Review of Economics & Finance
Submitted on 19/Aug./2013
Article ID: 1923-7529-2013-04-33-20 Şule Özler

Worker Composition and Export Decision: Evidence from Colombia[1]

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Abstract: In this paper, micro-level evidence on the link between trade and labor markets is provided using annual plant level data from Colombia. At the firm level, the manifestation of the observed relationship between trade and changing labor market conditions would be differing worker compositions between exporting and non-exporting firms. Specifically, two dimensions are considered: fraction of unskilled workers and fraction of female workers within the workforce. While the unskilled ratio has declined and female ratio has increased we demonstrate that changes in both of these ratios are concentrated in firms that export or start exporting in the period investigated. Next, the relationship is analyzed in an econometric model. The results indicate that the existing worker composition affect consequent export decisions of the firms, suggesting adjustment costs in worker composition. Where the results are statistically significant, unskilled ratio decreases the probability of exporting, while the female ratio increases it. On the other side, there is some evidence that unskilled ratio affects efficiency of the firm, while the relationship between female ratio and efficiency is weak.

JEL Classifications: F14, F15, F66

Keywords: Wage inequality; Globalization; Developing country; Gender

1. Introduction

Over the last Couple of decades, one of the most important issues concerning academic researchers as well as policy makers has been linkages between globalization and labor markets. Academic researchers, mostly focusing on the U.S. experience, have analyzed the impact of globalization on wages. The widening wage gap between skilled and unskilled workers in the U.S. has been attributed to factors such as increased trade with developing countries, technological change, and outsourcing.[2] However, not much attention has been paid to developing country evidence.[3] Given that

[1] Author's thanks go to James Tybout and Sofronis Clerides, who provided the original data. An earlier version of this paper was written with the author's dear friend late Hakan Orbay.

[2] Since Katz and Murphy (1992) convincingly made the point that the relative supply shifts could not explain the dramatic change in wage inequality attention has turned to demand side explanations. Feenstra (1997) provides a brief overview of the debate on sources of demand changes. In this debate Leamer (1993, 1994), Borjas and Ramey (1995), and Wood (1994)) view the source of wage inequality as the shift towards industries that use skilled labor relatively more intensely. Davis and

both skill-biased technological change and trade are global, developing country experience should provide important clues to understand the changing face of the labor markets.

Until recently, this literature also stayed away from linkages between globalization and changing gender composition in the labor markets.[4] There is, however, a sizable body of work in another strand of literature associating globalization with feminization of the labor force. Evidence suggests that export promotion and trade liberalization policies in developing countries have led to feminization of the labor force. [5]

In this paper, we investigate the relationship between trade and labor markets using annual plant level panel data for manufacturing plants in the four major exporting industries. Plant level data are usually confidential, however, we were provided with the data for Colombia. We are limited to the 1983-1991 period due to the availability of the data. At the same time this is a good period for our analysis since the period of 1983-1991 was a period of rapid export growth in Colombia. Plant[6] level evidence, as opposed to industry level analysis, is essential to the literature since there is substantial heterogeneity among firms even within narrowly defined industrial classification.[7] Furthermore, since it is firms that hire workers, any link between trade and labor markets must manifest itself at the firm level. One such manifestation would be different worker characteristics for exporting and non-exporting firms within an industry. Specifically, whether a relationship between export activity and worker composition exists at the firm level is precisely the question we ask here. We look at two dimensions of the worker composition: The ratio of unskilled workers to all workers (*unskilled ratio* from here on) and the fraction of females in the work force (*female ratio*) summarize these dimensions.

We find strong evidence that there is a relation between exporting activity and unskilled ratio as exporting firms have significantly lower unskilled ratios after controlling for industry and time effects. Furthermore, a decomposition analysis demonstrates that the overall decline in the unskilled ratio is mainly due to the within-firm shifts in the exporting firms. On the other hand, we find little support for the relation between female ratio and exporting. Exporting firms appear to have slightly higher female ratios. The patterns in the decomposition analysis for female ratio are more mixed, and change across industries.

Haltiwanger (1991), Bound and Johnson (1992), Lawrence and Slaughter (1993), Berman, Bound and Griliches (1994), Krugman (1995) argue that technological change has been biased in favor of skilled workers. Rodrik (1997) and Slaughter (1997) point to importance of analyzing changes in labor demand elasticites.

[3] See Feliciano (1993), Ravenga (1995), Feenstra and Hanson (1997), Hanson and Harrison (1999) for evidence on Mexico, Currie and Harrison (1997) on Morocco, Robbins (1994) on Chile, Amiti and Cameron (2012) on Indonesia, Arbache, Dickerson and Green (2004) on developing countries, Krugman (2008) on the US, Sacks and Shatz (1996) on developing countries, Wood (1997) on Latin America.

[4] Levinshon (1999), Ozler (1999) are among the few exceptions that investigate linkages between gender differences in job creation (destruction) and trade.

[5] See Beneria (1992), Cagatay and Ozler (1995, 1998) Elson (1996), Joekes and Weston (1994), Standing (1997). Ozler (1999, 2003) .

[6] In this paper we use firm and plant interchangeably, though the data are plant level.

[7] Bernard and Jensen (1997) use plant level data to analyze the wage gap in the U.S. economy and emphasize the importance of plant level heterogeneity. See Roberts and Tybout (1996) on heterogeneity in Colombian manufacturing industry.

The results of our econometric analysis indicate a strong impact of worker composition on export participation decision. In particular, we find that increase in the unskilled worker ratio reduces the probability of exporting, while an increase in the female ratio increases the probability of exporting. A high unskilled worker ratio is also found to increase average variable cost in two of the four industries. Female ratio, on the other hand, is found to increase average variable cost in one industry where it does not have a direct impact on export participation decision.

The remainder of this paper is organized as follows. Section 2 describes the framework for our analysis. Section 3 presents the patterns of the data. In Section 4 we describe the model, and the results of the econometric estimation. A discussion of the results is contained in Section 5.

2. Estimation Framework

A concern in studying worker composition and export activity at the plant level is the possible simultaneity of the two decisions made by the manager, namely the decision to export and the decision to adjust worker composition. The framework we have in mind is that, in each period, a firm first decides whether to export and then carries out worker adjustments in line with this decision. This is sensible since we look only at export participation decision and not at the amount exported.[8] Given this framework, firms that decide to export would change their worker composition to maximize the benefits from exporting.

Nonetheless, one might also ask whether the worker composition has any impact on the firm's decision to export. Conceptually, we envision two possible ways that worker composition might influence the decision of a firm to participate in export activity. First is what might be referred as the indirect effect. As it has been documented elsewhere, more efficient plants are more likely to participate in export markets.[9] Hence, if a certain worker composition has a bearing on plant efficiency, we would expect to see the effect on export participation as well.

Second, past worker composition might have a direct impact on export participation decision through its impact on fixed costs of exporting in a given year. This can be rationalized by assuming that worker composition affects the benefits from exporting and that it is costly to adjust worker composition. As an example, suppose it is true that females increase the value of exported goods due to an unobservable (to the econometrician) characteristic associated with being a woman (such as nimble fingers). Consequently, firms entering into export markets have to hire and train more females to increase output value. Such firms would have to incur expenditures for training and other costs associated with hiring new workers. These expenditures can be thought as a fixed cost of exporting. Thus a firm which already has a stock of female workers for this activity is more likely to participate in export activity.

Given that a firm exports in a particular year, it must have already taken any fixed costs associated with this decision and adjusted the worker composition in that year. Thus it is quite intuitive that export decision derives contemporaneous worker composition, as both are observations taken at the end of year. However, given a cost of adjusting worker composition, it is reasonable to assume that the firms consider their current worker makeup while deciding whether to export. In the context of data points, this is translated as causality from past worker composition to export decision.

[8] If the focus were intensity of export participation at the firm level the simultaneity problem between exporting and worker composition would be a source of concern.

[9] Clerides, Lach and Tybout (1998), Bernard and Jensen (1999a, 1999b)

While one can think of mechanisms leading to causality from export decision to past worker composition, it is reasonable to assume away such reverse-causality.[10] On the other hand, the indirect effect should be observed in contemporaneous data.

To guide us in the empirical estimations of the direct and indirect effects of worker composition, we adopt the framework developed in Clerides, Lach, and Tybout (1998), and introduce the idea that fixed cost of exporting in each period can be expressed as a function of past worker composition. The basic features of the model are as in the hysteresis literature.[11] Specifically, each manager faces stochastic cost and foreign demand processes, and sunk start-up costs when they first sell abroad. The manager, who also faces per period fixed costs of being an exporter, chooses in which periods to export. The twist in Clerides, et al. (1998) is to add the possibility of learning-by exporting by allowing the marginal cost of a plant to be potentially affected by the firm's export decision. A reduced form version of the theoretical model is then estimated using full information maximum likelihood. The primary difference between our reduced-from specification and that of Clerides, et al. (1998) is that, in both the participation decision equation and the average variable cost equation (proxying for plant efficiency), we include the two measures of worker composition that are of interest to us, namely, unskilled worker ratio and female ratio.

3. Patterns in the Data

The Colombian sample we use contains data for four major exporting industries classified according to three-digit standard industry classification code (SIC). These industries are Textiles, Clothing and Apparel, Industrial Chemicals, and Other Chemicals. The sample includes information only on firms that have employed at least 10 employees through the 1983-91 period. Individual plant observations have been matched across years to form a panel and only those firms that report information for the entire sample period have been included creating a balanced sample.[12]

The data is particularly well suited for our purposes as it provides detailed information on occupational categories by gender. The number of individuals by gender is provided for each of the following seven occupational categories: owners, management staff, skilled workers, local technicians, foreign technicians, unskilled workers, and apprentices. In addition to providing information on the breakdown of employees in various categories, the Colombian data also allows us to track down the transition of individual plants into and out of the export markets.

Since our primary focus here is on worker composition, let us first define the two worker composition measures we use in this study. The first, which we call unskilled ratio, is the ratio of total unskilled workers to the sum of unskilled workers, skilled workers and technicians. The second measure, called female ratio, is the share of total females in total employment.[13]

[10] For example, if adjustment costs are convex in the quantity of shifts, firms may prefer to do small consecutive adjustments rather than one large adjustment during the year they export. Still, we find it somewhat farfetched that firms prepare to export several years in advance in this manner.

[11] See Baldwin (1988), Dixit (1989), and Krugman (1989).

[12] The census data and matching process are described in Roberts and Tybout (1996). As reported in Clerides et. al. (1998), the average entry rate for all manufacturing industries was around 12.5% during the mid 1980s and the average exit rate was 11.4%. These groups accounted for 3.5% of the output and 3.1% of output, respectively.

[13] In the census total employment is defined as the sum of all occupational categories, including owners.

3.1 Selected Statistics on Employment

Tables 1-3 present some descriptive statistics on employment and its distribution across occupational categories by gender. Table 1 indicates the presence of considerable variation across industries in plant size, female ratio, and unskilled ratio. Furthermore, correlation between unskilled ratio and female ratio also varies a great deal across industries. While Industrial Chemicals has the lowest female intensity, Clothing has the most. Unskilled ratio is lowest in Other Chemicals and highest in Clothing. In Other Chemicals the correlation between the two ratios is highest with .27, and in Industrial Chemicals it is lowest with -.40; Table 2 provides information on female employment shares by occupation. Again, in most occupational categories, female shares vary considerably across industries. The most striking aspect of Table 2 is that in Industrial Chemicals female share among unskilled workers is very small (3.1%), while female share of skilled workers is considerably large (29%). Finally in Table 3, we present shares of occupational categories in total employment. The shares presented are not surprising and they primarily indicate a higher skill and managerial intensity in both of the chemicals industries in contrast to the other two industries.

Table 1. Selected statistics by industry

	Textiles	**Clothing**	**Industrial Chemicals**	**Other Chemicals**
Number of Observations	1764	2223	549	1467
Number of Plants	196	247	61	163
Mean of Total Employment	181.72	90.88	193.86	113.00
Mean of. Female Ratio	0.49	0.81	0.14	0.43
Mean of Unskilled Ratio	0.80	0.83	0.61	0.55
Correlation of Female and Unskilled Ratios	0.12	0.25	-0.40	0.27

Table 2. Female employment shares by occupational categories

	Textiles	**Clothing**	**Industrial Chemicals**	**Other Chemicals**
Owners	27.2%	37.3%	32.4%	37.0%
Managers	13.9%	31.9%	6.7%	18.7%
Skilled Workers	36.7%	58.3%	29.7%	39.5%
Local Technicians	10.2%	29.0%	5.8%	31.4%
Foreign Technicians	1.6%	49.2%	14.3%	18.6%
Unskilled Workers	36.7%	84.6%	3.1%	46.4%
Apprentices	17.2%	68.5%	21.4%	46.8%
All categories	35.3%	77.7%	12.0%	41.6%

Table 3. Shares of occupational categories in total employment

	Textiles	**Clothing**	**Industrial Chemicals**	**Other Chemicals**
Owners	0.6%	1.4%	0.1%	0.5%
Managers	1.6%	1.8%	2.8%	3.9%
Skilled Workers	17.6%	17.2%	30.5%	41.0%
Local Technicians	2.8%	1.2%	8.7%	5.6%
Foreign Technicians	0.1%	0.1%	0.1%	0.1%
Unskilled Workers	76.3%	77.8%	55.6%	47.8%
Apprentices	1.1%	0.6%	2.2%	1.1%

3.2 Effect of Export Activity on Worker Composition

We next investigate whether the worker composition differs by export participation. For each worker ratio we consider here, we estimate regressions where a log transformation of the worker ratio is the explained variable. For these regressions we pool the data across all the plants in the four industries, and over all the years, and include dummy variables to control for fixed affects across industries and over years.

Our measure of export activity is a firm level dummy variable indicating whether a firm has exported during a given year. In addition to the measure of export activity, we include a number of variables to control for plant characteristics. These characteristics are plant size, capital to labor ratio, imported machinery share, share of equipment in investment, share of transportation in investment, ratio of benefits paid to wages. For the plant size and capital to labor ratio, the firms are sorted into quintiles and a dummy variable is included for each quintile.

The results of this regression are reported in the first and second columns of Table 4 for the unskilled and female ratios, respectively. The results for the unskilled ratio indicate a strong effect of export activity on worker composition. Exporters have a lower ratio of unskilled workers. In contrast, the results in the second column indicate that export activity increases female ratio but this impact is not statistically significant.

Table 4. Effect of exporting on worker ratios

Dependent Variable:	**Unskilled**	**Female**
Constant	1.862*(0.06)	0.467* (0.07)
Exporter	-0.101*(0.03)	0.053 (0.04)
Plant Size Quartile Dummies		
Quartile 2	0.049 (0.04)	-0.123* (0.05)
Quartile 3	0.031(0.04)	-0.099* (0.04)
Quartile 4(Largest)	0.203*(0.04)	0.022 (0.05)
Capital-Labor Ratio Quartile Dummies		
Quartile 2	-0.099*(0.04)	-0.035 (0.04)
Quartile 3	-0.234*(0.04)	-0.316* (0.04)
Quartile 4(Highest)	-0.301*(0.04)	-0.507* (0.05)
Benefits/Wages	-0.314*(0.02)	-0.312*(0.03)
Imported mach./invest.	-0.314*(0.07)	-0.016 (0.07)
Equipment/invest	0.182*(0.04)	-0.129*(0.04)
Transportation/invest.	-0.052(0.06)	-0.031 (0.06)
Industry (3-digit SIC) Dummies		
Clothing	0.030 (0.03)	1.437*(0.04)
Ind. Chemic.	-0.495*(0.05)	-1.336*(0.05)
Other Chemic.	-1.088*(0.04)	-0.122*(0.04)
Year Dummies		
Year_84	0.005(0.05)	-0.025 (0.06)
Year_85	-0.054 (0.05)	-0.043 (0.06)
Year_86	-0.080 (0.05)	-0.026 (0.06)
Year_87	-0.107*(0.05)	-0.013 (0.06)
Year_88	-0.185*(0.05)	-0.020 (0.06)
Year_89	-0.178*(0.05)	0.027 (0.06)
Year_90	-0.206*(0.05)	0.002 (0.06)
Year_91	-0.260*(0.05)	0.031 (0.06)

Notes: In the parentheses on right side of estimated parameters are standard deviation of coefficients; The asterisk * indicates statistical significance at the level of 5%.

3.3 Export Activity and Changing Worker Composition

Next we turn to the dynamics of worker composition changes over the period studied. In order to describe the relationship between export activity and worker composition, we separate the plants in the sample into five categories based on their activity and determine the changes in individual categories. The details of this classification, which makes use the time pattern of exporting over 9 years, are described in the appendix. The five categories are:[14]

1. Non-exporters: Did not export during the sample period;
2. Exporters: Exported during the entire sample period;
3. Entrants: Did not export at the beginning, but started exporting during the sample period;
4. Quitters: Exported at the beginning, but ceased exporting during the sample period;
5. Unclassified: Exported sporadically during the sample period and could not be placed in the above categories.

We decompose changes in worker ratios into changes arising from employment shifts between export status categories and changes arising within export status categories. The within change in each export category is further decomposed into changes arising from shifts between plants in that category, and changes arising within plants in that export category. In equations 1-3 below we describe the decomposition in detail. A change in worker composition is decomposed into each export category's share effect and own effect as in the following equation:

$$\Delta e = \sum_{j=1}^{5} \Delta e_j \bar{\alpha}_j + \sum_{j=1}^{5} \bar{e}_j \Delta \alpha_j \qquad (1)$$

where e is the worker ratio of interest, j is the index indicating the export-status category and α_j is the employment share of a particular export-status category in total employment across all the five categories.[15] Over-bar denotes average of the initial and ending values of the ratio and the share. In (1), the first term represents the total change within categories and the second term yields the total change due to share shifts between categories.

Since we wish to compare individual contributions from each category we define total contribution from a category (tc_j) as follows,

$$tc_j = \Delta e_j \bar{\alpha}_j + (\bar{e}_j - \bar{e}) \Delta \alpha_j \qquad (2)$$

where $\bar{e}$ is the average of beginning and ending ratios for the industry. In (2), the first term is the contribution from category j due to change in its own ratio and thus it is labeled as own effect. The second term, share effect, represents the contribution due to shifts in the employment share. With the above definition, the share effect is positive for a category with higher than average ratio if it gains share or for a category with lower than average ratio if it loses employment share. Note that the sum

[14] In a previous version of the paper we used an alternative classification scheme: 1) non-exporters: never exported, 2) exporters: always exported, 3) entrants: started as non-exporter, began exporting and never stopped,4) quitters: began the period as exporter, stopped exporting and never resumed it, 5) switchers: switched status more than once. The main results of the two methods of classification are consistent with each other. The advantage of the current scheme is that it reduces switchers category.

[15] Total employment is computed in the same way as the denominator of the ratio under investigation. Thus, total employment number is different for female ratio and unskilled ratio.

of the share effects across categories is equal to the between term in (1) due to the fact that changes in employment shares must add up to zero.

Table 5. Decomposition of changes in unskilled ratio

	Total Contribution (1)	Share Effect (2)	(2a)	Own Effect Total (3)	Own Effect Between Plants (3a)	Own Effect Within Plants (3b)	Number of Firms (4)	Average Contrib. (×100) (5)
All Sample								
Non-Exporter	-1.811	-0.125	-	-1.686	-0.245	-1.441	413	-0.439
Exporter	-2.540	-0.017	+	-2.524	0.263	-2.786	97	-2.619
Entrant	-1.121	-0.033	+	-1.088	0.037	-1.126	122	-0.919
Quitter	-0.430	0.025	-	-0.455	-0.097	-0.358	21	-2.048
Unclassified	-0.318	0.034	-	-0.352	-0.018	-0.335	14	-2.272
Total	-6.221	-0.115		-6.106	-0.060	-6.046	667	-0.933
Textiles								
Non-Exporter	-1.012	-0.043	-	-0.969	-0.065	-0.904	118	-0.858
Exporter	-2.799	0.026	-	-2.825	0.365	-3.190	26	-10.766
Entrant	-0.683	0.021	+	-0.704	0.194	-0.898	39	-1.750
Quitter	-0.161	0.013	-	-0.174	-0.071	-0.102	6	-2.682
Unclassified	0.038	0.025	-	0.012	-0.050	0.062	7	0.538
Total	-4.617	0.042		-4.658	0.373	-5.032	196	-2.356
Clothing								
Non-Exporter	-1.615	-0.332	-	-1.282	0.043	-1.325	174	-0.928
Exporter	-0.302	-0.003	+	-0.299	-0.562	0.263	16	-1.888
Entrant	-1.603	-0.169	+	-1.434	0.079	-1.513	54	-2.969
Quitter	0.043	-0.001	-	0.044	0.000	0.044	1	4.321
Unclassified	-0.005	0.020	-	-0.025	-0.001	-0.024	2	-0.241
Total	-3.482	-0.485		-2.997	-0.442	-2.555	247	-1.410
Industrial Chemicals								
Non-Exporter	0.098	0.005	+	0.093	0.149	-0.056	23	0.426
Exporter	-7.324	-0.246	+	-7.078	0.703	-7.781	25	-29.294
Entrant	0.002	0.035	+	-0.033	-0.041	0.007	3	0.067
Quitter	-0.170	0.021	+	-0.192	0.055	-0.247	6	-2.838
Unclassified	-3.408	-0.422	-	-2.986	-0.190	-2.796	4	-85.195
Total	-10.802	-0.606		-10.196	0.676	-10.872	61	-17.708
Other Chemicals								
Non-Exporter	-3.840	-0.082	-	-3.758	-0.279	-3.479	98	-3.919
Exporter	-2.622	0.045	-	-2.667	0.073	-2.740	30	-8.739
Entrant	-2.329	-0.100	+	-2.228	-0.435	-1.793	26	-8.957
Quitter	-1.328	-0.020	+	-1.308	0.109	-1.417	8	-16.605
Unclassified	0.018	-0.006	-	0.025	0.000	0.025	1	1.843
Total	-10.101	-0.164		-9.937	-0.532	-9.405	163	-6.197

Notes: Numbers in columns (1) -(3b) are 100 times the actual numbers. Numbers in column 5 are calculated as (1)/(4)*100. Column (2a) indicates the sign of the share change.

As a further refinement, we decompose the own effect into within plant and between plant effects:

$$tc_j = \bar{\alpha}_j \sum_p \Delta e_p \bar{\alpha}_p + \bar{\alpha}_j \sum_p \bar{e}_p \Delta \alpha_p + (\bar{e}_j - \bar{e}) \Delta \alpha_j \qquad (3)$$

where subscript p indicates ratios pertaining to plants in the category.

The results of our decomposition for the unskilled ratio are presented in Table 5 above.[16] Over the period of nine years under consideration, when all the four industries are taken together the unskilled ratio decreases by 6.22 percentage points. Note that, over the whole sample, exporters and entrants increased their employment share (Column 2a). Since their unskilled ratios are lower than overall average, their share effects are negative (Column 2). In comparison, non-exporters lost employment share. The total share effect from this category is also negative.

The decline in unskilled ratio over the period is also observed for each industry, individually. The decline for Textiles, Clothing, Industrial Chemicals and Other Chemicals industries are 4.6, 3.5, 10.8, 10.1 points, respectively. Exporters and entrants taken together account for a large component of this decline. As the total contribution from each category significantly depends on the number of firms, we also provide average contribution by a firm in each category. We note that average contribution of exporting and entrant firms taken together is greater than non-exporting or quitter firms.

A striking aspect of this decomposition is more easily observable in Table 6 below, where we present the same decomposition as percentages of total change. Almost the entire decline in the unskilled ratio arises from changes in within categories and that in turn arises from changes within plants. Over the four industries 97% of the decline is due to within plant changes. In individual industries the fractions due to within plant changes are 109%, 73%, 101% and 93%, for Textiles, Clothing, Industrial Chemicals and Other Chemicals, respectively. More interesting to us is that a large fraction of the within plant change is accounted by exporters and entrants categories.

In order to see if the decline in unskilled ratio is through the entire manufacturing sector, we implement the decomposition described above using industry classifications instead of export categories. Considering 28 industries[17] at three-digit level we find that there is an overall decline in unskilled ratio where the decline is entirely accounted by changes within industries. The decline is observed in 23 of the 28 industries. In each industry where the decline is observed, it is due to changes within firms, rather than shifts between firms.

In Tables 7 and 8 we present the results of the decomposition for female ratio using export categories. Overall there is a slight increase in the female ratio over the time period (0.8 percentage points). At the industry level, we observe an increase in each of the two chemicals industries while we observe a decrease in the female ratio in Textiles and Clothing. Yet, the female ratio among the entrants increased in all industries. The distribution of this change into between and within effects differs across industries. In Textiles, for example, the increase in the female ratio among entrants is due to an increase in their share (entrants have a higher mean value of female ratio than other categories in Textiles). In Industrial Chemicals exporters account for a large fraction of the increase of female share in the industry. In contrast to Textiles, however, this increase is largely accounted

[16] Lack of information on hours worked does not allow us to report changes in the relative hourly wages. We can only observe total wages paid to total workers in different occupational categories. Based on these, the ratio of annual real wage per unskilled worker to annual real wage per skilled worker shows hardly any change over the years in the sample (this holds for each industry individually).

[17] The industry petroleum refining is left out due to lack of data. The results of the decomposition are available from the author.

by changes within the exporter category itself. The increase within the exporter category in turn is largely due to increases within plants. Not reported are decomposition results where 28 industries are used instead of export categories. The female ratio is found to increase for 21 of these industries, leading to an increase when the whole sample of the 28 industries is considered. Though the results are not as sharp as the results for the unskilled ratio they are similar in that a large fraction of the change is accounted by changes within plants. Specifically, the allocation of the change to between versus within changes indicate that in 16 of the 21 industries the increase is accounted by the increase within the industry. In the 13 of the 16 industries the increase is due to changes within plants.

Table 6. Decomposition of changes in unskilled ratio, percent of total change

			Own Effect			
	Total Contribution (1)	**Share Effect (2)**	**Total (3)**	**Between Plants (3a)**	**Within Plants (3b)**	**Number of Firms (4)**
All Sample						
Non-Exporter	29.1%	2.0%	27.1%	3.9%	23.2%	61.9%
Exporter	40.8%	0.3%	40.6%	-4.2%	44.8%	14.5%
Entrant	18.0%	0.5%	17.5%	-0.6%	18.1%	18.3%
Quitter	6.9%	-0.4%	7.3%	1.6%	5.8%	3.1%
Unclassified	5.1%	-0.6%	5.7%	0.3%	5.4%	2.1%
Total	100.0%	1.8%	98.2%	1.0%	97.2%	
Textiles						
Non-Exporter	21.9%	0.9%	21.0%	1.4%	19.6%	60.2%
Exporter	60.6%	-0.6%	61.2%	-7.9%	69.1%	13.3%
Entrant	14.8%	-0.5%	15.2%	-4.2%	19.5%	19.9%
Quitter	3.5%	-0.3%	3.8%	1.5%	2.2%	3.1%
Unclassified	-0.8%	-0.5%	-0.3%	1.1%	-1.3%	3.6%
Total	100.0%	-0.9%	100.9%	-8.1%	109.0%	
Clothing						
Non-Exporter	46.4%	9.5%	36.8%	-1.2%	38.1%	70.4%
Exporter	8.7%	0.1%	8.6%	16.1%	-7.5%	6.5%
Entrant	46.0%	4.9%	41.2%	-2.3%	43.4%	21.9%
Quitter	-1.2%	0.0%	-1.3%	0.0%	-1.3%	0.4%
Unclassified	0.1%	-0.6%	0.7%	0.0%	0.7%	0.8%
Total	100.0%	13.9%	86.1%	12.7%	73.4%	
Industrial Chemicals						
Non-Exporter	-0.9%	0.0%	-0.9%	-1.4%	0.5%	37.7%
Exporter	67.8%	2.3%	65.5%	-6.5%	72.0%	41.0%
Entrant	0.0%	-0.3%	0.3%	0.4%	-0.1%	4.9%
Quitter	1.6%	-0.2%	1.8%	-0.5%	2.3%	9.8%
Unclassified	31.5%	3.9%	27.6%	1.8%	25.9%	6.6%
Total	100.0%	5.6%	94.4%	-6.3%	100.6%	
Other Chemicals						
Non-Exporter	38.0%	0.8%	37.2%	2.8%	34.4%	60.1%
Exporter	26.0%	-0.4%	26.4%	-0.7%	27.1%	18.4%
Entrant	23.1%	1.0%	22.1%	4.3%	17.8%	16.0%
Quitter	13.2%	0.2%	12.9%	-1.1%	14.0%	4.9%
Unclassified	-0.2%	0.1%	-0.2%	0.0%	-0.2%	0.6%
Total	100.0%	1.6%	98.4%	5.3%	93.1%	

Table 7. Decomposition of changes in female ratio

	Total Contribution (1)	Share Effect (2)	(2a)	Own Effect Total (3)	Own Effect Between Plants (3a)	Own Effect Within Plants (3b)	Number of Firms (4)	Average Contrib. (×100) (5)
All Sample								
Non-Exporter	-0.839	-0.336	-	-0.503	-0.288	-0.215	413	-0.203
Exporter	0.780	-0.129	+	0.908	0.799	0.110	97	0.804
Entrant	0.882	0.468	+	0.414	-0.052	0.466	122	0.723
Quitter	-0.376	0.006	-	-0.383	-0.006	-0.377	21	-1.793
Unclassified	0.375	0.323	-	0.052	0.060	-0.007	14	2.678
Total	0.821	0.331		0.490	0.513	-0.024	667	0.123
Textiles								
Non-Exporter	-0.452	-0.089	-	-0.363	0.024	-0.387	118	-0.383
Exporter	-0.012	0.219	-	-0.230	0.311	-0.541	26	-0.044
Entrant	1.052	0.945	+	0.107	-0.498	0.605	39	2.697
Quitter	-0.731	-0.180	-	-0.551	0.046	-0.597	6	-12.179
Unclassified	-0.350	-0.084	-	-0.266	-0.156	-0.110	7	-4.994
Total	-0.492	0.811		-1.303	-0.273	-1.030	196	-0.251
Clothing								
Non-Exporter	-0.885	-0.318	-	-0.568	-0.062	-0.506	174	-0.509
Exporter	-0.927	-0.471	+	-0.456	-0.961	0.505	16	-5.797
Entrant	0.624	0.064	+	0.560	0.486	0.075	54	1.156
Quitter	-0.050	-0.002	-	-0.048	0.000	-0.048	1	-5.040
Unclassified	-0.007	0.006	-	-0.014	-0.001	-0.012	2	-0.367
Total	-1.246	-0.721		-0.526	-0.539	0.013	247	-0.505
Industrial Chemicals								
Non-Exporter	0.257	0.016	+	0.240	0.078	0.162	23	1.116
Exporter	1.396	0.089	+	1.307	0.543	0.764	25	5.585
Entrant	0.043	0.000	+	0.043	0.013	0.030	3	1.428
Quitter	0.083	0.008	-	0.075	-0.057	0.132	6	1.390
Unclassified	0.715	0.352	-	0.363	0.079	0.283	4	17.877
Total	2.494	0.466		2.028	0.656	1.372	61	4.089
Other Chemicals								
Non-Exporter	-0.088	-0.098	-	0.010	-0.231	0.241	98	-0.090
Exporter	0.284	0.040	-	0.244	-0.255	0.499	30	0.946
Entrant	0.675	-0.195	+	0.870	-0.080	0.950	26	2.595
Quitter	-0.623	0.001	+	-0.624	0.027	-0.652	8	-7.792
Unclassified	0.043	0.028	-	0.015	0.000	0.015	1	4.299
Total	0.290	-0.224		0.514	-0.539	1.053	163	0.178

Notes: Numbers in columns (1) - (3b) are 100 times the actual numbers. Numbers in column (5) are calculated as (1)/(4)*100. Column (2a) indicates the sign of the share change.

Table 8. Decomposition of changes in female ratio, percent of total change

	Total Contribution (1)	Share Effect (2)	Own Effect Total (3)	Own Effect Between Plants (3a)	Own Effect Within Plants (3b)	Number of Firms (4)
All Sample						
Non-Exporter	-102.3%	-41.0%	-61.3%	-35.1%	-26.2%	61.9%
Exporter	95.0%	-15.7%	110.7%	97.3%	13.4%	14.5%
Entrant	107.5%	57.0%	50.5%	-6.3%	56.8%	18.3%
Quitter	-45.9%	0.7%	-46.6%	-0.7%	-45.9%	3.1%
Unclassified	45.7%	39.3%	6.4%	7.3%	-0.9%	2.1%
Total	100.0%	40.3%	59.7%	62.5%	-2.9%	
Textiles						
Non-Exporter	91.8%	18.1%	73.7%	-4.9%	78.7%	60.2%
Exporter	2.3%	-44.4%	46.7%	-63.1%	109.8%	13.3%
Entrant	-213.5%	-191.9%	-21.6%	101.2%	-122.8%	19.9%
Quitter	148.4%	36.5%	111.9%	-9.3%	121.3%	3.1%
Unclassified	71.9%	17.0%	53.9%	31.7%	22.2%	3.6%
Total	100.0%	-164.7%	264.7%	55.5%	209.2%	
Clothing						
Non-Exporter	71.1%	25.5%	45.6%	5.0%	40.6%	70.4%
Exporter	74.4%	37.8%	36.6%	77.1%	-40.5%	6.5%
Entrant	-50.2%	-5.2%	-45.0%	-39.0%	-6.0%	21.9%
Quitter	4.1%	0.2%	3.9%	0.0%	3.9%	0.4%
Unclassified	0.6%	-0.5%	1.1%	0.1%	1.0%	0.8%
Total	100.0%	57.8%	42.2%	43.2%	-1.1%	
Industrial Chemicals						
Non-Exporter	10.2%	0.6%	9.6%	3.1%	6.5%	37.7%
Exporter	56.0%	3.6%	52.4%	21.8%	30.6%	41.0%
Entrant	1.7%	0.0%	1.7%	0.5%	1.2%	4.9%
Quitter	3.3%	0.3%	3.0%	-2.3%	5.3%	9.8%
Unclassified	28.6%	14.1%	14.5%	3.2%	11.4%	6.6%
Total	100.0%	18.7%	81.3%	26.3%	55.0%	
Other Chemicals						
Non-Exporter	-30.4%	-33.8%	3.4%	-79.6%	83.0%	60.1%
Exporter	97.9%	13.9%	84.0%	-88.0%	172.0%	18.4%
Entrant	232.6%	-67.1%	299.7%	-27.7%	327.4%	16.0%
Quitter	-214.9%	0.4%	-215.3%	9.4%	-224.6%	4.9%
Unclassified	14.8%	9.6%	5.2%	0.0%	5.2%	0.6%
Total	100.0%	-77.1%	177.1%	-186.0%	363.0%	

The regression results on the female ratio reported earlier do not indicate a link between contemporaneous export activity and female ratio. The decomposition analysis, on the other hand, is indicative of such a relationship. These two patterns taken together, do not rule out the possibility that a high current female ratio makes firms more likely to export in the future. In particular, the regressions using contemporaneous data may fail to show a relation between exporting and female ratio if the female ratio is sticky, i.e., adjusting this ratio is costly, for some reason. If this is the case, firms may start exporting but would not adjust this ratio (e.g., hire more females) immediately and thus the relationship will be weak. However, given the hypothesis that there is an economic relationship, one should observe a reverse causality, i.e., a higher female ratio makes firms more likely to export, in the presence of adjustment costs. This is precisely the direction we take in the next section.

4. Effect of Worker Composition on Export Participation

4.1 The Model and Econometric Methodology

In this section we describe a model that allows us to econometrically estimate the impact of past worker composition of a plant on its export participation. As discussed below, the worker composition affect is modeled to influence the participation decision through its impact on plant efficiency and also through its impact on fixed costs of exporting in a given year. The model is an adaptation of Clerides et. al. (1998), where the authors develop a framework to analyze the causal links between exporting and efficiency.

Consider an environment where each firm faces a downward sloping demand curve in the foreign market, yet too small to influence the behavior of others. There are random demand shocks, which are assumed to be exogenous to the plant and follow a serially correlated, plant specific process. There are two types of costs associated with export activity, a fixed cost of being an exporter per period and an entry cost every time the plant decides to re-enter the foreign market. Hence producers face a dynamic optimization problem, where each period they must choose whether to export or not on the basis of available information.

Let y_{it} denote the export participation decision of firm i in period t, i.e. $y_{it} = 1$ if firm i exported in period t and 0 otherwise. Furthermore, let M_t denote the fixed cost associated with being an exporter in period t and $F(\mathbf{y}_{\mathbf{it-1}})$ denote the entry cost to the export market which depends on past realizations of y_{it} denoted by the vector $\mathbf{y}_{\mathbf{it-1}}$. While in general entry costs may depend on history of export participation decisions, both Roberts and Tybout (1997) and CLT find that only the past years' decision to be significant. In what follows, we therefore focus on only the previous years export participation and write the entry cost as

$$F(\mathbf{y}_{\mathbf{it-1}}) = F^0 - (F^0 - F^1)y_{it-1} \qquad (4)$$

where F^0 is the entry cost for plants that have not exported in the previous year and F^1 is the entry cost if the plant have exported in the previous year.

In our specification of the model, we will let the fixed cost of exporting in year t, M_t, depend on the past worker composition of the plant. This can be rationalized by assuming that worker composition effects benefits from exports in some manner and that it is costly to adjust the worker composition. As an example, suppose that skilled workers increase the value of exported goods because exporting requires new product design and other forms of technical assistance. Consequently, firms entering into foreign markets will hire and train more skilled workers in order to increase output value, which can be thought as a fixed cost of exporting. However, if the firm already has a stock of skilled workers than that firm need not pay training costs and other costs associated with hiring new workers.

For the participation decision in period *t*, assume that managers maximize the expected value of the sum of current and discounted future profits, denoted by the value function $V_t\,(y_{it-1})$. The value function depends on the previous export participation due to the nature of the entry costs described above. Let us define $B_t(y_{it-1})$ to be the net future benefit of exporting in this period,

$$B_t(y_{it-1}) = \delta\big(\mathrm{E}_t(V_{t+1} \mid y_t = 1) - \mathrm{E}_t(V_{t+1} \mid y_t = 0)\big) \qquad (5)$$

where δ is the one period discount factor. Then, incremental benefit from exporting, y^*, will be

$$y_{it}^* = \pi^f - M + B_t(y_{it-1}) \qquad (6)$$

and firms export if this benefit is greater than the entry costs, or

$$y_{it} = \begin{cases} 1 & \text{if } y_{it}^* \geq F^0 - (F^0 - F^1)y_{it-1} \\ 0 & \text{otherwise} \end{cases} \qquad (7)$$

In order to arrive at a equation that can be estimated, we write the latent variable $y_{it}^* - F^0$ as a reduced form in terms of variables that are expected to help predict future marginal costs and demands as well as those that effect current profitability and fixed costs of exporting. Operationally, we include logarithm of age (A_{it}) and its square, first lag real capital (k_{it}) and business type dummy (0 for single owner firms and partnerships, 1 or others) as exogenous characteristics of the plant, denoted by $\mathbf{X}_{it}$ below. In addition, we have two lags of average costs (AVC_{it}) as a proxy for marginal costs, first lags female ratio (f_{it}) and unskilled ratio (u_{it}), exchange rate (e_t) and a serially correlated disturbance. We thus have,

$$y_{it} = \begin{cases} 1 & \text{if } 0 \leq \gamma_p + \beta^x X_{it} + \beta^e \ln(e_t) + \sum_{j=1}^{2} \ln(AVC_{it-j}) + \beta^f f_{it-1} + \beta^u u_{it-1} + (F^0 - F^1)y_{it-1} + \eta_{it} \\ 0 & \text{otherwise} \end{cases} \qquad (8)$$

which is the estimated participation equation.

We now turn to the indirect effect of worker composition on export participation, namely the effect through efficiency of the plant. We take the average cost per output (AVC) as the proxy for plant efficiency and assume the following log-linear specification,

$$\ln(AVC_{it}) = \gamma_c + \beta^x X_{it} + \sum_{j=1}^{2} \ln(AVC_{it-j}) + \beta^f f_{it} + \beta^u u_i + (F^0 - F^1)y_{it-1} + \nu_{it} \qquad (9)$$

Note that lagged participation variable in the cost equation is based on the hypothesis that firms may learn by exporting which was the question posed by Clerides et all. (1999). While our focus is different, we kept that variable in the cost equation to improve comparability of our results with theirs. In terms of plant characteristics, we include age variables and lagged real capital variable.

Unobserved plant characteristics such as managerial talent will cause the disturbances in the above equation to be correlated both across time and across two equations. The disturbances are assumed to have a plant specific variable (random effect) plus transitory noise as described below.

$$\eta_{it} = \alpha_{1i} + \varepsilon_{1it}\,; \quad \nu_{it} = \alpha_{2i} + \varepsilon_{2it}$$

where random effects and noise terms may be correlated for each plant. Total variance of η is normalized to 1.

One final point in the econometric approach is the problem of endogeneity when lagged values of the dependent variable are included in the estimation with random effects. We adopt Heckman's approach (1981a, b) as in Roberts and Tybout (1997) and Clerides et all. (1999). This amounts to adding 2 equations to the system, called pre-sample equations, which are identical to (8) and (9) except lagged dependent variables are removed.

Due to potential linkages between the participation and cost equations, we estimate (8) and (9) simultaneously using full-information maximum likelihood method. The FIML approach yields estimates of the two equations together with variances of random effects and transitory noise (relative to total unexplained variation).

4.2 Estimation Results

We estimate the system of equations described above separately for each of the four industries, and present the results in Table 9. We first focus on the two worker ratios that are of primary interest in this paper. We find that an increase in unskilled ratio decreases the likelihood of exporting in all the industries, except for Industrial Chemicals. The mechanism through which this affect works varies across industries. Specifically, unskilled ratio directly decreases the likelihood of participation in export activity in Clothing and Other Chemicals. The indirect effect of the unskilled ratio is observed for Textiles and Clothing, where an increase in unskilled ratio increases average variable cost.

Table 9. FIML Estimation results

	Textiles	Clothing	Industrial Chemicals	Other Chemicals
Participation Equation				
Intercept	-3.5566** (0.733)	-2.8415** (1.070)	-11.7154 **(2.848)	-2.6108 (1.894)
ln (exchange rate)	2.7647** (0.587)	2.6821** (0.798)	1.5323 ** (0.721)	0.3077 (0.893)
ln (real capit.), lagged	2.0854** (0.316)	2.1720** (0.361)	3.2191** (0.492)	1.9991** (0.449)
ln AVC, lag 1	-0.1281 (0.198)	-0.2023 (0.177)	-0.4851** (0.232)	0.2793 (0.175)
ln AVC, lag 2	-0.1709 (0.199)	0.0633 (0.186)	-0.1196 (0.229)	-0.5124** (0.183)
ln Age	-0.9851** (0.332)	-0.0217 (0.737)	3.3768* (2.049)	-0.5024 (1.221)
(ln Age), squared	0.2530** (0.061)	0.0365 (0.127)	-0.5095 (0.336)	0.0303 (0.197)
Business Type	0.2684* (0.139)	0.2576* (0.151)	0.6206** (0.169)	0.7419** (0.154)
Female Ratio, lagged	0.9065** (0.265)	-0.0897 (0.399)	2.3267** (0.783)	0.5588 (0.365)
Unskilled Ratio, lagged	-0.4961 (0.367)	-1.1817** (0.299)	0.6575 (0.422)	-0.7461** (0.321)
Export Part., lag 1	2.1179** (0.136)	1.8431** (0.146)	0.7797** (0.201)	1.6974** (0.226)
Cost Equation				
Intercept	0.0443 (0.131)	-0.5282** (0.141)	-0.8901** (0.436)	-0.5245** (0.235)
ln (real capit.), lagged	-0.0135 (0.039)	0.0771** (0.037)	0.0333 (0.088)	-0.1358** (0.045)
ln AVC, lag 1	0.7009** (0.029)	0.7261** (0.021)	0.6207** (0.043)	0.6732** (0.028)
ln AVC, lag 2	0.1262** (0.031)	0.1803** (0.021)	0.3263** (0.043)	0.1496** (0.030)
ln Age	-0.2941** (0.078)	0.0641 (0.092)	0.3860 (0.275)	0.1491 (0.152)
(ln Age), squared	0.0534** (0.014)	-0.0104 (0.016)	-0.0537 (0.046)	-0.0198 (0.025)
Female Ratio	0.0056 (0.033)	0.0337 (0.042)	0.1566 (0.159)	0.1659** (0.051)
Unskilled Ratio	0.1534** (0.048)	0.2065** (0.041)	0.1139 (0.074)	-0.0146 (0.042)
Export Part., lag 1	0.0026 (0.021)	0.0523** (0.018)	-0.0162 (0.031)	0.0069 (0.021)
Parameter Estimations				
Var(ε_1)	0.0631	0.7123	0.6230	0.0345
Var(ε_2)	0.0735	0.0593	0.0691	0.0866
Var(α_1)	0.1093	0.2789	0.7387	0.2607
Var(α_2)	0.0008	0.6198	0.7922	0.0014
Corr(ε_1,ε_2)	-0.0804	0.1479	0.0303	-0.0009
Corr(α_1,α_2)	-0.0471	-0.0763	-0.1332	0.2419

Notes: (1)Significance at 5% and 10% levels are indicated by (**) and (*), respectively;
(2)Numbers in parentheses are standard deviations of the estimated parameters.

Findings for the female ratio also exhibit variation across industries. Female ratio has a direct impact on participation decision in two of the four industries. In particular, we find that an increase in female ratio increases the likelihood of participation in Textiles and Industrial Chemicals. The indirect effect of female ratio is observed only in Other Chemicals where an increase in female ratio reduces the likelihood of exporting by decreasing plant efficiency.

The rest of the results are similar to those that are reported in Clerides et. all. (1999). First, there is no evidence indicating that participation in export activity increases plant efficiency. Turning to a brief discussion of the remaining variables, in the participation equation we find that participation history matters, supporting the basic premise of the hysteresis literature. The finding suggests the presence of substantial sunk costs in entering or exiting the export market. Higher stock of real capital significantly increases the likelihood of participation in all the four industries. An interpretation of this finding in the literature is that export shipments have fixed costs and the ability to produce large batches increases the ability to spread these costs, other things being equal.

In general, we find that plants with lower average variable costs are more likely to participate in export activity (when the coefficients on the distributed lag coefficients are added). However, perhaps due to high collinearity between individual lags, they are not generally significant. Age increases participation in Textiles and in Industrial Chemicals. In Textiles, for example, the estimated parameters evaluated at the sample mean suggest that as age increases beyond seven years, plants are more likely to participate in export activity. The positive impact of the business type variable indicates that plants with corporate ownership are more likely to be exporters. Finally, devaluation of real exchange rate increases the probability of exporting statistically in all the industries except in Other Chemicals, where the impact is not statistically significant. In the cost equation, increased size, measured by capital, decreases efficiency in Clothing, but increases in Other Chemicals. Lagged values of costs are significant and positive, indicating some degree of persistence in efficiency in all industries. In Textiles age enters significantly, but age squared does not, suggesting that older plants are more efficient. In other industries age does not have an impact on plant efficiency. Lagged participation is found significant and positive in Clothing but not statistically significant in other industries.

5. A Discussion of the Results

In this paper we investigate linkages between exporting and worker composition, measured by fraction of unskilled workers, and fraction of females. Summarizing our findings on unskilled ratio, we observe that participation in export activity reduces the contemporaneous unskilled ratio. We also observe that during the period there is an important decline in unskilled worker ratio. A decomposition of this decline into export classes indicates that exporters and entrants primarily drive the decline. The decline within those classes in turn is primarily driven by a decline within plants. The decomposition results are similar when we replace export categories with industry as categories.

Our findings are interesting in the context of a the debate on rise in demand for skilled workers due to a skill-biased technological change versus due to shift of demand to goods which use skilled labor more intensively. The finding that the change is primarily due to changes arising within plants suggests that the decrease in unskilled ratio is due to within plant technology upgrading. The fact that this is observed more strikingly for exporters and entrants highlights the presence of strong linkages between exporting and technological change.

We next investigate the impact of unskilled ratio on the decision of a firm to participate in export activity in the subsequent period. In an attempt to provide and answer to this question we use a framework where export participation decision and possibility of learning by exporting as firms become more efficient after they enter export markets are modeled jointly. Into this framework we introduce the idea that fixed cost of exporting can be expressed as a function of worker composition. Our estimations show that unskilled ratio decreases efficiency (in the sense that it increases average cost). Furthermore, higher unskilled ratio makes export participation less likely in the subsequent year. One interpretation of this result is that breaking into foreign markets require new product design or other types of technical assistance.

The findings regarding the female ratio are interesting yet more difficult to interpret. We don’t observe any link between contemporaneous female ratio and exporting. In the whole sample we observe a slight increase in female share, hiding more significant increases in some industries while the ratio declined in others. The decomposition analysis also indicates considerable variation across industries in terms of the sources of the change. We find that an increase in female ratio increases the likelihood of becoming an exporter in two industries, after controlling for the skill mix. One interpretation of this finding is that women are more “skilled” in certain jobs (such as embroidery), which is not captured with the typical definition of “skilled” jobs. Another possible interpretation is that becoming an exporter in this industry requires a larger share of office/ bureau workers, which are classified as skilled jobs, and again these are what are typically considered as women’s jobs, controlling for their “skill” requirements”. A third interpretation might be “docility”. Women workers might be “better suited” for subservient positions in highly demanding and competitive work environments, or for jobs that require more “flexibility”.

While these may explain why exporting firms may need women workers more than men, one still has to take account of the fact that we do not observe the relationship in contemporaneous data. This can be explained by presence of adjustment costs. One explanation for the adjustment costs could be a sense of culture within plants. It is likely that higher female concentration present a different set of demands on the plant organization, such as handling special problems of working females or a different mind-set of foreman, making this ratio sticky across plants. There may also be supply side factors such as women preferring to work at places where there is already a high concentration of women. We present these interpretations only as possible explanations for the economic importance of the female ratio. None of these are easily testable with the available quantitative data.

We conclude this paper by pointing an important area of future research. Most studies on trade and labor markets ask how trade policy, or changes in trade performance, influence labor markets. Our study indicates that a plant’s worker composition is an important determinant of its subsequent export participation. Hence, modeling export participation decision jointly with hiring firing decisions, and basing empirical work on this consideration appears to be needed. In addition, our study finds significant impact of female ratio on export participation decision, even after controlling for traditional skill measures. In the discussion of these results, we provided some potential interpretations. Needless to say, more work is needed to uncover the source of this impact.

Appendix: Plant Classification Algorithm for the Decomposition Analysis

The first step in the classification is to separate the plants that obviously fall into 4 distinct categories. Thus, if a plant has

1. Never exported in the sample period, it is in non-exporter category
2. Always exported, it is in exporter category
3. Changed exported status only once,
    - 3a. And started as non-exporter, it is in entrant category
    - 3b. And started as exporter, it is in quitter category.

In the second step, the rest of the firms are investigated to see whether they match in one of these categories. Note that the remaining firms have export status changed more than once. The following rules are applied sequentially, that is, a rule is applied if the previous did not classify the firm. Let N be the number of years that these firms are exported within 9 years.

4. If export status changed more than once,
    - 4a. If N = 8, exporter
    - 4b. If N = 1, non-exporter
    - 4c. If exported in N-1 of the last N years, entrant
    - 4d. If exported in N-1 of first N years, quitter
    - 4e. If N=7, and exported in the first and last years, exporter
    - 4f. If N=2, and not exported in the first and last years, non-exporter

All remaining firms are left as unclassified.

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