Offshoring and Firm-Level Task Composition: Is There a Gender Component?*

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1. Introduction

Recent work has emphasized the effect of trade in intermediate inputs on plant productivity (Amiti and Konings 2007), plant average wages (Amiti and Davis 2012), and product variety (Goldberg, Khandelwhal, Pavcnik, and Topalova 2010). Meanwhile, other work suggests that trade liberalization may help to increase the efficient matching of workers to firms, allowing for an additional source of gains from trade (see Davidson, Heyman, Matusz, Sjöholm, and Zhu (2010) and Krishna, Poole, and Senses (2011)). In this paper, we consider the implications of increased trade by foreign-owned firms (as a strong proxy for offshoring) on the reallocation of tasks within firms. Specifically, we empirically evaluate the impact of an exogenous shock to a firm's openness on its relative demand for productive tasks. Recent models of outsourcing (Feenstra and Hanson 1997, 1999) and tasks (Grossman and Rossi-Hansberg 2008) imply that outsourcing tasks to lower wage countries can enhance firm efficiency. An interesting question then is: what types of tasks are outsourced?

Similar to Hummels, Jørgensen, Munch, and Xiang (2011), we move beyond the common skill (non-production/production; college/high school) focus and analyze the organization of

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tasks (i.e., occupations) within the firm. We extend the analysis in Hummels, *et al* (2011) in two respects. First, we consider the differential implications of globalization on the gender composition of task reallocations. Second, we look at firms in an industrializing country, which is also a large recipient of the production processes offshored from rich countries. To our knowledge, the literature has largely neglected the effects of trade liberalization on the firm's gender structure, with the exception of papers investigating the impact of trade on the gender wage gap (e.g., Black and Brainerd (2004), Aguayo-Tellez, Airola, Juhn, and Villegas-Sanchez (2012), and Klein, Moser, and Urban (2010)). Our work also contributes to a growing literature on the implications of offshoring with our focus on Brazil, a country with large inflows of offshorable tasks and foreign direct investment. Earlier work, as mentioned above, has focused mainly on rich offshoring countries (e.g., Hummels, *et al.* (2011) for Denmark and Becker, Ekholm, and Muendler (forthcoming) for Germany).

We take a point of view that is complementary to Peri and Sparber (2009) and Ottaviano, Peri, and Wright (forthcoming) which consider the offshoring of tasks from the perspective of developed countries. By focusing on Brazil, this paper analyzes the types of tasks which are demanded in firms in developing countries with increased openness. On the one hand, manual tasks may be easier to offshore from high- to low-wage countries and hence increased openness may bring higher demand for manual task intensity in Brazilian firms. This would also imply an advantage for male workers, typically enjoying comparative advantages in manual and strength-based tasks, relative to women. Such "brain versus brawn" hypotheses have been analyzed in Rendall (2010) and Black and Spitz-Oener (2010), as well as in Juhn, Ujhelyi, and Villegas-Sanchez (2012) in the context of globalization. On the other hand, the improvements in technology associated with trade and foreign investment may be skill-biased (more precisely,

cognitive-skill biased), a finding documented in Csillag and Koren (2011), Amiti and Cameron (2012), and Burstein, Cravino, and Vogel (forthcoming). This implies a shift in demand towards cognitive tasks in more open firms, an advantage for women and more educated workers who typically have the comparative advantage in these tasks.

Is there a gender component to changes in firms' task composition in response to offshoring? We explore these issues empirically using detailed matched employer-employee data from Brazil, covering a period of substantial increases in foreign investment and exports. The data allow us to trace individually-identifiable workers over time and across employers and contains detailed information on individual characteristics such as gender, age, education, occupation, and tenure at the firm. We then match these administrative data to records from the Brazilian Customs Office on firm-level export transactions by product and destination to measure changes in a firm's exposure to global markets.[1] It is likely that, especially for foreign-owned firms, a large part of the firm's exports correspond to production offshored from rich countries. Finally, we use a unique concordance between the Brazilian classification of occupations and the U.S. Department of Labor's O*NET database to assign a numerical index (between 0 and 1) capturing the importance of distinct "skills" and "activities" to each occupation. These skill indices allow us to construct a measure of "manual" tasks and of "cognitive" tasks used in each occupation and, within cognitive tasks, we distinguish between communication and analytical tasks. Using these measures, we calculate each firm's average task intensity across its workforce.[2]

[1] In unreported results available by request, we show that a firm's foreign ownership is positively associated with the firm's export status. Without direct measures of outsourcing, we rely on this relationship between exports and foreign investment for the analysis. Firms which become exporters and exporters which increase the total value of exports are associated with an increased probability of foreign ownership, as our measure of offshoring.

[2] We consider broad cognitive relative to manual task classifications, as in much of the earlier literature. We further refine these classifications to consider within-cognitive occupational structures (analytical relative to communication

Our analysis proceeds in two stages. First, we document in a descriptive analysis that female workers shifted (in their occupational composition) towards cognitive tasks and away from manual tasks over the 1990s. Meanwhile, male workers increased their relative supply of manual tasks during this period of globalization. Next, we ask whether increased openness is responsible for these changes in task supply across genders. Our main specification, therefore, relates changes in a firm's exposure to global markets to changes in the firm's occupational structure. As unobserved, firm-level productivity shocks may be associated with increased exports and firm-level workforce composition changes, we instrument for changes in the firm's openness with changes in import demand from the firm's export destinations for the firm's exported products. This strategy mirrors the strategy in Hummels, *et al* (2011) and Autor, Dorn, and Hanson (forthcoming), with an application to the firm's exports rather than to the firm's imports, given our focus on a low-wage country at the "receiving" end of offshoring from rich countries.

Our main findings show that an exogenous increase in a firm's openness increases the demand for cognitive relative to manual tasks within the firm. Given our descriptive findings, one could expect these firm-level changes to relatively benefit women post-globalization. However, we find no impact of trade shocks on the share of women employed in the firm. In fact, tests by gender suggest that the relative increase in cognitive tasks in response to openness is wholly driven by the male workforce. Importantly, however, this effect is no longer significant when we allow for other changes in the firm's workforce composition (e.g., the age, education, and experience profile of the firm). This implies that the increased demand of cognitive tasks due to globalization is likely met by upgrading the workforce of a firm to more educated and more

tasks), as well as within-manual occupational structures (precision-based tasks relative to other manual (e.g., strength-based) tasks).

experienced workers rather than changing its gender composition. We argue that these results are consistent with a model in which offshoring and increased openness are cognitive skill-biased in industrializing countries.

From a policy standpoint, our work therefore contributes to a better understanding of policy implications for "outsider" groups in the labor market, such as women. Notably, our results suggest that global integration is not a cure-all for gender inequality, as the World Bank recently hinted (World Bank 2011), as long as unequal access to education and to some specific occupations remains.

2. Gender, Tasks, and Openness

One goal of this paper is to uncover the impact of offshoring (and of openness to globalization, in general) on firm-level gender composition. We focus on an industrializing country with significant inflows of investments from foreign companies relocating portions of the production process during the sample period. As Brazilian firms export manually-produced intermediate inputs to richer countries, one could anticipate an increase in the demand for manual tasks by Brazilian workers and a relative decrease in the demand for cognitive tasks with increased openness. By contrast, if new technologies brought by the foreign-owned firms are skill-intensive and require intensive use of cognitive skills, relative to traditional domestic production, then openness would be associated with an increase in the demand for cognitive skills.

As women have the comparative advantage in cognitive skills relative to men, each of the above predictions has a different implication on the demand for workers by gender. However, changes in the demand for cognitive skills could also be satisfied by hiring workers with

different levels of education and experience with no impact on the firm's gender composition. Our analysis will explore these two issues.

Table 1 reports descriptive changes in aggregate task supply for men versus women over Brazil's main globalization period (Panel A). Across all workers, the relative supply of manual tasks increased by approximately 7.4 percent. This average change masks important differences across the genders over the sample period. Men experienced an 11.9 percent decrease in the relative supply of cognitive tasks, while women witnessed a 3.5 percent relative increase in the supply of cognitive tasks. Even within cognitive tasks, women differentially increased their supply of communication-based tasks relative to analytical-based cognitive tasks over the globalization period.

If globalization increased the demand for cognitive skills, the trends presented in Panel A of Table 1 suggest that women may have benefited from Brazil's global integration. We turn next to test this hypothesis directly. We begin with the following framework in mind:

$$y_{jt} = \beta_1 OPEN_{jt} + \beta_2 X_{jt} + \varphi_j + \delta_t + \varepsilon_{jt} \quad (1)$$

where y_{jt} denotes a specific characteristic of firm j's workforce in year t. We consider two possible outcomes. First, we use as dependent variable the share of female employment within the firm. Second, we consider the firm's relative task composition (e.g., cognitive/manual), such that our main coefficient of interest (β_1) illustrates the relationship between a firm's exposure to foreign markets ($OPEN_{jt}$) and firm-level workforce composition. Our main analysis controls for total firm employment (X_{jt}), as well as firm-level fixed effects (φ_j) to account for both observable and unobservable (time-invariant) firm characteristics associated with global integration, and time fixed effects (δ_t). Robust standard errors are clustered at the firm level in all analyses.

We measure the firm's openness to global markets as the value of exports across all products and destinations, denoted in logs. Descriptive statistics reported in Panel B of Table 1 document Brazil's integration into global markets over our sample period. The 1990s witnessed an 8 percentage point increase in the share of exporting firms and an over 500 percent increase in the value of exports among exporting firms. The literature on heterogeneous firms in international trade (pioneered by Melitz (2003)) has long recognized the systematic differences in productivity, skill-intensity, and size of exporting firms (Bernard, Jensen, and Schott 2009). To correct for productivity shocks associated with the firm's decision to increase exports and increase the skill-intensity of tasks, we instrument for the firm's log export value with firm-level import demand. We calculate these firm-specific shocks to exporting as follows:

$$IMP_{jt} = \sum_{kc} \omega_{jkc} * IMP_{kct}$$

where IMP_{kct} denotes country *c*'s imports of product *k* (at the 6-digit Harmonized System level) less the country's imports from Brazil in time *t*. We weight this import demand by the firm's initial exposure to country *c* in product *k*, $\omega_{jkc} = \frac{EXP_{jkc}}{\sum_{kc} EXPjkc}$. Here, EXP_{jkc} denotes firm *j*'s exports in product *k* to country *c* at the firm's first entry into export markets, such that ω_{jkc} describes the Brazilian firm's share of exports at first entry in product *k* to destination *c*. The instrument relies on the fact that, for instance, changes in the demand for iron ore in China impact the global exposure of firms with export sales initially concentrated in iron ore to China, but these same changes in import demand have no direct impact on the firm's workforce composition. Table 1 reports the changes in firm-level log import demand as roughly consistent with changes in firm-level log export sales.

Table 2 reports our main results for three different dependent variables: the firm's relative cognitive-manual task intensity (Panel A), the firm's relative analytical-communication task intensity (Panel B), and the firm's share of female employment (Panel C). Column 1 reports coefficients from the ordinary least squares estimation of equation (1). An increase in a firm's exposure to foreign markets is associated with an increase in the firm's relative demand for cognitive skills. Within cognitive tasks, firms increasing exports increase their reliance on communication-based cognitive tasks relative to analytical cognitive tasks. These findings are confirmed in column 2 when we instrument for the firm's openness with firm-specific import demand shocks.[3] These results are consistent with the theory that offshoring to developing countries is accompanied by skill-biased technologies that are particularly intensive in communication-based tasks.

This relative increase in demand for cognitive (over manual) and communication (over other analytical cognitive) tasks in response to the exogenous changes in trade openness should favor women who shifted towards more cognitive and communication-based tasks over this time period (as we document in Table 1). However, Panel C of Table 2 shows that openness has no statistical relationship with the share of female employment at the firm. Columns 3 and 4 of Table 2 test these ideas more directly by decomposing the firm's overall task intensity (across all workers) into tasks supplied by men in the firm and tasks supplied by women in the firm. These results further contrast the hypothesis that openness favors female employment. In fact, it is the male employees within the firm who experience a relative shift towards cognitive and communication-based tasks in response to the globalization shock.

[3] We note that firm-specific import demand is a strong instrument for firm export sales, as the *F-statistic* on the first-stage regression is over 700,000.

The literature on trade liberalization suggests that increases in foreign market access increases the firm's skill composition (e.g., Verhoogen (2008)). Our results confirm that the technology associated with increased openness is skill-biased (specifically cognitive skill-biased). The effects we document in columns 3 and 4 imply a differential response to the increased demand for cognitive tasks by the worker's gender. In the final two columns of Table 2, we include additional controls for observable changes in the age, education, and experience profile of the firm coincident with globalization. When we account for other compositional changes within the firm, the differential gender effect is no longer present. This is suggestive of a story in which globalization increases the relative demand for cognitive tasks and this is matched by an increase in the schooling and experience of mainly male workers employed in the firm. The gender dimension of the firm does not seem to play a role in the adjustment to these changes in skill demand.

3. Conclusions and Policy Implications

This paper evaluates the effect of increased openness of firms in Brazil on their relative demand for productive tasks. As manual-intensive production tasks are strongly associated with male workers, and if globalization increases the relative demand for cognitive tasks, increased openness may result in a larger demand for female workers. Our empirical analysis confirms the first hypothesis (i.e., that openness increases the relative demand for cognitive tasks) but not the second hypothesis (i.e., that globalization increases the demand for women). On the one hand, this means that globalization *per se* may not be an engine for the inclusion of women in the productive labor force in industrializing countries. On the other hand, the empirical results note that schooling may be a key determinant of cognitive skills and hence accessing education is still

a prerequisite to exploit the positive employment effects of globalization. Furthermore, our regressions also suggest that the male workforce may be responding more quickly than female workers when adjusting observable skills in order to meet the demand for cognitive abilities. One may think that social norms and possibly discrimination may be reducing the ability of women to enhance their skills (via formal education) in order to best take advantage of the job opportunities brought about by globalization. More research is needed in this direction.

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Table 1: Descriptive Statistics, Changes 1990-2001

PANEL A: Gender and Average Task Composition			
	All Workers	Male Workers	Female Workers
Cognitive/Manual	-0.074	-0.119	0.035
Analytical/Communication	-0.002	0.044	-0.116
PANEL B: Openness			
	All Firms	Exporters	
Share of Exporters	0.083		
Log (Export Value)	1.293	5.244	
Log (World Import Demand)		7.177	

Source: Authors' calculations based on RAIS, SECEX, and O*NET (1990-2001).

Table 2: Openness and Task Composition, 1990-2001

	Exporters, All Workers	Exporters, All Workers	Exporters, Male Workers	Exporters, Female Workers	Exporters, Male Workers	Exporters, Female Workers
	OLS	IV	IV	IV	IV	IV
	PANEL A: Cognitive/Manual					
Log (Export Value)	0.002**	0.002*	0.002**	0.0003	0.001	-0.0003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	PANEL B: Analytical/Communication					
Log (Export Value)	-0.002***	-0.002**	-0.002*	-0.0001	-0.001	0.0003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	PANEL C: Share of Female Employed					
Log (Export Value)	0.0002	0.0001	0.0001	0.0003	0.000**	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of Obs.	108,951	108,951	91,292	45,371	91,292	45,371
Size Control	YES	YES	YES	YES	YES	YES
Additional Firm-Year	NO	NO	NO	NO	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Firm Fixed Effects	YES	YES	YES	YES	YES	YES

Source: Authors' calculations based on RAIS, SECEX, and O*NET (1990-2001).