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Exports and Job Training

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Abstract

This paper examines whether export participation matters for job training. The paper draws on longitudinal worker-firm data for Brazilian manufacturing, linked with detailed records on training activity from the main provider. The analysis uses industry-specific exchange rate movements to generate exogenous variation in export status at the firm-level. The findings indicate that export participation tends to increase the share of workers who receive technical upgrading. The results also reveal that technical upgrading has positive returns to trainees within exporting firms. These findings support the hypothesis that exporting requires skill upgrading, and suggest that this is partially achieved by training firms' existing workforce.

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Exports and Job Training*

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1 Introduction

A growing body of literature suggests that export participation leads to an increase in skill utilization within firms (Verhoogen 2008; Brambilla, Lederman and Porto, 2012). This relationship is consistent with several intuitive theoretical mechanisms. First, exporting may require expertise in international business and foreign languages (Matsuyama, 2007; Brambilla, Lederman and Porto, 2012). Second, it may induce firms to upgrade product quality, which is a skill intensive activity (Verhoogen, 2008; Bastos and Silva, 2010; Kugler and Verhoogen, 2012; Brambilla, Lederman and Porto, 2012; Bastos, Silva and Verhoogen, 2014). Third, by leading to an expansion in the scale of operations, entry in export markets may make it profitable for firms to pay the fixed costs associated with the adoption of more skill-intensive technologies (Yeaple, 2005; Bustos 2011).

While previous empirical research has documented a robust causal effect of export participation on skill intensity—as measured by workers' schooling or occupation—, little is known about whether it leads to skill upgrading of the existing workforce through job training. Since skilled labor is a scarce factor and skill-acquisition is costly, training may be a relevant channel of adjustment to globalization, with potentially important implications for productivity and labor earnings. In this paper, we examine these hypotheses in a rich combination of administrative data for the Brazilian manufacturing sector, linking a worker-firm labor census with customs data on export status and detailed training records from the main provider.

The worker-firm data we use cover the universe of manufacturing firms formally registered in Brazil, and include longitudinal records on earnings and worker attributes, as well as firm characteristics. Using unique firm identifiers, we have linked these data with information from customs declarations indicating whether the firm had positive export revenues in each year. Using unique worker identifiers, we have matched these data with detailed administrative records on training activity at the trainee-level from the main provider in the manufacturing sector. The individual training records contain detailed information on training category and course duration, enrollment and completions dates. The training courses provided are grouped in five categories, which serve different objectives. Technical upgrading courses are aimed at workers seeking to update, deepen or complement the professional skills they have acquired in a specific occupation or field or work. In contrast, the other training categories are aimed at training a new generation of practitioners of a given trade or profession.

The resulting data set gathers this information for the years 2009 to 2012, a period characterized by high volatility of the real exchange rate relative to several important export destinations. To identify the effects of export participation on the share of workers receiving different types of training within firms, we first adopt a difference-in-differences approach using the full sample of manufacturing firms. We then restrict the attention to switchers—that is, firms that recorded export activity in a subset of the sample period—thereby exploiting solely variation in the timing of exporting across firms. Controlling for observed firm attributes, results from both these approaches suggest that export participation is positively associated with the share of workers who received technical upgrading, but show no effects on the share of workers who completed training in other training categories.

While the focus on switchers contributes to reduce biases associated with firm heterogeneity, one may still be concerned that unobserved firm-specific shocks (e.g. in management practices) might lead some firms to both enter export markets and seek to upgrade the technical skills of the workforce. To account for this concern, we take advantage of the fact that firms operating in different industries were exposed to movements in different currencies to generate plausibly exogenous variation in the timing of exporting at the firm-level. The IV results point once more to a positive effect of export participation on the share of workers receiving technical upgrading within firms, but again show no effects for the other training categories. For technical upgrading, the point estimates are positive across all occupational groups, but more precisely estimated among workers performing occupations that typically do not require post-compulsory formal education. While the data do not allow us to fully discriminate between the various theoretical channels discussed above, these results appear to suggest that one or more of these mechanisms played an important role in driving these effects.

Given that export participation has a positive effect on the provision of technical upgrading within firms, an important complementary question is the extent to which the corresponding trainees benefit from these additional skills in the form of higher labor earnings. To examine this question, we exploit detailed information on training records and earnings trajectories at the worker-firm level. Because entry in export markets may affect wages via several forms of rent sharing (Egger and Kreickemeier, 2009; Egger, Egger and Kreickemeier, 2012; Davis and Harrigan, 2009; Helpman, Itskhoki and Redding, 2010), we restrict our attention to firms that were always exporters over the period of analysis. Using models with worker-firm fixed effects to account for unobserved heterogeneity of workers and firms, we document a robust positive relationship between completion of technical upgrading courses and hourly wages within exporting firms. This relationship holds within small, medium and large exporting firms.

In addition to the work cited above, this paper complements and extends other strands of existing research. In particular, it adds to a growing empirical literature using worker-firm data to examine the link between exporting, skills and wages (Frías, Kaplan and Verhoogen, 2012; Helpman, Itskhoki, Muendler and Redding, 2012). An important question in this literature has been the extent to which higher wages among exporting firms reflect sorting on individual ability or wage premia due to rent sharing. By suggesting that export participation leads to skill upgrading of firms' *existing workforce* via job training, and that this training leads in turn to higher wages, we uncover a related but still distinctly different channel by which exporting influences skill utilization and labor earnings. In doing so, our paper adds to a small literature on how other aspects of globalization influence job training. In particular, Hogrefe and Wrona (2015) develop a theoretical model examining the impact of offshoring on individual skill upgrading through on-the-job training. The model predicts that offshoring, by scaling up workers' wages, creates previously unexploited skill upgrading possibilities and, thus, leads to more on-the-job training. Using individual-level survey data from Germany, they document a positive relation between an industry-level measure of offshoring and job training.[1]

[1] More broadly, our paper is also related to the literature on labor market adjustment to globalization;

The remainder of the paper is organized as follows. In section 2, we provide a detailed description of the data employed and provide summary statistics. In section 3, we present our identification strategy for examining the impacts of exporting on the share of workers trained, and present the corresponding results. In section 4, we use the worker-firm information to examine whether technical upgrading is associated with higher labor earnings for the corresponding workers within exporting firms. Section 5 concludes.

2 Data

2.1 Data description

The analysis in this paper links and examines three main sets of administrative data for the Brazilian manufacturing sector in the period 2009-2012. *Relação Anual de Informações Sociais* (RAIS) is a longitudinal census gathering administrative social security records for employees and employers. It is collected by the Ministry of Labor in a compulsory survey of all firms and their registered workers, and covers a total of around 230 thousand formally registered firms and over 3.5 million workers each year in the manufacturing sector. RAIS provides information on workers' demographics (age, gender, schooling, race), job characteristics (occupation, wage, hours worked), as well as hiring and termination dates. It also includes information on a number of firm-level characteristics, notably number of employees, geographical location and industry code. Unique identifiers for workers and firms make it possible to follow them over time. We have performed extensive checks to guarantee the accuracy of the worker data using information on gender, date of birth, and maximum schooling level achieved. Only full-time wage earners with complete information on demographics and job attributes were kept for the analysis.[2]

Using the unique firm identifiers, we have merged these data with customs records on export transactions collected by *Secretaria do Comércio Externo* (SECEX) of the Ministry

see Greenaway and Nelson (2000), Bastos and Silva (2009), Falvey, Greenaway and Silva (2008, 2010) and the references therein.

[2] In particular, we kept for analysis employees working more than 20 hours per week, aged between 16 and 65, and earning at least the national minimum wage.

of Development, Industry and Foreign Trade. These data include information on firm-level export status in each year over 2009-2012, as well as the share of industry-level exports to each destination in 2008. To construct industry-specific real exchange rate instruments, we have supplemented these data with information on the consumer price index from the World Development Indicators of the World Bank and bilateral nominal exchange rates from the International Financial Statistics of the International Monetary Fund.

We further use detailed administrative records on training provision collected by the largest training provider in the manufacturing sector–*Serviço Nacional de Aprendizagem Industrial* (SENAI), the training arm of the national confederation of industry.[3] From these records, we extracted the set of workers trained in each year, worker-level information on demographics, occupation before starting the course, training category and course duration, as well as enrollment and completion dates. The data cover around 270,000 trainees per year.

SENAI provides five categories of job training: (1) technical upgrading; (2) apprenticeship; (3) initiation; (4) habilitation; and (5) qualification courses. The various course types have different objectives. In particular, technical upgrading courses differs considerably from the other training categories.

Technical upgrading courses are aimed at workers seeking to update, expand or complement the professional skills they have acquired in a specific occupation or field of work. Their duration varies between 40 and 120 hours. The curriculum is advanced and occupation-specific. They focus mainly on the skill needs resulting from technological innovations and new production and management processes. For instance, for industrial electricians, SENAI offers a course on electrical controls which lasts 80 hours.

[3]SENAI is the national service for training in the Brazilian industrial sector. It consists of a network of professional schools established and maintained by *Confederação Nacional da Indústria* (CNI), the national confederation of industry. SENAI is part of *Sistema S* which is a set of vocational training institutions managed by CNI. While SENAI is the manufacturing arm, CNI also manages similar institutions for other sectors, including wholesale trade, agriculture and transport. SENAI is one of the 5th largest training providers in the world and the largest in Latin America. It is financed by a tax charged to firms equal to 1% of their wage bill and is the main provider of job training in manufacturing (Silva, Almeida and Strokova, 2015).

In contrast, the other categories provided by SENAI are aimed at training a new generation of practitioners of a trade or profession. Apprenticeship consists of on-the-job training and often some accompanying study (classroom work and reading) to learn a trade or profession. They typically last 2 years and target the youth. Habilitation courses are also long duration courses (1,100 to 1,700 hours) targeted at high school students or graduates. They provide minimum qualifications for certain mid-level technical jobs (e.g. industrial automation), and seek to complement traditional education while the student is at school or unemployed. Qualification courses target older, low-skill workers and aim at preparing them for a new trade or profession. This category includes job retraining programs for workers who need new qualifications due to technological or organizational change. Generally it reflects changes in occupation rather than an upward movement in the same field. Courses are basic-level and duration varies between 160 and 500 hours. Initiation courses have similar objectives as qualification courses but are shorter duration (40 to 80 hours) and specialized on a certain function. For example, there is a qualification course for automotive painter job (180 hours) which includes three modules: automotive refinish (120 hours), colorimetry (40 hours) and polishing and crystallization (20 hours); and there are initiation courses for a car polisher job (40 hours) and automotive paint preparation job (80 hours).

2.2 Summary statistics

Our empirical analysis uses data for the years 2009 to 2012, a period characterized by high real exchange rate volatility. Panel A of Figure 1 depicts the evolution of the real effective exchange rate. We observe that the Brazilian currency observed a marked effective real appreciation until July 2011, when it started to move in the opposite direction. Panel B displays the evolution of the Brazilian currency (the *real*) relative to the the euro, the US dollar and the renminbi. We see that while the overall trend was broadly similar across these three currencies, the magnitude of relative changes varied considerably.

Table 1 reports summary statistics on the attributes of manufacturing producers over the sample period, discriminating firms according to export status. We observe that the main stylized facts about exporting firms reported in previous literature (Greenaway and Kneller, 2007) are also present in Brazil: exporters firms are clearly a minority, and tend to be larger, pay higher average wages and employ a more skilled workforce than the typical manufacturing firm. We also see that the number of exporters remained fairly stable over time.

Table 2 presents descriptive statistics on the attributes of trainees in manufacturing firms, across the various training categories. We observe that trainees receiving technical upgrading courses are more likely to be employed before starting the course than those who have received other training categories. We also observe that they are more likely to be employed in the same firm and occupation in the year before training. The table also provides evidence on the distribution of trainees across occupational groups. We consider four occupational groups based on the 1988 International Standard Classification of Occupations (ISCO-88). This classification provides four skill-levels which are based on (i) the level of general education required to perform a job; and (ii) the job-related formal training required to perform a job (ILO, 1990).[4] We observe that SENAI courses are mainly directed to workers in skill groups 2 and 1, who typically do not have post-compulsory education.

Table 3 presents information on the share of workers trained in exporting and non-exporting firms by training category and occupational group. We observe that exporting firms tend to have a higher share of workers who received training. On average, the proportion of workers who completed training is 4.3% in exporting firms versus 1.5% in non-exporting firms. The share of workers who completed technical upgrading courses in exporting firms is 3.6 times higher in exporters than in non-exporters. We also observe that not all occupational groups are equally likely to have received training. In exporting firms, the share of workers trained is larger among skill groups 1 to 3.

[4] See Appendix Table A1 for a detailed description. See also Maciente (2013) for a related classification.

3 The effect of export participation on job training

3.1 Empirical strategy

We are interested in examining the causal effect of exporting on the share of workers who received job training within firms. We estimate a model of the following form:

$$share_{jt} = \beta export_{jt} + \gamma X_{jt} + \eta_j + \delta_s + \theta_r + \phi_t + \mu_{jt} \qquad (1)$$

where j and t index firms and year, respectively; $share_{jt}$ is the share of trained workers in total employment of the firm j in year t; $export_{jt}$ is the export status of the firm; X_{jt} are other time varying firm characteristics; η_j is a firm fixed effect; δ_s is a sector fixed effect, defined at the 2-digit level of the national classification of economic activities (CNAE); θ_r is a federal state fixed effect; ϕ_t is a year effect; and μ_{jt} is the error term. We cluster the standard errors at the firm-level.

The set of firm controls include log employment, average age of workers, average tenure, male to female workers ratio, share of workers by education (less than high school, high school completed and more than high school), average log wage, share of white workers, share of workers by occupational groups. We compute the dependent variable using individual level information on the set of workers who completed training in each year.

The inclusion of firm fixed-effects accounts for the role of unobserved firm characteristics that are constant over time. While this difference-in-differences design controls for selection into exporting based on time-invariant firm characteristics (e.g., initial productivity), it does not account for the fact that exporting firms might be expected to experience different trends in the outcomes of interest relative to non-exporters. To improve comparability across firms, we estimate a second set of regressions where we restrict the estimation sample to include only switchers, defined as firms that recorded export activity only in a subset of years of the sample period. In this case, identification of the parameters of interest exploits solely variation in the timing of exporting across firms.

A concern that remains after restricting the estimation sample to switchers is that there may be unobserved firm-specific shocks (e.g. changes in management practices) that induce some firms to both enter export markets and improve the skills of the workforce through worker training. To address this concern, we use industry-specific destination-weighted real exchange-rate movements to construct an instrument for export status. Our strategy builds on the plausible assumption that an expansion of external demand in a given export destination (driven by favorable relative price movements) induces more firms to begin exporting, but especially so in industries for which that destination represents already a sizable share of total exports.[5]

For a given sector s and year t, the destination-weighted real exchange rate, z_{st}, is defined as the weighted average of the (reciprocal of) bilateral real exchange rates. The weights are the share of the industry's exports to a destination in total industry exports in 2008. Formally, we compute

$$z_{st} = \sum_{d} w_{ds2008} rpl_{dt} \tag{2}$$

where w_{ds2008} is the ratio of industry s exports to destination d over total industry exports in 2008; and rpl_{dt} is the log of the reciprocal of the corresponding bilateral real exchange rate in year t. As usually, the latter is defined as:

$$rpl_{dt} = log\left[\frac{CPI_{dt}}{CPI_{BRt}}/e_{dt}\right] \tag{3}$$

where CPI_{dt} denotes the consumer price index of export destination d in year t, CPI_{BRt} denotes Brazil's consumer price index in year t, and e_{dt} the nominal exchange rate. Using the reciprocal of the real exchange rate rather than the real exchange rate itself is purely a matter of convenience: an increase in z_{st} leads to an increase in external demand for the industry's exports, thereby increasing the likelihood of export participation in that industry.

3.2 Results

Table 4 reports the difference-in-difference estimates of the effect of export participation on the share of workers who complete training at the firm level, using the full sample

[5] Similar instruments based on real exchange rates have been used at the sector-level by Revenga (1992), Bertrand (2004), Falvey, Greenaway and Silva (2008) and Bastos and Wright (2012), among others.

of manufacturing firms. As described in section 2, the training data include detailed information on several training categories provided by SENAI. Based on the theoretical mechanisms discussed in the introduction, technical upgrading is the training category that is more likely to be related to exporting. These are courses aimed at workers seeking to update, expand or complement the professional skills they have acquired in a specific occupation or field or work. The other categories consist of longer term investments seeking to reconvert unqualified workers or retooling for new occupations workers whose skills became obsolete. Hence, we estimate (1) separately for the share of workers who completed technical upgrading and other courses. Column 1 uses the pooled data controlling only for year effects. Column 2 adds log firm size and other firm controls, as well as state and sector dummies. Column 3 adds firm fixed effects, but excludes firm controls and state dummies. Column 4 reports results from our preferred difference-in-differences specification, which includes firm, sector and state effects, as well as firm controls. For all these specifications, the results indicate that export participation is positively associated with the share of workers receiving technical upgrading within firms. By contrast, the effects of export participation on the share of workers trained in categories other than technical upgrading are insignificant when including firm effects.

Table 5 presents estimates from specifications similar to those in Table 4, but considering a sample including only switchers. Once again, we find that export participation is positively associated with the share of workers who received technical upgrading. In all specifications, the coefficient of the export status is positive and statistically significant. The effects of exporting on the share of workers trained in other categories are once again insignificant.

As discussed above, a concern that remains after restricting the estimation sample to switchers is that there may be unobserved firm-specific shocks (e.g. changes in management practices) that induce some firms to both enter export markets and improve the skills of the workforce through worker training. This would lead to a positive bias in OLS estimates, as we would be attributing the observed increase in technical upgrading to the effects of export participation when in reality it would be reflecting other underlying forces. On the other hand, if firms anticipate that they will enter export markets in the near future, they might have an incentive to begin upgrading the skills of the workforce before actually starting to export. In this case, OLS estimates on the contemporaneous effect of export participation on training would underestimate the extent of skill upgrading caused by exporting. To address these concerns, we now turn to the IV estimates on the causal effect of export participation on training. Real exchange rate movements change directly the incentives to export and are largely unpredictable. Hence they make it possible to circumvent (or at least mitigate) these challenges, and estimate the causal effect of exporting on training.

Table 6 presents IV estimates of (1) based on the sample of switchers, and using the industry-level real exchange rate instruments to generate exogenous variation in the incentives to export. The upper part of the table presents the results of the first stage, while the lower panel presents the results of the second stage. Column 1 includes only firm fixed effects and column 2 adds firm controls. As expected, the first-stage estimates indicate that a real depreciation (i.e. a rise in the industry-specific exchange rate variable) leads indeed to an increase in the probability of exporting. The instrument appears to be sufficiently correlated with the exporting variable for us to be able to identify the effect of that variable on the outcomes of interest: the individual coefficient is significant at the 5% level and the F-statistic is 10.7. Estimates from the second stage point once more to a positive causal effect of export participation on the share of workers receiving technical upgrading, but not for the other training categories. Results of the instrumented variable indicate a stronger effect in this case, suggesting that the OLS estimates are biased downwards.

In the analysis so far, we have examined the effects of exporting on the share of workers who completed training in that same year. In light of the theoretical mechanisms discussed in the introduction, firms might be also expected to increase the share of workers who received technical training in prior years (and are therefore already equipped with the skills required by exporting firms). While our training data do not contain information on training activity before 2009, we can use the 2009-2012 data to redefine the dependent variable, so that it accounts for training activity observed in that year or in any prior year during the sample period. Table 7 reports the corresponding IV results. We observe that the results are qualitatively similar, but the coefficient on technical upgrading is larger, as would be expected.

We proceed by examining whether the effect of export participation on technical upgrading is heterogeneous across occupational groups. In line with Guadalupe (2007) and Bastos, Straume and Monteiro (2009), we consider four occupational groups which require different skills (see Appendix Table A1). We then compute the share of workers who completed technical upgrading within each of these occupational groups. We adopt an IV strategy similar to that presented above, focusing on a sample of switchers that have workers in all four occupational groups considered. The corresponding IV results are presented in Table 8. Panels A to D report second-stage results for separate regressions each with a different dependent variable. We observe that the point estimate on the effect of export participation on technical upgrading is positive for all occupational groups, though only statistically significant for skill levels 1 and 2. It is important to note that these skill categories are fairly broadly defined: they include a wide diversity of occupations performed by workers that have typically completed compulsory education, but not further education (see Table A.1 in the appendix); and account for over 80% of jobs within exporting firms (see Table 1). They also correspond to occupational groups that SENAI courses typically target.

4 Returns to training among exporters

4.1 Empirical strategy

The results above indicate that export participation has a positive effect on the provision of technical upgrading within firms. A related question is the extent to which technical upgrading leads to higher labor earnings among exporting firms. To examine this hypothesis, we exploit detailed information on training records and earnings trajectories at the worker-firm level. Because entry in export markets may affect wages via several forms of rent sharing (Egger and Kreickemeier, 2009; Egger, Egger and Kreckemeier, 2012; David and Harrigan, 2009; Helpman, Itskhoki and Redding, 2008), we restrict the attention to firms that were always exporters over the period of analysis. We estimate a model of the following form:

$$wage_{ijt} = \beta training_{it} + \gamma X_{it} + \delta Z_{jt} + \eta_i + \kappa_j + \theta_r + \phi_t + \mu_{ijt} \quad (4)$$

where $wage_{ijt}$ denotes the log of the hourly real wage of worker i employed by firm j in year t; $training_{it}$ is the main regressor of interest, a dummy variable that equals 1 if the worker received the technical upgrading (either in year t or in previous years) and 0 otherwise; X_{it} is a vector of worker characteristics; Z_{jt} is a vector of firm characteristics; η_i is a worker fixed effect; κ_j is a firm fixed effect; θ_r is a state fixed effect; ϕ_t is a year effect; and μ_{ijt} is an error term. Standard errors are clustered at the firm-level.

The set of worker attributes includes age, gender, race, schooling and skill level based on the worker's occupation. When including worker fixed effects, we are comparing the change in log wages of those workers who received technical upgrading (before and after training) with the change in log wages of the workers who did not receive training during the same period, thereby sweeping away unobserved worker heterogeneity that is permanent over time. To account for unobserved firm heterogeneity, we also consider specifications that include worker-firm (or spell) fixed effects.[6] In this case, identification of the parameter of interest exploits variation over time in log wages and training status for workers that remain employed in the same firm, thereby sweeping away fixed unobserved heterogeneity of both workers and firms. Appendix Table A2 provides summary statistics on these data.

4.2 Results

Table 9 presents the results, including a progressively larger set of controls and fixed effects. Columns 4 to 6 report the results from our preferred specifications. Column 4 includes worker controls, worker fixed effects and firm controls, but not firm fixed effects. Column 5 includes worker-firm fixed effects but excludes worker and firm controls. Finally, column 6

[6] See Andrews, Schank and Upward (2006) for a detailed description of these methods.

includes worker-firm fixed effects, as well as worker and firm controls. The results indicate that returns to technical upgrading are positive and statistically significant in all these specifications. We also observe that the magnitude of the point estimate of interest is quite stable across these specifications, and points to positive wage effect of about 3%.

While the estimation sample includes only exporting firms, one might worry that the results are driven by only a subset of those firms. We therefore proceed by verifying the extent to which these results are specific to small, medium and large exporting firms. In Table 10 we split the sample according to a firm size classification of *Instituto Brasileiro de Geografia e Estatística* (IBGE), the national statistical institute. We observe that technical upgrading is associated with significantly higher labor earnings among firms in each of these categories.

The sample used in Tables 9 and 10 includes among the control group workers that received other types of training. Although the analysis in the previous section suggests that export participation does not impact the share of workers trained in those other categories, we cannot exclude the possibility that such training also affects labor earnings. We therefore verify if our estimates are sensitive to the exclusion of workers that received other types of training. In particular, we re-estimate (4) on a sample that excludes all observations that received any SENAI training course other than technical upgrading during 2009-2012. Appendix Tables A3 and A4 report the corresponding results. We observe that our findings remain qualitatively and quantitatively very similar when using this alternative sample.

5 Conclusion

This paper has examined the effects of export participation on job training in a rich combination of worker-firm panel data for the Brazilian manufacturing sector, linked with detailed records on training activity from the main provider. Using industry-specific exchange rate movements to generate exogenous variation in export status at the firm-level, we have provided evidence that export participation tends to increase the share of workers who received training. In line with several intuitive theoretical mechanisms proposed in the literature (Yeaple, 2005; Matsuyama, 2007; Verhoogen, 2008) the training category linked with exporting is technical upgrading, which is aimed at improving the skills of experienced workers for enhanced performance, rather than teaching the skills needed to enter a specific occupation or field of work (as in the other training categories). Drawing on detailed worker-firm records for exporting firms, we have also provided evidence that technical upgrading has positive returns to trainees within exporting firms. Our results therefore support the hypothesis that export participation requires skill upgrading, and suggest that this is partially achieved by training firms' existing workforce.

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A. Appendix

A.1. Definition of skill groups

We consider four occupational groups to proxy the skill level associated with the worker's occupation, as defined in the ISCO-88 classification. Table A.1 presents the definition of skill groups.

A.2. Summary statistics, worker-firm data

A.3. Further results

Table 1: Attributes of manufacturing firms by export status

	Non-exporters	Exporters	All firms
Log employment	1.888	4.160	1.997
	(1.231)	(1.711)	(1.349)
Average log hourly wage	1.724	2.253	1.749
	(0.371)	(0.493)	(0.394)
Share with schooling less than high school	0.515	0.389	0.509
	(0.360)	(0.271)	(0.357)
Share with schooling equal to high school	0.437	0.451	0.438
	(0.352)	(0.236)	(0.348)
Share with schooling more than high school	0.046	0.158	0.052
	(0.129)	(0.178)	(0.134)
Share of production workers	0.352	0.366	0.353
	(0.348)	(0.254)	(0.344)
Share of workers in skill level 4	0.040	0.069	0.041
	(0.135)	(0.116)	(0.134)
Share of workers in skill level 3	0.034	0.101	0.038
	(0.122)	(0.126)	(0.123)
Share of workers in skill level 2	0.813	0.667	0.806
	(0.279)	(0.249)	(0.280)
Share of workers in skill level 1	0.111	0.161	0.113
	(0.229)	(0.213)	(0.228)
Observations			
2009	224,546	11,761	236,307
2010	242,206	11,545	253,751
2011	221,807	11,331	233,138
2012	219,135	11,114	230,249
Total	907,694	45,751	953,445

Notes: Table reports means and standard deviations (in parentheses) for firms operating in the manufacturing sector over the period 2009-2012. A firm-year observation is defined as exporter if the firm had export revenue in that year. Wages are in 2010 Brazilian Reais, employment refers to the number of workers employed by the firm, and employment shares are relative to total employment. Skill levels 1 to 4 are based on the 1988 International Standard Classification of Occupations (see Appendix Table A1 for a detailed description).

Table 2: Training categories and trainee characteristics in the manufacturing sector

	Technical upgrading	Apprenticeship	Habilitation	Initiation	Qualification
Average trainee age	31.972	18.257	24.551	26.26	28.449
	(10.520)	(2.430)	(7.570)	(10.360)	(10.120)
Average course duration (in hours)	40.413	809.58	1109.348	164.707	174.566
	(44.970)	(501.700)	(508.450)	(372.330)	(201.130)
Share of trainees working	0.689	0.271	0.550	0.464	0.491
	(0.460)	(0.440)	(0.500)	(0.500)	(0.500)
Average tenure of trainees (in months)	54.872	11.335	37.4	33.01	54.637
	(70.560)	(14.880)	(46.290)	(46.630)	(54.630)
Log hourly wage	2.545	1.683	2.341	2.119	2.238
	(0.693)	(0.449)	(0.553)	(0.567)	(0.606)
Share with schooling less than high school	0.237	0.442	0.149	0.344	0.259
	(0.425)	(0.497)	(0.356)	(0.475)	(0.438)
Share with schooling equal to high school	0.635	0.516	0.767	0.568	0.678
	(0.481)	(0.500)	(0.423)	(0.495)	(0.467)
Share with schooling more than high school	0.128	0.042	0.085	0.088	0.063
	(0.334)	(0.201)	(0.279)	(0.284)	(0.243)
Share employed in year before training	0.775	0.35	0.305	0.233	0.443
	(0.417)	(0.477)	(0.455)	(0.482)	(0.479)
Share employed in same firm in year before training	0.605	0.229	0.211	0.157	0.201
	(0.488)	(0.420)	(0.499)	(0.497)	(0.456)
Share employed in same occupation in year before training	0.513	0.133	0.125	0.074	0.157
	(0.499)	(0.340)	(0.494)	(0.482)	(0.431)
Share of workers in skill level 4	0.027	0.006	0.014	0.027	0.019
	(0.162)	(0.077)	(0.116)	(0.124)	(0.112)
Share of workers in skill level 3	0.118	0.062	0.192	0.086	0.086
	(0.323)	(0.241)	(0.394)	(0.274)	(0.271)
Share of workers in skill level 2	0.729	0.786	0.699	0.746	0.735
	(0.444)	(0.410)	(0.458)	(0.437)	(0.441)
Share of workers in skill level 1	0.125	0.145	0.094	0.169	0.178
	(0.330)	(0.352)	(0.292)	(0.366)	(0.377)
Number of trainees in manufacturing firms					
2009	75,099	5,331	6,840	33,334	132,530
2010	166,694	7,660	9,358	49,237	46,670
2011	179,555	8,079	16,738	60,902	52,958
2012	164,784	7,550	11,568	50,279	61,214
Total	586,132	28,620	44,504	193,752	293,372
Age restriction	No	Yes	Yes	No	No
Education restriction	No	Yes	Yes	No	Yes

Note: Table reports means and standard devitations of attributes of SENAI trainees in manufacturing firms by training category. Skill levels 1 to 4 are based on the 1988 International Standard Classification of Occupations (see Appendix Table A1 for a detailed description).

Table 3: Training activity in manufacturing firms by export status

	Non-exporters	Exporters	All firms
Share of workers that received training by course category			
Technical upgrading	0.006	0.021	0.006
	(0.039)	(0.051)	(0.040)
Other categories	0.009	0.022	0.010
	(0.050)	(0.045)	(0.050)
Any category	0.015	0.043	0.016
	(0.081)	(0.093)	(0.086)
Share of workers that received training by occupation group			
Share of workers in skill level 4	0.006	0.011	0.007
	(0.067)	(0.068)	(0.067)
Share of workers in skill level 3	0.017	0.031	0.0197
	(0.103)	(0.099)	(0.103)
Share of workers in skill level 2	0.005	0.022	0.007
	(0.044)	(0.061)	(0.046)
Share of workers in skill level 1	0.005	0.018	0.006
	(0.049)	(0.076)	(0.052)
Observations	907,694	45,751	953,445

Notes: Standard deviations in parenthesis. Data refer to firms operating in the manufacturing sector over the period 2009-2012. A firm-year observation is classified as exporter if the firm had export revenue in that year. Skill levels 1 to 4 are based on the 1988 International Standard Classification of Occupations (see Appendix Table A1 for a detailed description).

Table 4: Export participation and share of workers trained, OLS estimates for full sample

	(1)	(2)	(3)	(4)
A: Dependent variable: share of workers receiving technical upgrading				
Export (=1 if yes)	0.019***	0.005***	0.001**	0.001*
	(0.000)	(0.000)	(0.001)	(0.001)
Log employment		0.001***		0.001***
		(0.000)		(0.000)
B: Dependent variable: share of workers receving training in other categories				
Export (=1 if yes)	0.011***	0.002***	-0.000	-0.000
	(0.0003)	(0.000)	(0.001)	(0.001)
Log employment		0.001***		0.000
		(0.000)		(0.000)
Firm effects	No	No	Yes	Yes
Sector effects	No	Yes	No	No
State effects	No	Yes	No	No
Firm controls	No	Yes	No	Yes
Observations	953,445	953,445	953,445	953,445

Notes: Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All regressions include year effects. Firms controls are: average age of workers; average tenure; male to female workers ratio; share of workers with less than high school completed; share of workers with exactly high school completed; share of workers with more than high school completed; average log wage; share of white workers; and share of workers in each of skill levels 1 to 4.

Table 5: Export participation and share of workers trained, OLS estimates for switchers

	(1)	(2)	(3)	(4)
A: Dependent variable: share of workers receiving technical upgrading				
Export (=1 if yes)	0.002***	0.001**	0.001**	0.001**
	(0.001)	(0.000)	(0.000)	(0.000)
Log employment		0.002***		0.001
		(0.000)		(0.000)
B: Dependent variable: share of workers receving training in other categories				
Export (=1 if yes)	-0.000	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Log employment		0.001		0.002
		(0.000)		(0.001)
Firm effects	No	No	Yes	Yes
Sector effects	No	Yes	No	No
State effects	No	Yes	No	No
Firm controls	No	Yes	No	Yes
Observations	29,347	29,347	29,347	29,347

Notes: Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All regressions include year effects. Firms controls are: average age of workers; average tenure; male to female workers ratio; share of workers with less than high school completed; share of workers with exactly high school completed; share of workers with more than high school completed; average log wage; share of white workers; share of workers in each of skill levels 1 to 4.

Table 6: Export participation and share of workers trained, IV estimates for switchers

First stage	(1)	(2)
Dependent variable: Export (=1 if yes)		
Industry-specific trade-weighted log real exchange rate	0.004***	0.004***
	(0.001)	(0.001)
F-statistic	11.312	11.171
Second stage		
A: Dependent variable: share of workers receiving technical upgrading		
Export (=1 if yes)	0.056*	0.058**
	(0.028)	(0.029)
B: Dependent variable: share of workers receving training in other categories		
Export (=1 if yes)	18.501	18.849
	(19.465)	(19.603)
Firm effects	Yes	Yes
Firm controls	No	Yes
Observations	29,347	29,347

Notes: Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All regressions include year effects. Firms controls are: log employment; average age of workers; average tenure; male to female workers ratio; share of workers with less than high school completed; share of workers with exactly high school completed; share of workers with more than high school completed; average log wage; share of white workers; and share of workers in each of skill levels 1 to 4.

Table 7: Alternative definition of dependent variable, IV estimates for switchers

First stage	(1)	(2)
Dependent variable: Export (=1 if yes)		
Industry-specific trade-weighted log real exchange rate	0.004***	0.004***
	(0.001)	(0.001)
F-statistic	11.312	11.171
Second stage		
A: Dependent variable: share of workers receiving technical upgrading		
Export (=1 if yes)	0.080**	0.083**
	(0.036)	(0.037)
B: Dependent variable: share of workers receving training in other categories		
Export (=1 if yes)	0.021	0.025
	(0.027)	(0.028)
Firm effects	Yes	Yes
Firm controls	No	Yes
Observations	29,347	29,347

Notes: Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All regressions include year effects. Firms controls are: log employment; average age of workers; average tenure; male to female workers ratio; share of workers with less than high school completed; share of workers with exactly high school completed; share of workers with more than high school completed; average log wage; share of white workers; and share of workers in each of skill levels 1 to 4.

Table 8: Export participation and share of workers trained by occupational group, IV estimates for switchers

First stage	(1)	(2)
Dependent variable: Export (=1 if yes)		
Industry-specific trade-weighted log real exchange rate	0.004**	0.004**
	(0.002)	(0.002)
F-statistic	10.673	10.771
Second stage		
A: Dependent variable: share of workers in skill level 4 receiving technical upgrading		
Export (=1 if yes)	0.052	0.049
	(0.067)	(0.065)
B: Dependent variable: share of workers in skill level 3 receiving technical upgrading		
Export (=1 if yes)	0.086	0.097
	(0.229)	(0.241)
C: Dependent variable: share of workers in skill level 2 receiving technical upgrading		
Export (=1 if yes)	0.061*	0.063*
	(0.034)	(0.035)
D: Dependent variable: share of workers in skill level 1 receiving technical upgrading		
Export (=1 if yes)	0.104**	0.106**
	(0.042)	(0.042)
Firm effects	Yes	Yes
Firm controls	No	Yes
Observations	18170	18170

Notes: Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All regressions include year effects. Firms controls are: log employment; average age of workers; average tenure; male to female workers ratio; share of workers with less than high school completed; share of workers with exactly high school completed; share of workers with more than high school completed; average log wage; share of white workers; and share of workers in each of skill levels 1 to 4.

Table 9: Returns to technical upgrading within exporting firms, OLS estimates

Dependent variable: log hourly wage	(1)	(2)	(3)	(4)	(5)	(6)
Received technical upgrading (=1 if yes)	0.055***	0.039***	0.031***	0.029***	0.028***	0.028***
	(0.004)	(0.005)	(0.004)	(0.005)	(0.006)	(0.006)
Log employment		0.036***		0.024***		0.045***
		(0.008)		(0.002)		(0.005)
Worker controls	No	Yes	No	Yes	No	Yes
Worker effects	No	No	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Firm effects	No	No	No	No	Yes	Yes
State effects	No	Yes	No	Yes	No	Yes
Observations	14,009,134	14,009,134	14,009,134	14,009,134	14,009,134	14,009,134

Notes: Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All regressions include year effects. Worker controls are: age, race, gender, schooling level, and skill level based on occupation. Firms controls are: log employment; average age of workers; average tenure; male to female workers ratio; share of workers with less than high school completed; share of workers with exactly high school completed; share of workers with more than high school completed; average log wage; share of white workers; share of workers in each of skill levels 1 to 4; and 2-digit industry dummies. Sample restricted to firms that exported in all years during 2009-2012.

Table 10: Returns to technical upgrading within exporting firms by firm size, OLS estimates

Dependent variable: log hourly wage	(1)	(2)	(3)	(4)	(5)	(6)
A. Micro and small firms (employment < 100 workers)						
Received technical upgrading (=1 if yes)	0.070***	0.048***	0.054***	0.053***	0.054***	0.053***
	(0.007)	(0.007)	(0.011)	(0.011)	(0.012)	(0.012)
Observations	146,079	146,079	146,079	146,079	146,079	146,079
B. Medium size firms (employment between 100 and 500 workers)						
Received technical upgrading (=1 if yes)	0.060***	0.050***	0.044***	0.044***	0.044***	0.043***
	(0.005)	(0.004)	(0.006)	(0.007)	(0.007)	(0.007)
Observations	926,724	926,724	926,724	926,724	926,724	926,724
C. Large firms (employment > 500 workers)						
Received technical upgrading (=1 if yes)	0.053***	0.037***	0.029***	0.028***	0.027***	0.027***
	(0.004)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
Observations	12,936,331	12,936,331	12,936,331	12,936,331	12,936,331	12,936,331
Worker controls	No	Yes	No	Yes	No	Yes
Worker effects	No	No	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Firm effects	No	No	No	No	Yes	Yes
State effects	No	Yes	No	Yes	No	Yes

Notes: Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All regressions include year effects. Worker controls are: age, race, gender, schooling level, and skill level based on occupation. Firms controls are: log employment; average age of workers; average tenure; male to female workers ratio; share of workers with less than high school completed; share of workers with exactly high school completed; share of workers with more than high school completed; average log wage; share of white workers; share of workers in each of skill levels 1 to 4; and 2-digit industry dummies. Sample restricted to firms that exported in all years during 2009-2012.

Table A1: Description of ISCO skills based on occupations

Skill	Descritpion	ISCO Major group
Skill level 1	Competence associated with general education usually acquired by completion of compulsory education.	(9) Elementary occupations
Skill level 2	Requires knowledge as for first skill level, but typically a longer period of worker-related training or work experience.	(4) Clerks; (5) Service workers and shop and market sales workers; (6) Skilled agriculture and fishery; (7) Craft and related workers; (8) Plant and machine operators and assemblers.
Skill level 3	Requires a body of knowledge associated with a period of postcompulsory education but not to degree level.	(3) Technicians and associate professionals
Skill level 4	Normally requires a degree or an equivalent period of relevant work experience.	(1) Legislators, senior officials and managers; (2) Professionals

Table A2: Attributes of workers employed at exporting manufacturing firms by training status

	Did not received any training in sample period	Did not receive technical upgrading in current or previous years	Received technical upgrading in current or previous years	Full sample
Log hourly wage	2.130	2.136	2.603	2.154
	(0.738)	(0.734)	(0.679)	(0.737)
Share with schooling less than high school	0.474	0.467	0.237	0.458
	(0.499)	(0.498)	(0.425)	(0.498)
Share with schooling high school	0.415	0.423	0.632	0.430
	(0.492)	(0.494)	(0.482)	(0.495)
Share with schooling more than high school	0.110	0.109	0.130	0.110
	(0.313)	(0.312)	(0.336)	(0.313)
Share of production workers	0.458	0.458	0.427	0.457
	(0.498)	(0.498)	(0.494)	(0.498)
Share of workers in skill level 4	0.046	0.045	0.030	0.044
	(0.210)	(0.207)	(0.173)	(0.206)
Share of workers in skill level 3	0.069	0.070	0.129	0.072
	(0.254)	(0.256)	(0.335)	(0.260)
Share of workers in skill level 2	0.736	0.736	0.737	0.736
	(0.440)	(0.440)	(0.440)	(0.440)
Share of workers in skill level 1	0.147	0.147	0.102	0.145
	(0.354)	().354	(0.303)	(0.353)
Tenure	53.329	53.073	65.031	53.516
	(65.741)	(65.420)	(72.972)	(65.754)
Share of men	0.701	0.706	0.901	0.713
	(0.457)	(0.455)	(0.298)	(0.451)
Share of white	0.643	0.645	0.669	0.646
	(0.478)	(0.478)	(0.470)	(0.478)
Observations	11,439,308	13,489,458	519,676	14,009,134

Notes: Table reports means and standard deviations (in parentheses) for workers employed at manufacturing firms that exported every year over the period 2009-2012, by training status. Wages are in 2010 Brazilian Reais. Sample restricted to workers employed in firms that exported in all years over that period.

Table A3: Returns to technical upgrading within exporting firms, OLS estimates with restricted sample

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: log hourly wage						
Received technical upgrading (=1 if yes)	0.056***	0.040***	0.033***	0.031***	0.029***	0.029***
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Log employment		0.036***		0.023***		0.046***
		(0.008)		(0.001)		(0.000)
Worker controls	No	Yes	No	Yes	No	Yes
Worker effects	No	No	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Firm effects	No	No	No	No	Yes	Yes
State effects	No	Yes	No	Yes	No	Yes
Observations	11,958,984	11,958,984	11,958,984	11,958,984	11,958,984	11,958,984

Notes: Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All regressions include year effects. Worker controls are: age, race, gender, schooling level, and skill level based on occupation. Firms controls are: log employment; average age of workers; average tenure; male to female workers ratio; share of workers with less than high school completed; share of workers with exactly high school completed; share of workers with more than high school completed; average log wage; share of white workers; share of workers in each of skill levels 1 to 4; and 2-digit industry dummies. Sample restricted to firms that exported in all years during 2009-2012.

Table A4: Returns to technical upgrading within exporting firms by firm size categories, OLS estimates with restricted sample

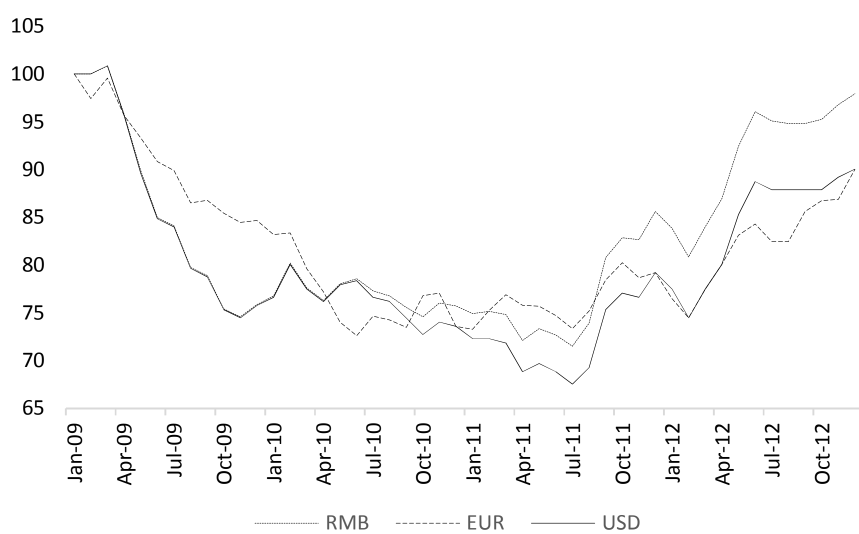
Dependent variable: log hourly wage	(1)	(2)	(3)	(4)	(5)	(6)
A. Micro and small firms (employment < 100 workers)						
Received technical upgrading (=1 if yes)	0.072***	0.048***	0.056***	0.056***	0.056***	0.055***
	(0.008)	(0.007)	(0.011)	(0.011)	(0.011)	(0.011)
Observations	140,172	140,172	140,172	140,172	140,172	140,172
B. Medium size firms (employment between 100 and 500 workers)						
Received technical upgrading (=1 if yes)	0.062***	0.051***	0.047***	0.046***	0.046***	0.045***
	(0.005)	(0.004)	(0.006)	(0.006)	(0.006)	(0.006)
Observations	883,859	883,859	883,859	883,859	883,859	883,859
C. Large firms (employment > 500 workers)						
Received technical upgrading (=1 if yes)	0.054***	0.038***	0.031***	0.030***	0.029***	0.028***
	(0.004)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
Observations	10,934,953	10,934,953	10,934,953	10,934,953	10,934,953	10,934,953
Worker controls	No	Yes	No	Yes	No	Yes
Worker effects	No	No	Yes	Yes	Yes	Yes
Firm controls	No	Yes	No	Yes	No	Yes
Firm effects	No	No	No	No	Yes	Yes
State effects	No	Yes	No	Yes	No	Yes

Notes: Robust standard errors clustered by firm in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All regressions include year effects. Worker controls are: age, race, gender, schooling level, and skill level based on occupation. Firms controls are: log employment; average age of workers; average tenure; male to female workers ratio; share of workers with less than high school completed; share of workers with exactly high school completed; share of workers with more than high school completed; average log wage; share of white workers; share of workers in each of skill levels 1 to 4; and 2-digit industry dummies. Sample restricted to firms that exported in all years during 2009-2012.

Figure 1: Real exchange rate, Brazil, 2009-2012

Panel A: Real effective exchange rate index, Jan 2009=100

Panel B: Selected bilateral real exchange rate indexes, Jan 2009=100



Notes: Indexes are based on data from the International Financial Statistics of the International Monetary Fund. A rise in the index denotes a depreciation of the real relative to foreign currencies.