor to be recognized and engage with employers. In Chile and Panama, there is little intervention of the state on the formation of unions other than notification of the authorities. In Uruguay there are no formal

⁶ This doesn't imply that workers in the informal sector do not form other types of labor organizations similar to unions. Those organizations, also referred as unions, have characteristics that differ from the traditional role of unions, and are not considered in this research.

regulations on the formation and activities of unions. In most countries freedom of association is guaranteed for all workers except for public officials or government workers.

Table 1. Descriptive Evidence on Unions and the Bargaining System

	Argentina	Bolivia	Chile
GDP per capita 2006 (in US\$)	5485.5	1230.5	8912.2
%manufacture	22.27	14.38	13.20
Union density			
1990-1995	28.7	30.9	13.6
1995-2000	25.6	16.4	11.3
2000-2006	37.6	12.9	13.8
ILO conventions			
C87:Freedom of association	1960	1965	1999
C98:Right to organize and Collective bargain	1956	1973	1999
Freedom of association	All workers except for Military personnel	All workers but public administration	All workers but public administration
Restrictions	One union per industry and geographical area recognized.	One union per establishment.	More than one union per establishment allowed
Union formation	Most representative union is recognized Needs to represent at least 20% of the workers	Needs government authorization. At least 20 workers are needed for professional unions. And 50% for firm unions.	Unions are automatically recognized Small firms (less than 50 wrks) need 8 workers to form a union. Otherwise, at least 25 workers are needed.
Collective bargain	Allowed at regional, provincial or firm level Contracts need to be approved by the Ministry of Labor	Allowed for Unions, Federations and Confederations.	Firm level bargain is recognized. National level bargaining is voluntary. Worker associations (nonunionized) can engage into collective bargaining.
Access to financial information	Yes	No	No
Right to strike	Right to strike is recognized Only unions that are registered have the right to strike	Right to strike is recognized. Requires 3/4 support. Strikes in public sector, general strikes and solidary strikes are illegal.	Right to strike is recognized, except in public sector. Requires simple majority support.
Protection	Adequate	Inadequate	Adequate

Notes: GDP per capita and Manufacture as % of GDP were obtained from the World Bank Indicators (2012). Union Density Information is obtained from Household surveys, Anner (2008), Hayter and Stoevska (2011), Cassoni, et al. (2005), and information from the OIT. Characteristics of the bargaining systems were obtained from the countries labor codes, O'Connell (1999), Anner (2008); Murillo and Schrank (2005), Ronconi (2012), Anner (2008b) and Murillo (2000).

Table 1. Descriptive Evidence on Unions and the Bargaining System (continued)

	Mexico	Panama	Uruguay
GDP per capita 2006 (in US\$)	8830.8	5201.6	5907.3
%manufacture	18.7	7.1	17.0
Union density			
1990-1995	22.4	14.2	17.3
1995-2000	21.0	11.0	14.7
2000-2006	16.4	12.0	19.0
ILO conventions			
C87:Freedom of association	1950	1958	1954
C98:Right to organize and Collective bargain	Not recognized	1966	1954
Freedom of association	No prior authorization is required to create a trade union.	All workers but public officials administration	There exist few regulations on unions
Restrictions	Unions require officially authorization. More than one union per firm allowed, but only the most representative is recognized	Only one union per establishment.	No noticeable restrictions
Union formation	Unions need at least 20 workers	Unions require 40 members.	There are no minimum of requirements
Collective bargain	Employers have the obligation to engage into collective bargaining with unions at request.	Worker associations (nonunionized) can engage into collective bargaining.	Collective bargaining usually at industry level.
Access to financial information	No	Yes	No
Right to strike	Right to Strike recognized. Requires simple majority. Strikes in the Public sector requires 2/3 support	Right to Strike recognized in case of working conditions improvements. Requires simple majority.	No noticeable restrictions
Protection	Inadequate	Mostly adequate	Adequate

Notes: GDP per capita and Manufacture as % of GDP were obtained from the World Bank Indicators (2012). Union Density Information is obtained from Household surveys, Anner (2008), Hayter and Stoevska (2011), Cassoni, et al. (2005), and information from the OIT. Characteristics of the bargaining systems were obtained from the countries labor codes, O'Connell (1999), Anner (2008); Murillo and Schrank (2005), Ronconi (2012), Anner (2008b) and Murillo (2000).

The restrictions on minimum requirements for formation and nature of the bargaining relationship also show significant heterogeneity. Uruguay, in absence of a legal framework, does not have restrictions on union formation. In contrast, Panama requires at least 40 workers to form a union, the strongest restriction in the sample. Argentina, Bolivia, and Mexico, have similar requirements, with more flexibility for smaller establishments in Chile.

The bargaining systems range from a highly centralized system in Argentina to a decentralized system in Chile. In Mexico, the system is highly centralized due to considerable coordination between unions and the state (O'Connell 1999). Uruguay, which historically had a centralized system, has slowly transition toward bargaining at the firm level (Cassoni, et al., 2005). Chile and Panama have decentralized system that also allows nonunion workers to collectively bargain. In Bolivia, while a mixed bargaining system is allowed, collective bargaining at centralized levels is common. Only unions in Argentina and Panama have access to financial information before they engage in collective bargaining.

According to an Organisation for Economic Co-operation and Development (OECD) (1996) evaluation, and more recently the Annual Survey of Violations of Trade Union Rights (ITUC 2007), Argentina, Chile and Uruguay have an adequate system to protect unions, while Bolivia and Mexico are considered inadequate. In the case of Panama, except for the requirements to form unions, protection is deemed adequate except in export-processing zones. In terms of enforcement capacity, the information reported in Ronconi (2012), shows that in the 2000s, Bolivia and Mexico had the lowest enforcement capacity, while Chile, Panama and Uruguay, have by far the best enforcement capabilities in the region.

3. DATA AND IMPUTATION STRATEGY

The present analysis uses data from the Enterprise Survey (ES) 2006, concentrating on the manufacturing sector in six selected Latin American countries (Table 2).⁷ The Enterprise Survey provides a standardized establishment level data set, with a representative sample of establishments in the non-agricultural, private sector.⁸ The survey provides rich information that

⁷ The six countries in this analysis were selected for having a large enough presence of unionized (and not unionized) establishments in the sample. Other countries in the region, for example, Ecuador, El Salvador, Nicaragua, Honduras, Paraguay and Peru, have less than 5% of the interviewed unionized establishments.

⁸ Details on the implementation and survey structure can be found in the implementation notes for the Latin America Enterprise Surveys Data Set, and the methodological notes found at <http://www.enterprisesurveys.org/Methodology>.

can be used to identify aspects of establishment performance, market competition, managerial characteristics and labor force structure, among other things.

Table 1. Sample Size by Country and Eligibility

Economy Size	Countries	Sample size (manufacture)	Eligible	Complete
Small	Bolivia	359	298	215
	Panama	238	185	112
	Uruguay	317	251	136
Middle	Argentina	623	540	294
	Chile	627	564	409
Large	Mexico	1,113	974	802
	All	3,277	2,812	1,968

Notes: Prepared from the information of the Enterprise Survey 2006: Eligibility is assessed on whether or not the observation reports information on Sales. Complete data refers to cases when all the basic information (sales, capital and labor) is available for analysis.

A limitation of the ES data is the relatively high non-response incidence regarding sensitive information.⁹ Table 2 presents a summary availability of information based on alternative criteria for data completeness. The minimum eligibility criteria is to restrict the data to establishments with no more than 500 permanent workers, reported total sales last year, and provided information on unions.¹⁰ This reduces the sample by 14% (call this the “eligible sample”). The sample is reduced by 40% when one requires establishments to have complete information on sales, union status, capital and production cost.

Even though the analysis could be conducted by removing the incomplete cases, case-wise deletion provides valid inferences only if the share of deleted cases is small or if the data are missing completely at random (MCAR).¹¹ If this is not the case, the inferences obtained from a complete set might be significantly biased. In this paper, a Multiple Imputation (MI) approach is used to account for the missing information. The imputation process is based on the

⁹ Missing information is coded as follows: the subject’s refusal to answer, they did not know the information asked or the question was not applicable for the establishment.

¹⁰ Only 98 observations in the sample correspond to establishments with more than 500 permanent workers. These observations are excluded because there are not enough observations to compare union and nonunion establishments. Some of estimations are sensitive to their inclusion in the sample.

¹¹ In the nomenclature of Little and Rubin (2002), data are missing completely at random if the probability of being missing does not depend on any observed or unobserved data. A weaker condition is missing at random (MAR) or ignorable non-response, which means that the distributions for missing and non-missing observations are similar after conditioning on measurable covariates.

assumption that all the missing information are “missing at random” (MAR) in the sense of Little and Rubin (2002). This implies that the process that characterizes missingness of the information is entirely explained by the observed information. Under this assumption, the approach uses available information to create multiple independent imputed samples for the unobserved data that can be independently analyzed and the results combined to provide a single MI result.

This procedure advantage over simple imputation approach is that MI introduces new information to the system, by using the empirical distribution of the missing variables. Because this strategy uses all available information, observations with partial missing information are still considered to characterize the missingness and imputation equations. The next section describes the specification and implementation details of the MI strategy used in the paper.¹²

3.1. Multiple imputation: Implementation

The working sample is restricted to establishments with complete information on labor, union status and sales variables. Establishments owned by the public sector (more than 50%) are excluded. To reduce the bias caused by new or large establishments, the sample is restricted to those with at least 3 years of operation and at most 500 permanent workers. Finally, in order to avoid biases due to data errors and inconsistencies, some minor edits are implemented.¹³ This reduces the working sample from 3,277 to 2,812 enterprises across the 6 countries.

For consistency, imputation models are kept constant across countries, except for the characteristics of region and industry.¹⁴ The imputation model includes variables capturing market competition, establishment structure, infrastructure characteristics, investment, labor force characteristics, and level of unionization.¹⁵ Imputation models are estimated using weights to obtain results representative at the national level. Iterative chained equations (ICE) are used to obtain imputed values given the observed data.¹⁶ While one cannot rule out the possibility that part of the information in the dataset is “missing not at random” (MNAR), i.e. missing is a

¹² Details on the MI process are explained in appendix A

¹³ In some instances, information such as wages, sales or costs are either too high or too low, to be consistent with other information within the establishment and other similar establishments (typos). Depending on each case, the values were inflated or deflated (reducing the excess of zeroes), or change the value to missing data.

¹⁴ The regions with major economic activity are selected for interviews in each region. The industry fixed effects correspond to the ISIC codes 15-37 (ISIC Rev.3.1).

¹⁵ A complete list of the variables that are used in the imputation process can be found in the appendix C.

¹⁶ While the literature recommends 5-10 imputed samples to obtain appropriate inferences (Rubin 1987), 50 imputed samples are obtained for the analysis in order to obtain stable results (Horton and Lipsitz 2001). Following the literature, 20 iterations are used for the burn-in period to achieve convergence on the system (van Buuren 2007).

function of unobserved characteristics, Graham, et al. (1997) shows that the sensitivity to unobserved factors is frequently small, and that even under such circumstances, the MI approach provides better inferences than working with complete reported data.

Table 3. Multiple Imputation Summary

Variable	Method	Complete	Imputed	% Imputed	Total
Nr of workers in t-1	PMM	2623	189	6.7%	2812
Cost of labor as % of sales	PMM	2563	249	8.9%	2812
Cost of electricity as % of sales	PMM	2572	240	8.5%	2812
Cost of communications as % of sales	PMM	2570	242	8.6%	2812
Cost of materials and inputs as % of sales	PMM	2479	333	11.8%	2812
Cost of fuel as % of sales	PMM	2441	371	13.2%	2812
Cost of transportation as % of sales	PMM	2460	352	12.5%	2812
Cost of water as % of sales	PMM	2408	404	14.4%	2812
Cost of rentals as % of sales	PMM	2453	359	12.8%	2812
Log Nr of workers in t-1	OLS	2623	189	6.7%	2812
Log sales in t-1	OLS	2288	524	18.6%	2812
Log wages production workers	OLS	2721	91	3.2%	2812
Log wages non production workers	OLS	2589	223	7.9%	2812
Log capital (book value)	OLS	1961	851	30.3%	2812
Log capital (market value)	OLS	2346	466	16.6%	2812
Log materials and Inputs	OLS	2441	371	13.2%	2812
Log salaries	OLS	2574	238	8.5%	2812

Note: the complete set of the variables and imputations are shown in appendix C. OLS imputation uses linear predictions to obtain the imputed values. PMM is a predictive mean matching algorithm that uses the value of the closest observation (using predicted means) to impute missing information.

Table 3 presents a summary of the imputations for the most important variables in the study. As one can observe, information regarding capital, a fundamental variable in the analysis, has one of the largest incidences of missing information (30.3% book value of capital and 16.6% market value). Among production costs, the costs of electricity and communication have the lowest missing rates (8.5% and 8.6%), while costs of fuel and water have the highest rates of missing information (13.2% and 14.4%).

3.2. Summary Statistics

Table 4 presents the summary statistics of the combined imputed samples. Most countries' establishment unionization rates are between 20-30%.¹⁷ The exceptions are Bolivia, with the

¹⁷ An establishment is classified as unionized if any share of their workforce is considered to be part of a union.

lowest shares of unionized establishments (13.4% or 7.0% weighted), and Argentina, with more than 90% of establishments being unionized. Unionized establishments are larger (in terms of number of workers) and operate for longer hours per week. With the exception of Chile, unionized establishments show a more intensive use of their installed capital. Both hours of operation and use of capital are positively correlated to the capital intensity.

Except for Argentina, unionized establishments have higher levels of sales per capita than their counterparts, and, with the exception of Argentina and Mexico, unionized establishments have higher levels of capital intensity.¹⁸ Unionized establishments are on average older.¹⁹ With the exception of Argentina, companies owned by foreign capital are more likely to be unionized, but establishments with a single majority shareholder are less likely to be unionized. In all countries but Panama, unionized establishments are more likely to have some type of certification for production quality. Similarly, unionized establishments invest more in physical capital, and research and development. In terms of workforce characteristics, unionized establishments are more likely to have an ongoing training program, with larger shares of the workforce trained. Apart from Chile, unionized establishments have larger shares of production workers.

¹⁸ Per capita measures are calculated dividing the variables of interest by the total number of permanent workers plus equivalent temporary workers in the establishment. Capital per capita is calculated using the hypothetical or “market value” of capital. It is the establishment estimation of fair value of their machinery.

¹⁹ There is no information available on when unions formed within the establishment.

Table 4. Summary Statistics

	Argentina		Bolivia		Chile	
	Nonunion	Union	Nonunion	Union	Nonunion	Union
Nr of establishments	46	494	258	40	415	149
Share	8.5	91.5	86.6	13.4	73.6	26.4
Share weighted	11.0	89.0	93.0	7.0	71.9	28.1
Union density (% unionized)		68.50%		5.80%		13.00%
Log sales per capita	10.58	10.46	8.79	9.66	10.41	10.77
Nr of equivalent permanent workers	22.73	58.27	28.07	143.03	40.69	115.24
Log capital (market value) per worker	9.13	8.99	7.75	8.83	8.84	9.22
Cost of labor as share of sales	19.1%	24.3%	23.1%	19.9%	24.7%	21.9%
Cost of inputs as share of sales	37.3%	42.7%	39.0%	37.1%	42.5%	42.1%
% Level of utilization of facilities	66.6%	70.2%	62.5%	63.7%	72.3%	68.5%
Avg hrs. of operation per Week	70.03	62.33	59.12	82.05	64.23	81.51
%Sales coming from manufacture	93.5%	93.4%	97.4%	98.7%	95.1%	98.1%
%Sales subcontracted	17.4%	8.7%	12.1%	13.5%	6.9%	4.9%
Age of establishment	25.01	35.19	21.76	29.60	25.94	41.30
Exp. top manager	30.39	27.65	21.15	19.73	26.53	24.14
Owned by foreign capital	5.5%	5.0%	3.9%	28.7%	2.1%	7.1%
>50% own by largest shareholder	93.8%	75.2%	84.8%	65.2%	90.1%	80.6%
Quality certification	16.5%	24.8%	8.6%	38.4%	19.8%	37.1%
New production or process	79.4%	80.1%	83.7%	93.7%	78.3%	74.9%
Investment in R&D or capital	75.2%	75.4%	62.0%	79.4%	77.9%	82.6%
% with no training program	72.4%	47.3%	42.2%	30.8%	60.7%	41.4%
% with 1-33% trained wf	0.9%	13.5%	20.6%	11.1%	21.0%	20.4%
% with 34-66% trained wf	0.2%	8.6%	17.0%	22.3%	8.2%	17.8%
% with 67-100% trained wf	26.5%	30.5%	20.1%	35.7%	10.1%	20.5%
Share prod Workers	63.2%	73.7%	65.0%	72.3%	70.7%	65.8%
Share skill Workers	53.6%	55.7%	68.6%	61.2%	54.7%	64.1%
% with 7+ yrs avg worker education	99.7%	97.6%	81.6%	70.0%	98.5%	94.0%
Share temporary workers ^a	10.5%	5.6%	28.3%	14.9%	9.0%	5.8%

Note: The averages are calculated using survey weights and all imputed data.^a The Share of temporary workers is defined as number of total temporary workers divided by total number of permanent and temporary workers.

Table 4. Summary Statistics (Continued)

	Mexico		Panama		Uruguay	
	Nonunion	Union	Nonunion	Union	Nonunion	Union
Nr of Establishments	639	335	148	37	181	70
Share	65.6	34.4	80.0	20.0	72.1	27.9
Share weighted	72.6	27.4	78.9	21.1	79.4	20.6
Union Density (% unionized)		21.00%		12.30%		10.80%
Log sales per capita	9.69	9.95	10.15	10.53	9.94	10.30
Nr of equivalent permanent workers	24.72	69.59	32.94	80.79	21.90	45.88
Log capital (market value) per worker	8.31	8.27	8.90	10.36	8.64	8.91
Cost of labor as share of sales	25.6%	24.5%	20.8%	23.5%	21.3%	19.0%
Cost of inputs as share of sales	26.9%	26.7%	34.3%	39.9%	47.4%	46.4%
% Level of utilization of facilities	73.9%	73.8%	71.8%	79.6%	65.9%	64.9%
Avg hrs. of operation per Week	60.69	67.45	55.81	67.79	70.35	88.36
%Sales coming from manufacture	96.4%	99.0%	93.4%	91.0%	96.8%	96.5%
%Sales subcontracted	8.5%	13.2%	5.6%	10.1%	9.4%	8.0%
Age of establishment	17.61	22.71	23.30	35.52	27.41	33.70
Exp. top manager	16.90	19.02	22.08	26.14	25.29	26.70
Owned by foreign capital	1.6%	6.6%	8.0%	9.2%	2.7%	13.1%
>50% own by largest shareholder	84.5%	73.2%	89.2%	76.4%	82.7%	64.6%
Quality certification	9.8%	25.9%	11.2%	7.7%	6.6%	14.5%
New production or process	26.3%	57.0%	73.8%	65.9%	70.9%	82.0%
Investment in R&D or capital	22.6%	48.9%	63.9%	78.8%	56.0%	64.6%
% with no training program	87.2%	49.5%	58.3%	38.9%	76.8%	47.5%
% with 1-33% trained wf	1.9%	5.1%	15.2%	14.6%	10.1%	24.7%
% with 34-66% trained wf	4.4%	14.3%	10.7%	23.7%	4.9%	6.7%
% with 67-100% trained wf	6.5%	31.2%	15.7%	22.8%	8.3%	21.1%
Share prod Workers	72.8%	74.4%	66.2%	71.1%	72.8%	74.0%
Share skill Workers	85.3%	78.1%	74.4%	78.7%	56.4%	57.7%
% with 7+ yrs avg worker education	13.3%	10.6%	94.8%	93.7%	64.9%	58.2%
Share temporary workers ^a	4.1%	6.0%	16.6%	18.9%	7.8%	7.0%

Note: The averages are calculated using survey weights and all imputed data.^aThe share of temporary workers is defined as number of total temporary workers divided by total number of permanent and temporary workers.

4. ECONOMETRIC STRATEGY

To determine the effects of unions on productivity, the starting point is the model developed by Brown and Medoff (1978). This is a variant of a Cobb-Douglas production function that distinguishes between two types of workers (nonunion and union). Assuming constant returns to scale, the production function can be written as follows:

$$Q_i = A_i K_i^\alpha (L_{i,n} + cL_{i,u})^{1-\alpha} \quad (1)$$

where Q is a measure of output or productivity, K is the level of capital, L_n and L_u are nonunion and union workers respectively, all measured at the establishment level i ; A is the constant of proportionality that depends on the measurement units of capital, labor and output, and accounts for other characteristics that determine productivity; and “ α ” and “ $1-\alpha$ ” are the output elasticities with respect to capital and labor, assuming constant returns to scale. In this framework, “ c ” reflects the productivity differences between union and nonunion labor. After some manipulation, equation (1) can be linearized and written as:

$$\log q_i = \log A + a * \log k_i + \delta * P_i \quad (2)$$

where $q = \frac{Q}{L}$ and $k = \frac{K}{L}$ are measures of labor productivity and capital per capita, $P = \frac{L_u}{L_u + L_{nu}}$ is the share of unionized workers in the establishment, and L is total number of workers in the establishment. Here δ represents the overall impact that unions have on establishment labor productivity, once we control for capital intensity.

Because equation (2) is rather restrictive a more flexible specification is used, following a general form of a translog specification for the production function (Christensen, Jorgenson, and Lau, 1973). After including an error term, and additional controls for productivity, the specification to be estimated can be written as follows:

$$\log q = \alpha_0 + \alpha_1 * \log k + \alpha_2 * \log L + \alpha_3 \log K^2 + \alpha_4 \log L^2 + \alpha_5 \log K \log L + \delta P + X' \beta + e \quad (3)$$

Although similar specifications have been widely used in the literature, there are limitations that need to be discussed (for details on the discussion see Brown and Medoff 1978 and Hirsch and Addison 1986). First, while physical production is preferable, in its absence, this paper uses value added.²⁰ The potential problem is that this measure might confound effects of both prices and quantity changes, as firms might shift some of the increasing cost (wages) to the consumers. Following Hirsch (2004), this problem is mitigated by controlling for industry fixed effects and measures of market competition.

A second problem is that the specification assumes union and nonunion establishments share the same production function, except for the productivity parameter associated to unions.

²⁰ Value added is defined as annual sales minus production costs on materials, electricity and water, divided by total labor force.

Although this problem could be alleviated by introducing different set of interactions, it may require more information than what is available. In addition, the flexibility obtained using a translog production function (equation 3) should help reduce the severity of the problem.

The most vexing problem is the potential endogeneity of establishment unionization. According to Clark (1984), one might not expect unionization and sales to be simultaneously determined, since unionization should have happened long before the survey interview. Concerns with respect to the inter-temporal effects of unionization remain. If union negatively affects profits, businesses will be less likely to survive. This survivor bias should lead to overstate union productivity effects since businesses with detrimental union effects on performance are least likely to remain in the sample (Addison and Hirsch 1989). Further, omitted variables in the specification can also generate inconsistent estimates if the unobserved characteristics have systematic variations between union and nonunion establishments.

Taking advantage of the rich information contained in the survey, the preferred specifications controls for different characteristics such as age of the establishment, manager experience and ownership characteristics, among others, that provides a flexible specification, reducing the impact of otherwise unmeasured characteristics. Nevertheless, because of potential survivor bias and the presence of additional unobserved factors, the estimations could be upward biased, should be considered with care, and should not be interpreted as causal effects. To test the sensitivity of the productivity estimates to the controls, different specifications are used to control for aspects related to market competition, establishment characteristics and organization, and innovation policies. Though the estimates here presented are “descriptive” in nature, the evidence is informative, as they are the first step toward identifying how unions affect productivity in developing countries.

5. RESULTS

Following the specification shown in equation (3), the natural logarithm of value added per worker is used as the productivity measure. For observations where production costs exceed the value of total sales, total cost is constrained and the cases controlled using a dummy variable.²¹ For the production factors, employment is measured as the total number of permanent workers plus the equivalent number of seasonal workers, while capital is measured as log of the market

²¹ Overall, only 1.3% of the observations fall within these characteristics.

value of machinery and equipment (including vehicles).²² In addition, the basic model includes controls for region and broad industry fixed effects. The main variable of interest, union density, is included as a share between 0 and 1, which indicates what share of the permanent labor force in the establishment is unionized.

Table 5. Effect of Unions on Establishment Productivity, by Country

	Argentina	Bolivia	Chile	Mexico	Panama	Uruguay
Avg. % unionization in union establishments	77.0%	82.5%	46.2%	76.8%	58.2%	52.2%
% Workforce unionized	-0.389+	0.160	0.167	0.095	0.256	0.178
	(0.026)	(0.695)	(0.353)	(0.555)	(0.467)	(0.448)
Log capital pc	-0.777	0.316	-0.45	-0.086	-0.248	-0.114
	(0.306)	(0.421)	(0.194)	(0.650)	(0.490)	(0.717)
Log total labor force	-0.427	-0.792	-0.443	0.19	0.045	0.522
	(0.425)	(0.150)	(0.357)	(0.548)	(0.951)	(0.549)
Log K log L	-0.012	0.161*	-0.005	-0.015	-0.001	-0.034
	(0.878)	(0.004)	(0.914)	(0.595)	(0.986)	(0.520)
Log K ²	0.033	-0.027	0.027	0.017	0.012	0.008
	(0.380)	(0.250)	(0.122)	(0.115)	(0.546)	(0.606)
Log L ²	-0.001	-0.124	0.000	-0.031	-0.031	0.029
	(0.983)	(0.162)	(0.998)	(0.395)	(0.646)	(0.813)
Constant	13.648*	6.917*	11.143*	7.987*	10.390*	8.291*
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
$\delta V A_{pc} / \delta K$, at means	-0.006	0.207	0.203	0.250	0.043	-0.026
$\delta V A_{pc} / \delta L$, at means	0.196	-0.104	-0.055	-0.068	0.093	0.409
Observations	540	298	564	974	185	251

Note: ^ p<0.1, + p<0.05, * p<0.01. P-values in parentheses. All models are estimated using sample weights. All models include region and broad industry fixed effects.

Table 5 presents the results of the basic specification which controls only for production factors, and region and industry fixed effects. These basic results show that for most countries in our sample, unions have a positive but weak correlation with productivity. In the absence of endogeneity, the point estimates indicate that, on average, if a nonunion establishment unionizes it could increase productivity per worker between 0.077 log points (approximately 8%) to up to

²² Equivalent seasonal workers are measured as the total number of temporary workers multiplied by the average time a temporal worker participates in the establishment in a year. As described in the survey manual, information collected on the market value (hypothetical value) of capital is recommended to be used as the best approximation for capital intensity in the establishment.

0.149 log points (15%).²³ Although the point estimates are sizable, the results also indicate that there is considerably heterogeneity across establishments, shown by the low significance levels of the parameters. The only exception is Argentina; the estimate shows that unions have a large negative and significant impact on productivity ($-0.389 \times 77\% = 0.299$ log points). It should be kept in mind that in contrast to other countries in the sample, most of Argentina's manufacture establishments are unionized.

Given the type of production function used here, the coefficients for capital and labor are more difficult to interpret than in the standard Brown and Medoff model. To facilitate interpretation, at the bottom of Table 5, the derivatives with respect to labor and capital are obtained and evaluated at the mean.²⁴ The parameters are consistent with the expectations for Bolivia, Chile and Mexico. In Argentina, Panama and Uruguay, however, the estimates are somewhat unexpected as the marginal effect of capital is almost zero, with a positive marginal effect from labor. Although these results are worrisome, they remain consistent across different specification, and should not be crucial for the main focus of the analysis.

5.1. Sensitivity to Additional Controls

The basic model estimated in Table 5 does not take into account other characteristics that can explain productivity or that can differ between unionized or nonunionized establishments. Tables 6 and 7 present estimations using richer specifications. Table 6 presents results of the union productivity effect only, to show how sensitive the estimates are to additional controls, while Table 7 presents the results of the full specification model.

Controlling for the level of competition should improve the estimates by partially accounting for differences in prices caused by union effects on labor costs. The second row of in Table 6 provides the estimates after controlling the number of competitors the in the market. In Chile and Uruguay, the productivity estimates are greatly reduced, with the estimates for Uruguay becoming negative. In Chile, these results seem to be driven by the impact that some competition (2-5 competitors in the market) has on sales and productivity (see Table 7). In

²³ The average marginal effect is obtained by multiplying the union coefficient estimate by the average unionization rate among union establishments (i.e. Marginal effect in Bolivia: $82.5\% \times 0.16 = 0.132$ log points).

²⁴ The estimates of the basic specification using the basic Brown and Medoff (1978) model are shown in appendix C. The results are comparable to the estimations of Table 5, except for Bolivia, where the Brown and Medoff basic model predicts a much larger productivity relationship.

Uruguay, while partial model (not shown here) suggests a story similar to Chile, after controlling for other factors, competition seems to have a small and not significant impact on productivity.

An implicit assumption in the model is that all sales (production) come from the establishment's own manufactured goods produced using full capacity of the available resources. Longer hours of operation or greater use of production capacity can spuriously increase productivity estimates if they are not controlled for. Likewise, if establishments subcontract production to smaller units, or generate sales via services (rather than manufacture), it may bias the productivity estimates. Results in Table 7 show the results controlling for level of utilization of capital, weekly hours of operation, and sales structure (services and subcontracts). Controlling for these productivity adjustments suggests that union productivity enhancements are not coming from more intensive use of production factors, showing larger estimates increase for all countries. Chile and Uruguay show the most drastic changes on productivity, with modest changes elsewhere. The results in Table 7 show that the parameters for these controls are consistent with the expected signs.

Other factors correlated with union status and productivity are linked to establishment characteristics and management quality. To account for establishment characteristics, variables controlling for years of operation, whether the establishment is part of a larger firm, and if the establishment is owned by foreign capital are included in the specification. Controlling for these factors reduces the productivity relationship in Bolivia, and increases it in Chile to almost significant levels ($p=12.5\%$). According to the results in Table 7, the fall in the union-productivity relationship in Bolivia is explained because most of the positive relationship was driven by foreign owned companies, which are typically unionized. This is consistent with the fact that being part of a larger firm and being owned by foreign capital is correlated with better managerial policies (Aitken, et al. 1996). Alternatively, in Chile, not accounting for younger establishments, which are more productive and less likely to be unionized, was understating union productivity effects.

To control for management quality and organization, variables describing the ownership structure and management characteristics are included in the specification. Argentina and Panama show the largest positive change in the estimates of the union-productivity relationship. These results suggest that unionized establishments have relatively more inefficient management, which puts downward pressure on productivity if management characteristics are

not accounted for. The results in Table 7 suggest that the strong relationship between productivity and decision strength of the largest shareholder is the main factor explaining the impact on the union-productivity estimates in Panama.

Although some of the previous controls are arguably not directly affected by unions, aspects such as investment, training, and workforce structure could be affected their presence. In the interest of disentangling the direct effect unions on productivity, additional controls are introduced in the specification. Under the assumption that unions have a negative impact on investment (rent seeking behavior), controlling for investment should have a positive impact on the union-productivity relationship. The results on Table 6, however, indicate that controlling for investment and innovation have little impact on the union estimates.

Because unions are often associated with lower turnover, unionized establishments might be more likely to provide more training, since they can benefit from the returns of such investment through higher productivity (Kuhn 1985; Allen 1984). Although human capital upgrades are legitimate sources of productivity enhancements, they may not necessary generate improvements in technical efficiency. Including training as a control variable in the estimations (see Table 7) shows that, on average, training has a positive, mostly not significant, impact on productivity. Adding these controls to the specification has the expected negative effect on the union-productivity relationship for all countries, especially for Panama, indicating that training is an important channel through which unions improve productivity.

Unions can also influence the structure and composition of the workforce within establishment, changing the mix of production factors and affecting productivity. The last estimates in Table 6 control for two aspects of workforce characteristics: workers' average education and workforce structure. Except for Chile and Panama, controlling for these effects increases the impact of unions on productivity. In Bolivia, Mexico and Uruguay, similar to the evidence at the micro level (Rios-Avila and Hirsch, forthcoming), unionized establishments are associated with low-educated, low-skill workers, and not controlling for it understates productivity. The evidence, however, is insufficient to detect the effect of other workforce characteristics on union-productivity effect.

Although there is limited evidence on the productivity effects of unions for these countries in the literature, the evidence that does exist appears consistent with the results found here. Using information from a national survey of manufacturing in Mexico in 1999, Fairris

(2006) finds that unionized establishments are about 11% more productive than their counterparts (compared to the 9% estimate here). In the case of Uruguay, Cassoni, et al. (2005) finds a modest 5.7% effect, qualitatively similar to the 12% (0.12 log points) found here. These similarities increase the confidence in the results shown in Table 6.

Table 6. Effect of Unions on Establishment (Est.) Productivity, Sensitivity to Specifications

	Argentina	Bolivia	Chile	Mexico	Panama	Uruguay
% Workforce unionized	-0.389+	0.160	0.167	0.095	0.256	0.178
Basic model	(0.026)	(0.695)	(0.353)	(0.555)	(0.467)	(0.448)
% Workforce unionized	-0.388^	0.190	0.038	0.114	0.286	-0.083
+Competition	(0.054)	(0.662)	(0.832)	(0.447)	(0.401)	(0.763)
% Workforce unionized	-0.328+	0.232	0.156	0.145	0.280	0.117
+Productivity adjustments	(0.028)	(0.609)	(0.316)	(0.382)	(0.419)	(0.578)
% Workforce unionized	-0.322+	-0.013	0.251	0.101	0.305	0.072
+Est. characteristics and ownership	(0.034)	(0.976)	(0.125)	(0.535)	(0.393)	(0.755)
% Workforce unionized	-0.264^	-0.034	0.219	0.073	0.407	0.114
+ Management and organization	(0.058)	(0.930)	(0.170)	(0.620)	(0.242)	(0.570)
% Workforce unionized	-0.273^	-0.05	0.254	0.049	0.461	0.092
+Investment policy and technology	(0.090)	(0.891)	(0.117)	(0.732)	(0.178)	(0.683)
% Workforce unionized	-0.279^	-0.101	0.251	0.026	0.378	0.073
+Training	(0.097)	(0.797)	(0.118)	(0.863)	(0.272)	(0.787)
% Workforce unionized	-0.257+	-0.009	0.173	0.093	0.349	0.117
+Labor force structure	(0.049)	(0.981)	(0.281)	(0.539)	(0.295)	(0.558)
Observations	540	298	564	974	185	251

Note: ^ p<0.1, + p<0.05, * p<0.01. P-values in parentheses. All models are calculated using all controls specified in the previous model. All models are estimated using the sample weights, and include region and broad industry fixed effects.

Table 7. Effect of Unions on Establishment (Est.) Productivity, Full Specification

	Argentina	Bolivia	Chile	Mexico	Panama	Uruguay
% Workforce unionized	-0.257+ (0.049)	-0.009 (0.981)	0.173 (0.281)	0.093 (0.539)	0.349 (0.295)	0.117 (0.558)
Competition						
Establishment has 2-5 competitors	0.044 (0.850)	-0.342 (0.331)	0.443+ (0.013)	-0.359* (0.002)	-0.009 (0.970)	-0.425 (0.268)
Establishment has 5 or more competitors	-0.105 (0.718)	-0.209 (0.509)	0.154 (0.323)	-0.287+ (0.016)	0.138 (0.645)	-0.368 (0.217)
Establishment faces international market	-0.047 (0.822)	-0.206 (0.510)	0.029 (0.908)	0.341 (0.261)	0.127 (0.765)	0.046 (0.876)
Capacity and Utilization						
Level of utilization of capital	0.008* (0.004)	0.006^ (0.060)	0.002 (0.236)	0.002 (0.210)	-0.001 (0.890)	0.016* (0.003)
Log hours of operation per week	-0.245 (0.230)	0.148 (0.454)	-0.128 (0.165)	0.062 (0.643)	0.152 (0.569)	-0.239^ (0.086)
% Sales not from manufacture	-0.014 (0.972)	1.203 (0.288)	0.927+ (0.041)	0.796 (0.240)	1.326^ (0.058)	-1.012 (0.418)
% Sales that are subcontracted	-0.246 (0.224)	0.275 (0.408)	0.190 (0.357)	0.116 (0.619)	0.206 (0.614)	-0.430 (0.201)
Est. Characteristics						
Owned by foreign capital (>50%)	0.227 (0.472)	0.727+ (0.013)	0.239 (0.274)	-0.117 (0.540)	0.335 (0.280)	0.182 (0.734)
Establishment part of larger firm	0.150 (0.343)	-0.311 (0.307)	0.073 (0.541)	0.084 (0.440)	0.107 (0.750)	0.220 (0.620)
Age of the establishment (Years of operation)	0.009 (0.236)	0.028 (0.107)	-0.010 (0.111)	0.027* (0.000)	0.002 (0.896)	0.006 (0.524)
Age ² /100	-0.006 (0.101)	-0.009 (0.587)	0.007 (0.173)	-0.029* (0.000)	-0.007 (0.711)	-0.0004 (0.960)
Management and Organization						
>50% own by largest shareholder	0.128 (0.439)	-0.234 (0.378)	0.031 (0.751)	-0.036 (0.653)	0.541^ (0.051)	-0.034 (0.845)
Any of the main owners female	-0.043 (0.683)	-0.331^ (0.066)	0.052 (0.615)	-0.214* (0.004)	0.366^ (0.071)	-0.264 (0.223)
Experience top manager	0.018 (0.254)	0.028^ (0.069)	0.007 (0.456)	0.000 (0.982)	-0.039 (0.253)	-0.009 (0.780)
Experience ² /100	-0.042+ (0.013)	-0.097* (0.010)	-0.023 (0.170)	-0.005 (0.760)	0.076 (0.246)	-0.002 (0.965)
Public or private	-0.057 (0.686)	0.303 (0.280)	0.150 (0.160)	0.173^ (0.080)	0.283 (0.263)	0.311 (0.138)
Investment and Innovation						
Uses foreign company technology	0.312+ (0.044)	-0.064 (0.829)	0.162 (0.255)	0.180 (0.308)	0.422 (0.233)	0.005 (0.989)
Product quality certification	0.027	0.165	0.150	0.356*	0.514	0.567+

	(0.877)	(0.578)	(0.114)	(0.001)	(0.110)	(0.022)
Introduced new process or product	0.366+	-0.409+	0.211+	0.055	0.130	0.137
	(0.018)	(0.028)	(0.036)	(0.510)	(0.545)	(0.436)
Invested in capital or R&D	0.144	0.053	-0.027	0.156^	-0.003	-0.038
	(0.216)	(0.755)	(0.821)	(0.088)	(0.989)	(0.811)
Training						
1-33% workforce trained	-0.006	-0.275	0.070	0.137	0.472	0.201
	(0.982)	(0.308)	(0.519)	(0.471)	(0.123)	(0.472)
34-66% workforce trained	0.588*	-0.249	0.191	-0.008	0.043	0.322
	(0.001)	(0.284)	(0.293)	(0.960)	(0.873)	(0.409)
67-100% workforce trained	0.200	-0.219	0.121	0.067	-0.174	-0.280
	(0.127)	(0.109)	(0.375)	(0.597)	(0.543)	(0.143)
LF characteristics						
Avg education 4-6 yrs		0.174		0.167^		
		(0.631)		(0.094)		
Avg education 7-12 yrs		0.126		0.365+		0.341
		(0.614)		(0.045)		(0.169)
Avg education 13+ yrs	-0.088	0.006	0.055		-0.271	
	(0.385)	(0.984)	(0.689)		(0.199)	
Share of production workers	-0.882+	-0.448	-0.179	-0.291	0.377	-1.518*
	(0.016)	(0.161)	(0.632)	(0.261)	(0.503)	(0.000)
Share of skill workers	-0.088	-0.148	0.098	0.340+	-0.146	-0.118
	(0.461)	(0.536)	(0.449)	(0.022)	(0.675)	(0.604)
Share of temporary workers	0.868	-0.843+	-0.499	-1.240	-0.257	-0.831
	(0.419)	(0.017)	(0.335)	(0.119)	(0.826)	(0.477)
Share of female workers	-0.670+	-0.601+	-0.483+	0.182	0.090	-0.313
	(0.037)	(0.020)	(0.035)	(0.320)	(0.796)	(0.569)
Constant	13.614*	7.422*	11.527*	7.361*	7.495*	10.519*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Observations	540	298	564	974	185	251

Note: ^ $p < 0.1$, + $p < 0.05$, * $p < 0.01$. P-values in parentheses. The base categories for competition are those establishments facing none or 1 other establishment in the market. For training, the base category corresponds to establishments with no training programs. For education, the base category corresponds to workers with 3 or fewer years of education for Bolivia and Mexico, 7 to 12 years for Argentina, Chile and Panama, and 4-6 years of education for Uruguay. All models are estimated using sample weights, and include region and broad industry fixed effects.

5.2. Interpretation

Taken as a whole, the results shown in Table 6 suggest that unions are associated with positive union-productivity effects, but that there is a lot of heterogeneity in the relationship both within and across countries (the former seen by the low significance levels of results). The results also provide some evidence that the union-productivity estimates are reasonably robust in richer specifications that take into account typically unobserved establishment characteristics. On one

end of the spectrum, using the preferred specification (all controls), it can be observed that unions in Bolivia have no effect on productivity (practically zero), while a negative and significant estimate is seen in Argentina (-0.284). On the other side, large positive, albeit insignificant, effects are observed in Chile and Panama, while estimates for Mexico and Uruguay are positive and consistent across specifications, but not significant.

The evidence presented in Table 6 also brings some light on determinants of the union-productivity relationship. Controlling for productivity adjustments increases union productivity estimates. This suggests unions might be improving technical efficiency, adjusting for differences in sales and production structures across establishments, consistent with the reduction of “X-inefficiencies” (Hirsch and Addison 1986; Addison and Hirsch 1989; Kaufman, 2004). Part of the positive productivity effects, however, seem to be related to large unionization rates across large establishments, foreign owned, with typically better management. Consistent with the hypothesis in Fairris (2006), unions seem to be improving productivity by improving job training. Finally, lower levels of worker human capital seem to have contributed to an understatement of the productivity effects of unions.

Taken at face value, the estimate found for Argentina indicates that output per worker in a fully unionized establishment is 25 log points lower than in an equivalent nonunion establishment. Were we to have obtained such a result in other countries, it would have raised the question how union establishments could survive given lower productivity and (presumably) higher compensation. Argentina, however, is a special case compared to other countries in the region. There are very few establishments in the sample that are *not* unionized, and those nonunionized are rather different (relatively younger and smaller).

As Kuhn (1998) and others have argued, negative productivity effects have been typically found in environments of union and management conflict, which might explain the results observed in Argentina. In Table 8, two aspects of labor regulations and the perception of management are presented. About 44% of establishments in Argentina consider that labor regulations are serious or very serious obstacles to the operation of the establishment. Similarly,

60% of establishments declare that labor regulations have affected their hiring and firing decisions, which is almost twice as high as in other countries.²⁵

Table 8. Perception of Labor Regulations

	Argentina	Bolivia	Chile	Mexico	Panama	Uruguay
Labor regulations and H/F decisions						
Hire decision affected	8.4	2.2	5.4	0.7	4.3	13.6
Fire decision affected	7.2	3.3	12.6	1.9	6.9	2.1
Hire and Fire affected	44.5	9.3	19.4	3.5	6.1	17.3
Labor regulation as obstacles						
No obstacle	8.1	52.3	29.8	49.6	56.8	38.7
Minor obstacle	12.6	13.8	24.0	25.4	15.9	9.1
Moderate obstacle	34.4	20.2	26.2	19.1	18.8	30.4
Serious obstacle	26.9	7.5	15.6	3.8	7.5	14.0
Very serious obstacle	17.9	3.7	4.4	0.7	0.7	7.0

Note: All information reflects the weighted share of establishments within each category for each country.

To assess the extent that perceptions of labor regulations affect the union-productivity relationship, Table 9 presents two alternative specifications that show the interaction between unionization rates and the perception of regulations. The direction of the estimates suggests unions have a smaller (or larger and negative) effect on productivity in cases of negative perception of labor regulation. For instance, except for Mexico or Uruguay, the union-productivity effect is smaller (or more negative) if establishments perceive that labor regulations have affected their decisions on hiring or firing workers.

Regarding the perception of labor regulations as obstacles to production, the results are similar. Establishments that do not consider labor regulations as obstacles to production, less conflictive environments, show a more positive impact on productivity compared to establishments that consider labor regulations a moderate or serious obstacle to production.

²⁵ For more details on establishment perceived obstacles, taxes, regulations, and other topics, including comparisons to countries in the region can be found in the Country Profiles, and accessed at <http://www.enterprisesurveys.org/Reports>.

Table 9. Labor Regulations and effect on Union Productivity effects

	Argentina	Bolivia	Chile	Mexico	Panama	Uruguay
Labor regulations and H/F decisions						
% Workforce unionized	-0.119	0.15	0.188	0.0862	0.377	-0.206
x No H/F decision affected	(0.414)	(0.736)	(0.399)	(0.578)	(0.288)	(0.533)
% Workforce unionized	-0.304+	-0.638	0.148	0.129	0.237	0.614 [^]
x H/F decision affected	(0.031)	(0.275)	(0.411)	(0.570)	(0.697)	(0.084)
Labor regulation as obstacles						
% Workforce unionized	-0.344	0.216	0.0975	0.0795	0.456	-0.006
x No or minor obstacle	(0.266)	(0.681)	(0.673)	(0.595)	(0.298)	(0.982)
% Workforce unionized	-0.407+	0.051	0.428	0.0437	-0.0505	-0.649
x Moderate obstacle	(0.046)	(0.933)	(0.160)	(0.877)	(0.938)	(0.325)
% Workforce unionized	-0.175	-0.886	-0.112	0.289	0.791	0.669
x Serious or v. serious obstacle	(0.122)	(0.134)	(0.660)	(0.195)	(0.110)	(0.209)
N	540	298	564	974	185	251

Note: [^] p<0.1, + p<0.05, * p<0.01. P-values in parentheses. All models are estimated using the full specification shown in Table 14.

An alternative explanation is rooted on the settings under which unions operate. O'Connell (1999) describes Argentinian unions to be highly centralized and protected by the government, which provides unions with fewer incentives to internalize the costs of bargaining demands, potentially harming productivity. As noted in Anner (2008), unions in Argentina also have access to financial information of the employers, which can be used during bargaining. Access to this information may allow unions to better internalize the cost of increasing wages, providing incentives to engage contracts that benefit both workers and employers. In an environment of conflict, it is more likely that financial information is used to redirect resources toward higher wages (rent seeking behavior), reducing establishment's flexibility to transfer resources to investment or innovation, reducing productivity. Given the unique situation of Argentina, there is little reason to suspect that unionized establishments will be at a disadvantage in the domestic market, as unionized establishments primarily compete with each other.

The positive, albeit insignificant, union productivity effects seen in Chile can be associated with the decentralized collective bargaining system in this country. As Campero (2001) and Vergara (1998) describe, the decentralized bargaining system in Chile has allowed establishments to negotiate wage and benefits linked to specific productivity targets. This is consistent with O'Connell's (1999) hypothesis, which indicates that decentralized collective bargaining systems can increase productivity by allowing unions to internalize their externalities, facilitating their input in production process decisions. Our evidence shows, however, that once

labor force structure characteristics are taken into account, the union-productivity relationship becomes statistically insignificant.

In the remaining countries, unions appear to have a positive but insignificant effect on productivity (Bolivia is an exception). It can be argued that the decentralized bargaining system in Panama, as in Chile, explains its large positive union productivity estimates, but large heterogeneity within Panama makes these estimates insignificant. In Bolivia, Mexico and Uruguay, where union-productivity estimates are smaller, there are no specific reasons that might lead one to expect a highly positive or negative union effect.

Uruguay has transitioned toward a decentralized bargaining system that tries to incorporate productivity clauses in their contracts (O'Connell 1999; Cassoni, et al. 2005), similar to the Chilean model. In Mexico, the combination of a centralized bargaining system, and conflicts between employers and unions, reflected in the violation of union rights, should have generated a negative productivity impact, which is not observed. In the case of Bolivia, the results show that unions have no net effect on productivity, and positive relationships are mainly driven by establishment characteristics, in particular the type of ownership. Then again, the presence and strength of unions might be too limited (compared to the other countries) to generate substantive pressure for productivity enhancements.

5.3. Robustness to Unionization measurements

Union density might contain measurement errors because employers, who may not have perfect information on union membership, report “guestimate” of union density in the establishment. In this case, a categorical union measure (say from 1 to 50; 51 to 100 percent, with zero unionization the omitted base group), may contain less measurement error than a continuous measure of union density does. Table 10 presents estimates using two alternative measures of unionization within establishments, using the same controls as in the full specification (Table 7). Although these results are informative regarding nonlinear effects of unions, the interpretation of some coefficients might be difficult as some countries, like Bolivia and Panama, might not have sufficient observations to identify the corresponding union effects.

Table 10. Effect of Unions on Establishment Productivity: Alternative Union Measures

	Argentina	Bolivia	Chile	Mexico	Panama	Uruguay
(1)						
% Workforce unionized	-0.257+	-0.009	0.173	0.093	0.349	0.117
	(0.049)	(0.981)	(0.281)	(0.539)	(0.295)	(0.558)
% unionization	77.0%	82.5%	46.2%	76.8%	58.2%	52.2%
Avg effect on productivity	-0.194	-0.007	0.082	0.071	0.198	0.066
(2)						
Union dummy	-0.347*	0.0331	0.017	0.094	0.138	0.138
	(0.008)	(0.922)	(0.851)	(0.423)	(0.585)	(0.465)
(3)						
Less than 50% unionized	-0.205	0.213	-0.055	0.156	0.010	0.226
	(0.232)	(0.773)	(0.609)	(0.374)	(0.978)	(0.362)
More than 50% unionized	-0.379*	0.003	0.177	0.074	0.290	0.032
	(0.005)	(0.994)	(0.153)	(0.558)	(0.391)	(0.873)

Note: ^ p<0.1, + p<0.05, * p<0.01. P-values in parentheses. All models are estimated using the full specification shown in Table 14.

In the first part of Table 10, the results from the preferred model are used as reference. It includes information on the average unionization rate within union establishments to estimate the average union effect on productivity. The first alternative measure uses a dummy variable for unionization, and its coefficient can be interpreted as an average union-productivity effect. The estimates are somewhat consistent with the estimated average union impact observed in row 1. In Argentina, the average productivity effects using dummy variables are larger, in absolute value, than in the preferred specification. In Chile, on the other hand, while the previous estimate shows a large and positive impact on productivity, the estimates using a dummy variable indicate that the effect is practically zero. This shows that there is some heterogeneity (nonlinearity) in the effects of unions across different levels of unionization.

An alternative measure is to estimate the union effects using dummy variables for different levels of unionization density in the establishment. While some cells are difficult to identify due to insufficient observations, this measurement is better capturing non-linear effects of unions. In Argentina, regardless of the level of unionization, the estimates are strongly negative, and increasing for establishments with higher unionization rates. In Mexico and Uruguay, the results suggest that some levels unionization (less than 50%) can have a positive impact on productivity. In contrast, for Chile and Panama, unionization is positively correlated with productivity for establishments with high rates of union density. Among establishments with low unionization rates, however, unions have either a negative or no relationship with productivity.

6. PROFITABILITY AND INVESTMENT

The evidence provided so far indicates that unions have, on average, positive effects on productivity, except for Argentina and Bolivia. It is possible that these productivity enhancements are insufficient to compensate for the higher costs imposed by unions (mainly wage costs), which could translate into lower profitability or lower investment.²⁶ Using the preferred specification, additional models are estimated to test the union effect beyond productivity (Table 11). While the results cannot be interpreted as causal effects, they can be considered partial effects (correlations) from unions, after accounting for other measurable covariates.

The first aspect to analyze the effect unions have on profitability. A price-cost margin index is used to measure the percent of profit per dollar in sales. Following Hirsch and Connolly (1987), along with other studies in the industrial organization literature, the profits equation includes the log of the capital-sales ratio as control. According to the results, the positive productivity effects seem to be insufficient to offset the additional union wage costs, with Argentina showing the largest negative and significant impact in the region. There are some exceptions.

In Bolivia, highly unionized establishments, which showed no relationship to productivity, appear to be positively correlated to profitability. A detailed analysis on the structure cost, not shown here, suggests that these types of establishments have much higher rates of capital per capita with lower shares of labor costs, which translates into higher profitability without productivity improvements. In Mexico, Panama and Uruguay, the positive estimates of union profitability can be explained by the abnormally high productivity estimates, and relatively lower union pressure (low density). This last characteristic might also explain why in Panama and Chile, the productivity estimates of highly unionized establishments translated into small positive (or negative) profitability estimates.

²⁶ Estimations elsewhere have found that unions wage premium in developing countries are modest but not negligible. The estimated wage gaps for the countries in the sample are: 11% Bolivia, 14% Chile (Rios-Avila and Hirsch (Forthcoming)), 15% Mexico (Fairris, 2003), 20% Panama (Falaris, 2008) and 7% Uruguay (Cassoni, et al. 2005). Bolivia and Chile estimates use household data for 2000 to 2009. Mexico and Panama are based on household data from 1996 and 1997 respectively. In Uruguay, the estimates correspond to establishment level surveys from 1988 to 1995.

The second aspect for measuring performance is related to investment and innovation. The literature indicates that unions might affect investment by reducing investment returns in the market (i.e., rent seeking behavior) or increasing conflicts with management (monopoly face of unions). It also suggests that unions increase investment, as it reduces “X-inefficiencies” improving the returns to investment (Machin and Wadhvani, 1991). More recently, Doucouliagos and Laroche (2013) has found that unions are negatively correlated with investment, consistent with unions taxing quasi-rents of capital, reducing the incentives for long term investment.

Three variables are used for the empirical analysis. The first one indicates a new product or production process has been introduced in the last three years, while the second and third variables indicate if there has been any investment in physical capital or in research and development (R&D) in the last year.²⁷ The specification excludes all variables regarding innovation. It also includes a dummy variable for an increase in sales, to account for availability of establishment resources. While these variables are not adequate to describe long term investment relationships, they still provide an important snapshot of current establishment behavior.

According to the results (Table 11), the estimates suggest that unions have a negative effect on all aspects of investment, and when positive they are small and non-significant. Mexico and Panama are the exceptions. In Mexico, highly unionized establishments are more likely to introduce new processes/products in the market, while establishments with low unionization show positive and somewhat significant correlation with investment on capital and R&D. In Panama, unionized establishments were much more likely to invest in R&D than their counterparts, with significant estimates for highly unionized establishments.

²⁷ Although data on amount invested on physical capital and research and development exists, these variables have substantial missing information, and potential measurement error. Variables indicating whether or not establishments invested have minimal missing information and are more adequate for the analysis.

Table 11. Effect of Unions on Establishment Performance

	Argentina	Bolivia	Chile	Mexico	Panama	Uruguay
Profitability						
Less than 50% unionized	-0.137 [^] (0.080)	-0.204 (0.235)	-0.0135 (0.675)	0.0633 (0.355)	-0.0817 (0.379)	0.115 [^] (0.066)
More than 50% unionized	-0.176 ⁺ (0.043)	0.0619 (0.390)	-0.0441 (0.279)	-0.0185 (0.535)	0.0311 (0.736)	-0.0231 (0.591)
Introduced new process or product						
Less than 50% unionized	-0.0589 (0.724)	0.183 [^] (0.098)	-0.119 [^] (0.070)	-0.0338 (0.595)	0.00424 (0.978)	0.0254 (0.861)
More than 50% unionized	0.0848 (0.196)	0.0165 (0.830)	-0.0589 (0.368)	0.126 ⁺ (0.023)	0.0206 (0.864)	0.0268 (0.884)
Investment in capital						
Less than 50% unionized	-0.0251 (0.889)	0.0886 (0.653)	-0.0788 [^] (0.058)	0.0777 [^] (0.063)	0.027 (0.808)	-0.0879 (0.601)
More than 50% unionized	-0.0369 (0.766)	0.0115 (0.942)	-0.0733 (0.405)	0.00436 (0.874)	0.137 (0.380)	0.0196 (0.837)
Investment in R&D						
Less than 50% unionized	-0.0635 (0.667)	0.174 (0.406)	-0.0878 (0.111)	0.0648 (0.313)	0.17 (0.294)	-0.0714 (0.561)
More than 50% unionized	-0.0514 (0.465)	-0.051 (0.660)	-0.0329 (0.364)	0.0281 (0.574)	0.232 [^] (0.085)	-0.0953 (0.680)
Observations	540	298	564	974	185	251

Note: [^] p<0.1, ⁺ p<0.05, * p<0.01. P-values in parentheses. All models are estimated using the full specification model presented in Table 14. For the models with innovation and investment, those variables are excluded from the model.

7. CONCLUSIONS

This paper has aimed to fill some gaps in the literature by studying the effects that unions have on productivity and performance at the establishment level in selected countries in Latin America. These Latin American countries have been historically known for the strong role unions have played in their political and economic histories. Following periods of dictatorship, debt crisis and economic recovery, however, these countries developed in ways that have produced substantial heterogeneity in their collective bargaining systems and the roles that unions play in their economies.

According to the results presented here, unions appear to have small but positive effects on productivity across all countries in the sample, with the notable exception of Argentina, where a strong negative productivity effect is found, and Bolivia, where no effect is found. The positive relationships between unions and productivity appear to be sufficient to offset higher labor costs, translating in small and insignificant profitability estimates. In addition, with few exceptions, unions seem to have either a null or negative effect for current investment decisions.

While some of the observed effects can be linked to labor regulations, unions and managements conflicts, economic structure, or unionization organizations, no single narrative can readily explain all results presented here. Even at the establishment level, a precisely estimated union- productivity effect of zero is difficult to interpret, being consistent with unions having either no effect or having offsetting positive and negative effects. The empirical analyses presented here, however, provide an important step toward a better understanding of the role of unions in developing countries in Latin America, an area where there has been little prior evidence. Given the nature of the data and the limitations they place on modeling, the results presented here cannot be strictly represented as causal effects. Instead, they represent the best estimates of partial correlations that capture a portrait of the net outcomes resulting from unions and collective bargaining in these Latin American economies. With the development of new data, similar analysis can be extended to different regions and time frames, and can open the opportunity for future research that provides a more detailed analysis of the effects and channels through which unions affect establishment performance.

APPENDIX A

Multiple Imputation using Chain Equations

In cases when the missing data structure follows an arbitrary missing pattern and simultaneous imputations of multiple variables are required, two standard imputation approaches can be used: multivariate normal imputation and imputations using chained equations (ICE). While the first approach estimates a model that tries to identify the underlying multivariate distribution, it imposes restrictions on the estimation, assuming the system follows a normal multivariate distribution. The ICE approach, by contrast, lacks a formal theoretical justification, but provides more flexibility in the specification of the imputation models, being consistent with different types of underlying distributional assumptions.

The idea of the ICE approach is to construct univariate imputation models for each variable with missing information, using a fully conditional specification where all variables, other than the one being imputed, are used as independent variables. These conditional models are used to obtain predictions for the missing information, and can be used in subsequent iterations. In cases where the missing data structure follows an arbitrary pattern, an iterative imputation process is needed to account for possible dependence of the estimated parameters to the imputed data. Formally, the procedure can be described as follows.

Let X_1, X_2, \dots, X_p be a set of variables with missing information (imputed variables), and let Z be a set of complete predictors. For each imputed variable, it is possible to construct a univariate imputation models f_i , where each model can be a different distribution function (normal, logistic, etc), that best identifies the specific underlying distribution of the variable X_i :

$$X_1^{t+1} = f_1(X_1|X_2^t, \dots, X_p^t, Z, \theta_1)$$

$$X_2^{t+1} = f_2(X_1|X_1^t, \dots, X_p^t, Z, \theta_2)$$

$$X_p^{t+1} = f_p(X_1|X_1^t, X_2^t, \dots, X_{p-1}^t, Z, \theta_p)$$

Once the imputation models are specified for the first iteration, only complete observations are used for each individual model. Based on the imputation models, random draws using the empirical distribution of the imputed variables are obtained and used in the next iteration of the imputation until convergence is obtained. Although there is no specific rule on the number of imputations needed to obtain convergence of the system, the literature suggests

that 10 iterations are typically sufficient to achieve convergence (van Buuren, 2007). However, depending on the complexity of the imputation system, more iterations may be needed. Once convergence is achieved, a random draw of the empirical process is obtained and used to create an imputed sample. This process is repeated for each additional set of imputed samples needed until M different imputed samples are created.

Although the validity of the MI approach relies on the asymptotic properties of the imputation procedure with M approaching infinity, in practice fewer imputations are needed to obtain consistent and stable results. According to Rubin (1987), M=5 imputations should be sufficient to obtain valid inferences for most procedures, but depending on the amount of information missing and the type of analysis required, a larger set of imputed samples could be required.

Once M completed samples are obtained, each of them can be used to obtain M independent estimations for the desired model. Assume the model to be estimated can be written as:

$$y_m = X'_m \beta_m + e_m \text{ for } m = 1, \dots, M$$

such that we have a set of parameters β_m and a variance covariance matrix Σ_m for each imputed sample m. Following Rubin's rule (Rubin, 1987) the results for the parameters and variance covariance matrices can be combined as follows:

$$\tilde{\beta}_M = \frac{1}{M} \sum \tilde{\beta}_m, \text{ and}$$

$$\tilde{\Sigma}_M = \frac{1}{M} \sum \tilde{\Sigma}_m + \left(1 + \frac{1}{M}\right) * \sum \frac{(\tilde{\beta}_m - \tilde{\beta}_M)(\tilde{\beta}_m - \tilde{\beta}_M)'}{M - 1}$$

Here, $\tilde{\beta}_M$ and $\tilde{\Sigma}_M$ are the parameters and variance covariance matrix corresponding to the combination of models across the M imputed samples. See Rubin (1987) for more details.

APPENDIX B

Specification of Imputation Model

Table B1. Variables with Complete Information:

Variable	Definition
Part larger	Indicates if the establishment if part of a larger firm
Public or private shareholding	Indicates if the establishment has stocks in private hands or public stock exchange.
Foreign owned	Indicates if more than 50% of the establishment is owned by foreign capital
% largest shareholder	Indicates if the largest shareholder owns more than 50% of the establishment
Age	Number of years since the establishment began operations
Manager experience	Number of years of experience of top manager
Quality certification	Indicates if establishments have an ISO quality certification
Electric problems	Indicates if establishments have suffered 2 or more outages
Has a generator	Indicates if establishments possess a generator
Electricity request	Indicates if establishments have submitted a request for electricity connection
Water request	Indicates if establishments have submitted a request for water connection
Water obstacle	Indicates if establishments consider access to water as a major obstacle of production
Electricity obstacle	Indicates if establishments consider access to electricity as a major obstacle of production
Mono production	Indicates if all production comes from the main product
Sales export	% of sales that come from export
Inputs from small establishments	% Inputs bought from smaller firms
Foreign input	% Inputs imported
Principal buyer	Indicates if consumers are main buyers from production
Customs and trades	Indicates if Customs and trades regulations are an obstacle for operations
Own transport	Indicates if establishment possess its own transportation system
Transport problem	Indicates if transportation is considered a major obstacle for operation
Subcontract production	% Sales that are subcontracted to other firms
Competition	Indicates the level of competition the establishment faces: None or one competitor (no competition), 2-5 competitors (medium competition), 5 or more competitors (high competition), operates on international market
Sales change	Indicates if sales of main product have gone up or down in the last year
Prices change	Indicates if prices of main product have gone up or down in the last years
Domestic Competition	Pressure from domestic competitors on production costs is important
International Competition	Pressure from international competitors on production costs is important
Foreign Technology	Establishment uses foreign technology for their production
New product or New process	Indicates if the establishment introduced a new or significantly improved product/service or production process
Informality	Indicates if informal markets are a consider a major obstacle for establishment operations
Share of Production Workers	Share of Production workers as % of total permanent workers
Share of skill workers	Share of Skill workers as % of total permanent workers

Share of seasonal workers	Share of seasonal workers as % of total permanent equivalent workers
Share of female workers	Share of Production workers as % of total permanent workers
Level of utilization of capital	% of current output compared to maximum output possible under normal circumstances
Hours of operation per week	Normal weekly hours of operations of the establishment, Includes the variable in levels and logs
New buildings	Indicates if establishment submitted an application to obtain a construction-related permit in last 2 years
Land problem	Indicates if access to land is considered a major obstacle for operation
Government problem	Indicates if government regulations are considered major obstacles for operation
Investment	Indicates if establishment has investment any resources on machinery or vehicles during last fiscal year
Hires seasonal workers	Indicates if establishment hires seasonal workers at all.
Industry fixed effects	Includes industry fixed effects using ISIC Rev.3.1 classification to 2 digits.
Nr of permanent workers	Total number of permanent workers, including its logarithm, logarithm squared and interaction with a union Dummy
Nr workers on t-1	Total number of permanent workers 3 years ago
Nr production workers	Total number of workers directly engaged in the production process. Includes its log
Nr non production Workers	Total number of workers not engaged in the production process. Includes its log
Zero production workers	Indicates if there are no production workers in the establishment
Nr of seasonal workers	Nr of workers that are hired for a short-term (i.e. for less than a fiscal year), with no guarantee of renewal of employment contract. Includes its log and interaction with union dummy
Labor regulations	Indicates if establishments consider labor regulations as major obstacles for operations
Inadequate Education	Indicates if establishments consider inadequate education as major obstacles for operations
Manufacture production	% of sales that come from manufacture
Refusal capital	Indicate if the establishment refused to provide information on book or market capital values
Refusal land	Indicate if the establishment refused to provide information on book or market land value
Log sales	Logarithm of total sales in last fiscal year. Includes its square.
Sales in t-1 dummy	Indicates if the establishment didn't provide information on sales 3 years ago.
Union	Variables indicating if the establishment is unionized, the union density within the establishment and a dummy if more than 50% of the establishment is unionized.
Information quality flags	Two dummies indicating if the interviewer perceives the information provided is true, or if the data was taken from administrative records.
Workers avg education	Average education attainment of typical worker. 0-3 yrs of education, 4-6 yrs of education, 7-12 yrs of education and 13+ yrs of education
Training	Indicators of training among permanent workers: No active training program in the establishment, 0-33% of workers trained, 34-66% of workers trained and 67-100% workers trained.
Owner female	Indicates if any of the main owners of the establishment is female.
Region	Fixed effects using region dummies survey in each country. Varies across countries.

Table B2. Imputed Variables:

Variable	Method	Definition
Nr of workers in t-1	PMM	Total number of permanent workers 3 years ago
Cost of labor	PMM	Total annual cost of labor as share of sales
Cost of electricity	PMM	Total annual cost of electricity as share of sales
Cost of communications	PMM	Total annual cost of communications as share of sales
Cost of materials and inputs	PMM	Total annual cost of materials and inputs as share of sales
Cost of fuel	PMM	Total annual cost of fuel as share of sales
Cost of transportation	PMM	Total annual cost of transportation as share of sales
Cost of water	PMM	Total annual cost of water as share of sales
Cost of rentals	PMM	Total annual cost of rent of equipment, building and land as share of sales
Log Nr of workers in t-1	OLS	Log Total number of permanent workers 3 years ago
Log Sales in t-1	OLS	Log Sales 3 years ago
Log wages production workers	OLS	Log average wage of production workers
Log wages non production workers	OLS	Log average wage of non-production workers
Log capital (book value)	OLS	Log of net book value of machinery
Log capital (market value)	OLS	Log of hypothetical cost of purchase of machinery
Log materials and inputs	OLS	Log of total cost of material and inputs
Log salaries	OLS	Log of total cost of salaries

OLS: This method uses linear predictions (plus the empirical standard error) to impute the values of the missing values.

PMM: This method uses linear predictions to match observations with missing values to those with complete information. The observed values are then used for the imputation.

Table B3. Other Measurements:

Variable	Definition
Log value added pc	Value added is defined as sales minus costs on materials and inputs, electricity, fuel and water. It is divided by total equivalent permanent workers.
Log total equivalent permanent workers	Total equivalent workers are estimated as total permanent workers plus equivalent seasonal workers. Equivalent seasonal workers are estimated as total number of temporary/seasonal workers multiplied by the average time (in months) a temporal worker participates in the establishment in a year.
Log capital per capita	Log of hypothetical value of capital divided by total number of equivalent workers. Hypothetical value captures the market value of capital, or how much the establishment would pay for it in current state.
Profit	Price cost margin, defined as total sales minus total production costs, divided by total costs.
Sales growth	Defined as the difference between current log sales, and log sales three years ago
Investment in R&D	Indicates if the establishment has spent on research and development
Investment in capital	Indicates if the establishment has bought any fixed assets in the previous period

APPENDIX C

Effect of Unions on Establishment Productivity, by Country. Basic Brown and Medoff Specification

	Argentina	Bolivia	Chile	Mexico	Panama	Uruguay
% Workforce unionized	-0.377 [^] (0.057)	0.488 (0.166)	0.227 (0.212)	0.061 (0.675)	0.304 (0.367)	0.188 (0.409)
Log capital pc	-0.009 (0.914)	0.260* (0.000)	0.232* (0.000)	0.249* (0.000)	0.017 (0.814)	-0.03 (0.678)
Log total labor force	0.201* (0.000)	0.077 (0.426)	0.172* (0.001)	0.164* (0.000)	0.126 (0.101)	0.396* (0.000)
Constant	9.308* (0.000)	5.668* (0.000)	6.949* (0.000)	6.680* (0.000)	9.188* (0.000)	8.166* (0.000)
Observations	540	298	564	974	185	251

Notes: [^] p<0.1, ⁺ p<0.05, * p<0.01. P-values in parentheses. Models include region and broad industry fixed effects

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