Female Labor in Egyptian Manufacturing Sector: The Demand Side Story

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1- Introduction

Recently there has been a common agreement that women integration both economically and politically is fundamental for economic growth and development particularly in developing nations. Labor market outcomes related to females including Female Labor Force Participation (FLFP), employment rates and wages together with access to education are considered to be main channels through which women are integrated in the economy. At the economic front, and via its role in enhancing women's relative economic status female inclusion in the labor market is critical for the country's economic efficiency. While at the social front, sluggishness of FLFP affects negatively women's bargaining power and hence her empowerment. This is prevents women from reaping full benefits of economic growth achieved at the macro level, reflecting negatively on womens' and children's health and well being (Ackah et al., 2009 and Klasen and Pieters, 2013).

Accordingly, the concern with the female access to employment, and education, arises from the concern with the resource mobility and capacity utilisation. If women are constrained from participating in the labour market, efficient use of resources is not achieved. This issue is of most importance to the Middle East in general and Egypt in specific due to the exceptionally low participation rates of females as well as their high unemployment rates.

Compared to the world average of 52%, labor force participation rate for Egyptian women is very low ranging between 20% and 25% through out the 2000s, (Center for Economic and Social Rights, 2013). Moreover while women represent only 23% of the labor force their unemployment rate increased from 23.7% in 2006 to 27.6% in 2012 (Assaad and Kraft 2013). In addition, women constitute very low share in the wage non-agriculture employment. Finally around half of the women in the labor force are employed in the informal sector under poor working conditions and relatively low wages (UNDP and Ministry of Economic Development 2010).

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Meanwhile recently women witnessed significant progress in their education status in Egypt. The gross enrolment ratio in secondary education reached 85,86% in 2014 (WDI). Literacy rates for adult females aged 15 years and above increased to 67.18% in 2013 compared to 30.8% in 2005. Moreover primary completion rate of females as a present from relevant group reached 104.27 % in 2013. However, the majority of the unemployed women are educated (94 % of unemployed women reached secondary level in 2012) and after leaving school, 70 % of women are out of the labor force and 15 % are unemployed.

This high and rising education attainment together with the delayed marriage among the young females in Egypt were expected to raise the chances of female participation in the labour market na decreases their unemployment rates. However, unemployment and inactivity rates among females remain high (Assaad and Krafft 2015a).

The high unemployment and inactivity rates among females are considered to be one of the most important challenges facing Egypt today. On one side this could be attributed to supply side factors related to why Egyptian females choose to withdraw from the labour market including individual characteristics, household socioeconomic characteristics as well as norms and traditions shaping gender roles in the society. On the other side it could be explained by demand side factors related to employers choices and preferences of males versus females or visa versa including firm specific characteristics industry level characteristics, as well as institutions and macroeconomic environment.

Most of the empirical literature addressing Labor markets outcome related to females in Egypt focused on the supply side factors (Assaad and El-Hamidi 2001 and 2002; El-Hamidi 2003; Assaad 2000; 2002 and 2004; Hendy 2011; Nazier and Ramadan 2016) while demand side factors are left unleashed mainly due to data unavailability. Accordingly, Female labor market outcomes in Egypt has for long been regarded as a supply-side issue, this paper however aims to fill this gap in the Egyptian literature on the demand-side issue taking advantage of the newly available Economic Census 2013 data. Accordingly the analysis aims to examine main determinants of female labour demand in Egypt.

2- Theoretical background and Literature Review

The economic theory states that demand for labor is a derived demand from demand for goods and services it produces. Moreover, demand for labor is treated as any other demand model in the economic literature; with a measure of labor demanded as the dependent variable and a set of key

determinants as the independent variables (Bashier and Wahban 2013). On the theoretical front, we can distinguish between static and dynamic labor demand models. The current paper falls under the static demand models.

Static labor demand models investigate the long-run effects of an exogenous shock, i.e. the outcome in the labor market after the adjustment process has been fully fulfilled. Hence it does not consider the existence of adjustment costs and is not capable of analysing the path of employment towards the equilibrium (Lichter et al. 2012). The standard form of the static labor demand theory reflects how employers decide on the quantity of labor used in production and how these quantities response to marginal changes in product demand and factor prices. It is basically a branch of production theory, that study the mechanism through which product market shocks and shocks to prices in input markets transmit to employment and wages. Where the structure of production is a crucial component of this transmission mechanism. Accordingly, most progress achieved simply reflects progress made in production theory (Addison et al. 2014).

To derive labor demand equations the labor demand theory starts with is a representative profit-maximizing (cost minimizing) firm that can change the amount of the labor used in production without bearing extra cost. Through solving the firm optimization problem in the long run the conditional and unconditional demand functions are derived. This implies identifying the production function and assumes strictly increasing and strictly concave functions. In this context, different specifications have been used advancing from the standard Cobb-Douglas production function, through CES, to generalized Leontief or translog functions. The estimated labor demand function is then used to estimate labor demand elasticity and the elasticities of substitution between different inputs (Addison et al. 2014).

A review of the international empirical literature reveals that in contrast to the short-run dynamic analysis, there has been many studies estimating long- run labor demand

While for Egypt, there exists a relatively huge literature that provides both theoretical and empirical investigation and explanation of employment, unemployment and their determinants in general and for females in specific (Assaad 2008; Assaad et al. 2000; Awad 2003; El Ehwany and El-Laithy 2000; El-Megharbel 2007; Fawzy 2002; Nassar, 2011 and Radwan 2002; Ibrahim 2013; Atta and Shehata 2008; Hassan and Sassanpour 2008; Dessus and suwa-Eisenmann 1999; Assaad and El-Hamidi 2001 and 2002; El-Hamidi 2003; Assaad 2000; 2002 and 2004; Hendy 2011 and Nazier and Ramadan 2016). However these studies are either macro studies that use national time

series or sector (industry) level data or uses micro level data that is mainly obtained from labor or household surveys and hence they address supply side females employment and its determinant.

Accordingly, labor demand in general and females labor demand in specific is a rather neglected topic in empirical labor economics literature in Egypt. This could be mainly due to a lack of micro data describing establishments. To our knowledge no documented empirical study at the micro level of disaggregation -using firm-level data- in Egypt exists.

In this context, the main aim of this study is to fill in this gap in the Egyptian literature on the demand-side issue taking advantage of the newly available Economic Census 2013 data. Accordingly the analysis aims to examine main determinants of females' labor demand in Egypt.

3 - Conceptual Framework and Methodology

this study utilize a model based on a labor demand equation that is obtained from the firm's cost minimization problem. It follows standard practice and adopts the dual approach and minimizing problem under a constant output (Hamermesh 1993; Litcher et al. 2012). Accordingly, the econometric model underlying the estimation of the female labor demand is based on the assumption of cost-minimizing firms and a Hicks-neutral Cobb-Douglas demand function for the representative firm *i* in sector j*:*

$$Y_{ij} = A^{\gamma} L_{ij}^{\alpha} K_{ij}^{\beta} \qquad (1)$$

Where Y denotes real output, A is total factor productivity; K is capital stock; L is units of labor employed; α and β denote the factor share coefficients and γ represents the increase in efficiency in the production process.

Correspondingly $\mathrm{MP_L} = \frac{\partial \mathrm{Y}}{\partial \mathrm{L}} = \mathrm{A}^{\gamma}\alpha\frac{\mathrm{Y}}{\mathrm{L}}$ is the marginal product for labor while $\mathrm{MP_K} = \frac{\partial \mathrm{Y}}{\partial \mathrm{K}} = \mathrm{A}^{\gamma}\alpha\frac{\mathrm{Y}}{\mathrm{LK}}$ is the marginal product for capital. labor and capital is utilised by A profit-maximizing firm that that the marginal product of each factor equal its return i.e. MP for labor equals the wage (w) and the MP of capital equals its user cost (r).

Solving this system simultaneously and taking natural logarithm and manipulation, the firm's demand for labor can be written as follows

$$l_{ij} = \lambda_0 + \lambda_1 y_{ij} + \lambda_2 w_{ij} + \lambda_3 k_j \qquad (2)$$

Where lower letters indicates logarithmic values. By definition λ_1 is the output elasticity of labor demand and λ_2 is the wage elasticity of labor demand.

Estimation:

The study examines labor demand for females versus males. Thus adding subscript *f* indicating females and adding a disturbance term ε to equation (2) the labor demand equation for female estimated is specified in equations 3:

$$l_{fij} = \lambda_{f0} + \lambda_{f1} y_{ij} + \lambda_{f2} w_{fij} + \lambda_{f3} w_{mij} + \lambda_{f4} k_j + \beta_{Zf} Z + \beta_{fIND} IND + \beta_{fGOV} GOV + \varepsilon_{fij} \quad (3)$$

Labor demand in a firm is expected to depend on firm-specific characteristics. Variables included in the regression at the firm level are:

1. Formality,
2. Firm size and age,
3. Rate of capacity utilization,
4. Legal form,
5. Dummy for whether the firm export or not,
6. Capital labor ratio
7. Share of male workers
8. Share of workers in each occupation by gender.

Thus, equation (2) is augmented by adding vector Z including firm specific effects to examine effect of firm-specific characteristics on Labor demand.

Moreover, industry characteristics are expected to affect Labor absorption in each firm. As firms in different industries usually operate under different technologies this may result in varied labor demands. For example, employment generation could be higher in labor- intensive industries than in resource-intensive ones. Assuming that this is a source of industry-specific differences industry dummies IND for two digit industries are included in our analysis as an explanatory variable.

Finally in the case of demand for female labor the social context is an important determinant of employer preferences for females versus males or visa versa. To account for that vector GOV including three governorate level variables in addition to governorates dummies is added.

Adding these set of variables to equation (2) results in the full empirical model in (3) and (4) examining determinants of female labor demand and occupational groups labor demand respectively that will be used in this proposed study. Variable definition and construction are reported in appendix 1.

This empirical model specification has several estimation issues that are worth noting. **First**, our main data source is the Egyptian Economic census 2013 "C13". While this set of data provide wage disaggregated by occupational groups it does not include wages classified by gender. Yet our estimation model for female labor demand needs wages for females by firm. Thus this study uses a two-stage estimation technique to estimates female wage per firm [1]. This technique permits combining comprehensive wage information available from the ELMPS 2012, with the information available from the C13. The two-stage approach combines the ELMPS 2012 with the C13 to estimate female wages by firm for the C13 sample. This usually comprise the following three steps:

1- Identifying firm characteristics available in the ELMPS2012 and the C13

In this stage the ELMPS2012 and the C13 questionnaires were compared to identify common firm variables found in the two datasets. This was not a major limitation on the analysis, because the two data sets include a fair number of common variables like location, industry, occupation, sector...etc.., The choice of the set of explanatory variables included is based on a careful review of the wage literature as well as an in-depth investigation of the correlation between the common set of explanatory variables and the wage measures. Variables included were: Firm size, share of female workers, sector, and industry and governorate dummies.

2. Estimating female wage using the ELMPS2012 data

This is the first step of the two-step estimation technique. The ELMPS2012 is used to estimate wages by gender for individual female/male i as a function of the common set of firm j characteristics where she/he works chosen in the pervious step. A log-linear function of wages per female/male, w_{fij}, is estimated as follows

$$\ln w_{fij} = X_j'\beta + \eta_{fij} \qquad (4)$$

Where X_j is a vector of characteristics of firm j where individual i works; and $\eta_{fij}$is a disturbance term that is distributed as N(0, σ^2). Moreover bootstrap was performed to correct the standard deviation.

[1] This methodology is inspired by statistical modelling in the area of poverty mapping. It is a recently developed methodology, which permits the imputation of consumption and welfare indicators from one survey, into another survey. Specifically, income data in one survey is combined with demographic and household data available in another survey in order to derive statistically reliable estimates of poverty and inequality (Elbers et al., 2003). In this paper a similar methodology is adopted but to drive wage data missing in the C13 using available wage and employment characteristics related to the firm in the ELMPS 2012.

3. Predicting wages by gender per firm for the C13 sample

This stage uses the estimated coefficients of the regression models in the previous step and the C13 data to predict wage rate per female/male by firm in the C13 data $\widehat{w}_{fij}$.

Second, product demand shocks are expected to change labor demand for an industry in the same direction. Thus, estimating labor demand equation without controlling for these shocks would lead to biased estimates. This study attempts to control for this by estimating conditional labor demand functions. Including output in the conditional labor demand functions is expected to account for at least a part of the product demand shocks hence reducing the biasness (Hasan et al. 2007 and Fajnzylber and Maloney 2005, Nazier 2013).

Third, endogeniety of wages is one identification problem in estimating equation (5). Both labor demand and labor supply depends on real wage thus shocks to the labor demand affect wages. Hence, the wage and the disturbance term in the estimated labor demand equation could be correlated this may lead to biased estimates. In order to be able to consider parameters of equation (3) as parameters of the labor demand function, we assume that wages are exogenous i.e. labor supply at the unit of analysis which is the firm is perfectly elastic, so that shocks to the labor demand do not affect wages. Although this seems as a strong assumption it could be defended based on two theoretical arguments. First, according to Nickell and Symons (1990) since labor supply and demand depends on two quite different real wages thus the identification problem does not exist. On one side, firm uses the industry's output price to measures productivity thus labor demand depends on nominal wages deflated by the producer price. On the other side, what consumers care about is their real income given their overall consumption basket hence labor supply depends on nominal wages deflated by the consumer price index (Akhter and Ali 2007 and Slaughter 2001). Second, Hammermesh (1993) pointed out that the appropriateness of this assumption depends on the degree of disaggregation of the data. Usually individual firms choose employment at a given exogenous wages therefore they face perfectly elastic labor supplies. While, the economy as a whole chooses wages according to given exogenous quantities; thus, it faces almost perfectly inelastic labor supply. Given that the data used in this study is at the firm level their labor supply schedule, is thus closer to perfectly elastic than perfectly inelastic.

4- Data

The present study makes use of two data sets. First, the Egypt Economic Census 2013 "C13" conducted by CAPMAS is the main data source for this proposed study. It was conducted in Egypt in 2013 with questions referring to 2012. We have access to 50% sample of the data, which

contains 62,108 enterprises. A main advantage of this data is that it contains very detailed information on establishments at a nationally representative level. For example, for each firm we have information on firm characteristics like age, legal form, including foreign ownership, gender participation, access to finance, annual sales, costs of inputs and labor disaggregated by type, associated wages, in-kind benefits for all enterprises that hire outside labor and number of owners/unpaid workers by type. The data also include information on trade as captured by amount of production exported and Intermediate inputs both domestic and imported, capacity utilization, as well as informality based on either "keeping regular accounting books" "having a commercial registration number" or "contributing to social insurance fund. Hence it provides data for firm level factors that is expected to affect demand for labor.

Second, the Egyptian Labor Market Panel Survey 2012 "ELMPS 2012" conducted by the Economic Research Forum (ERF) in cooperation with CAPMAS. It is third round of a periodic longitudinal survey that tracks the labor market and demographic characteristics of households and individuals in 2006 and 1998. It provides detailed information on the individual education, employment status and employment characteristics, time allocation, job mobility, wages, parental background, household characteristics and household enterprises. This data set is used to complement the C13. It is used to predict the female wages by firm as illustrated in the methodology section above. It is also used to obtain the governorate level variables included in vector GOV to capture social context and to enrich the available information on the specific characteristics of females.

The study focuses on 12476 firms in the manufacturing sector (Table 2) with an average age of 11.5 years. The average number of workers per firm is 6 workers while the maximum number is 11130 workers. The average share of females employed is 3.6% per firm. While for males it is 96.4%. Average real hourly wages for females is less than that of males; moreover the variation for females is higher than for males. In addition while the maximum wage rate is higher for females the minimum wage rate is lower for females indicating that for the minimum females earn relatively less. The average rate of capacity utilization is 23.9%.

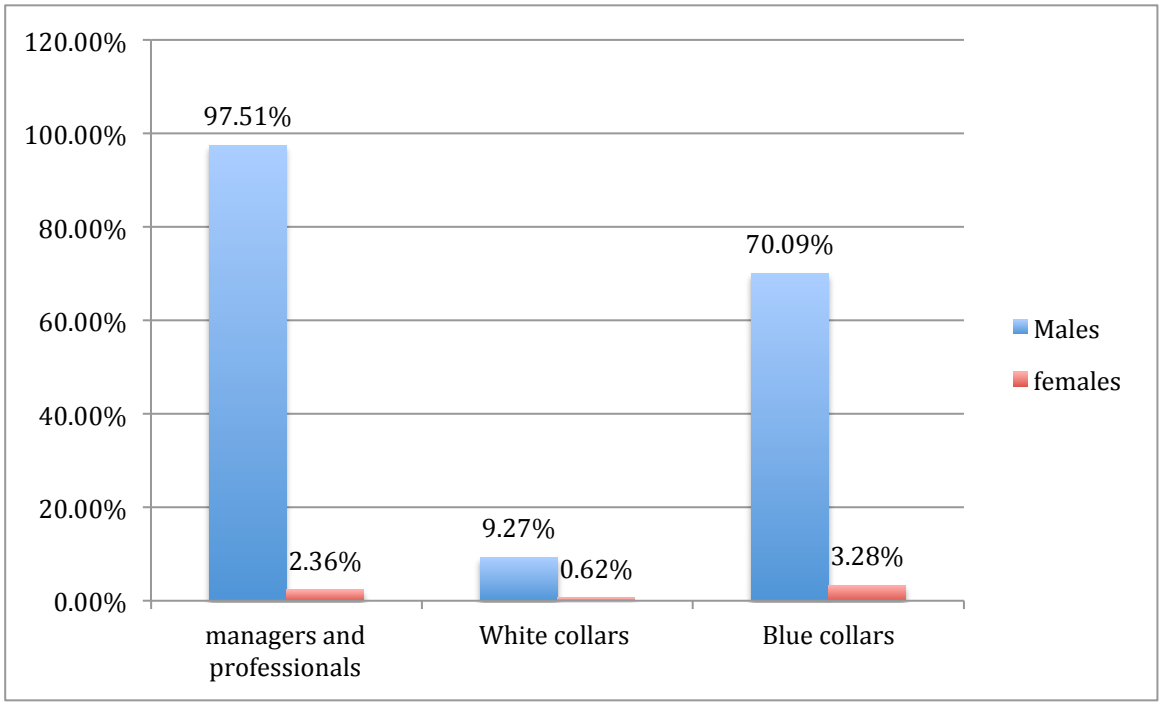
Table 1: Sample Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Share of Female workers	0.0356	0.1377	0.0000	1.0000
Log value added	10.6509	1.2895	4.4659	25.0919
Log Real Capital	9.7214	1.9305	0.0000	22.1854

Female hourly wage	1.0796	0.6691	0.0035	3.8114
Male hourly wage	1.3439	0.2171	0.2976	2.6193
Firm age	11.5714	12.0131	0.0000	113.0000
Capital Labor Ratio	8.7375	1.6278	0.0000	16.5126
Rate of Capacity utilization	23.9609	33.3316	0.0000	99.0000
Share of male workers	0.9644	0.1377	0.0000	1.0000
Total Number of workers	6.2357	67.3988	1.0000	11130
Observations		**12476**		

Figure 1 shows the average share of females and males by occupation per firm, males exceeds females in all occupations.

Figure 1: Average share of males and females from total workers in each occupation per firm



As commonly known the majority of firms are informal[1] (about 83.9%), small sized of 1-3 employees (69.3%), does not export during the survey period (99.74%), individually owned (85.87%) and age less than 50 years (figure 2).

Figure 2: Sample Distribution according to different firm characteristics (%)

[1] We consider the firm to be formal if it holds accounting statement or reported a commercial Registration-License number or both.

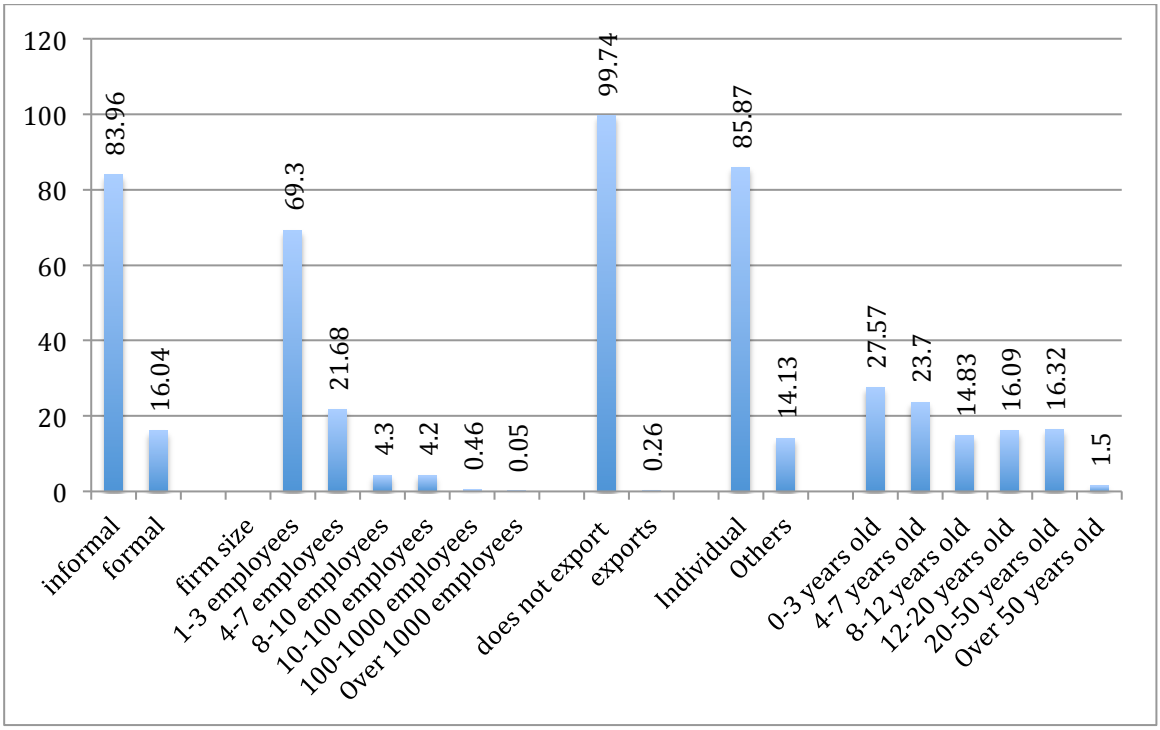


Figure 3 shows that in average the share of employed females from total firm employment is higher for formal firms, if the firm exports, the larger the firm size, for non individual owned firms and for young (0-3) years old firms and old firms (over 50 years old).

Figure 3: Average Share of Female Workers per firm by firm characteristics

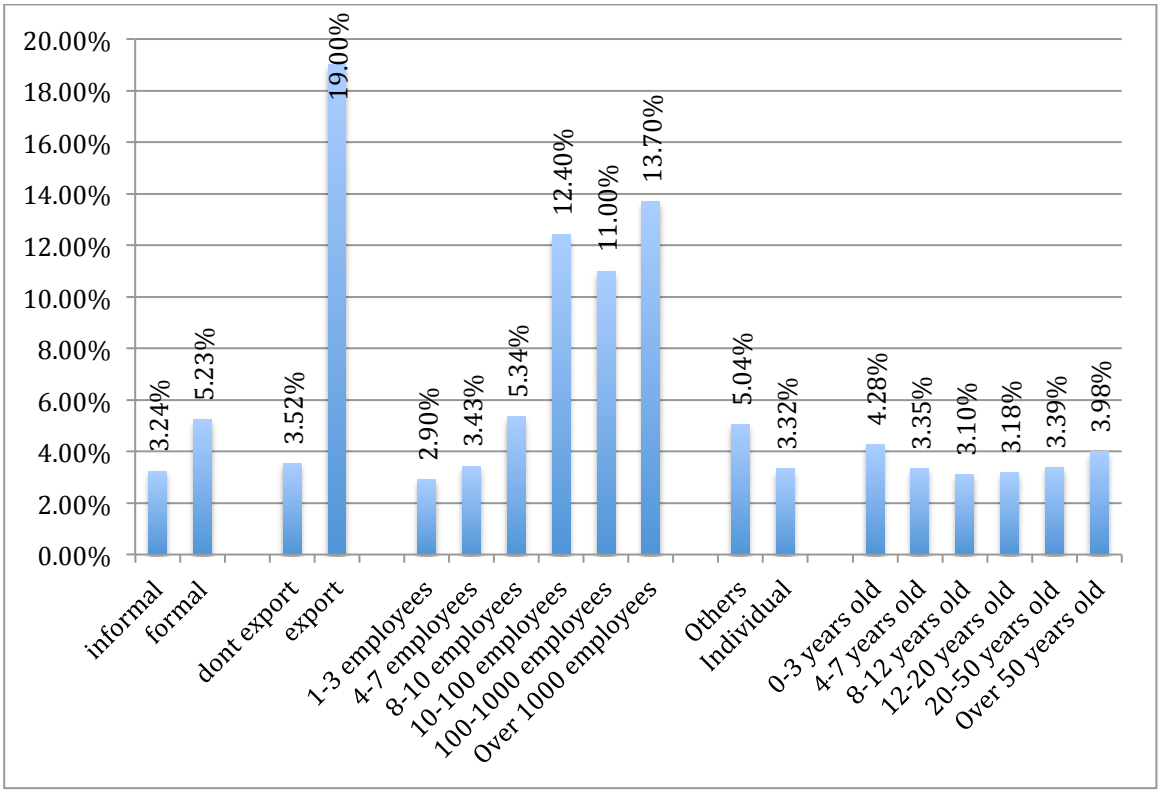


Figure 4 shows a negative association between the share of females from total firm's worker and females' wage rate and a positive association with males' wage rate suggesting that males and females labor are substitutes.

Figure 4: Share of female workers and females wage rates

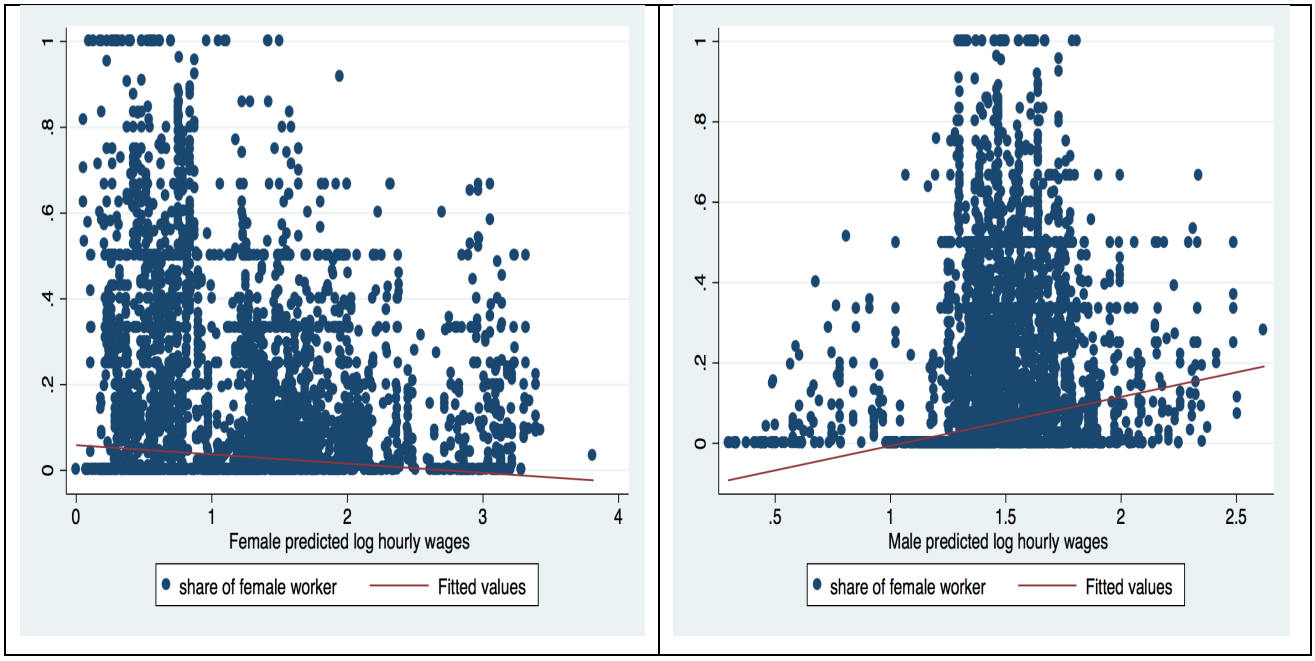


Figure 5 shows noticeable variation in the average ratio of female workers per firm by governorate. The ratio is higher in Lower Egypt governorates. Ismailia has the maximum ratio of 35.9%, followed by Port Said, Gharbia and Kaliobeya.

Figure 5: Ratio of female workers by governorates

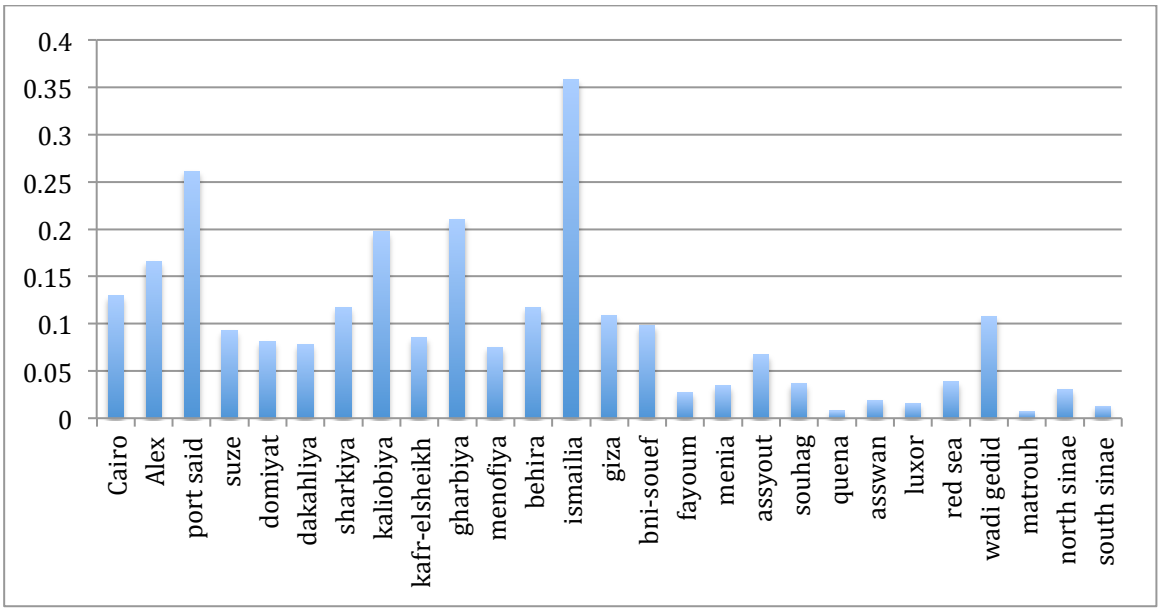
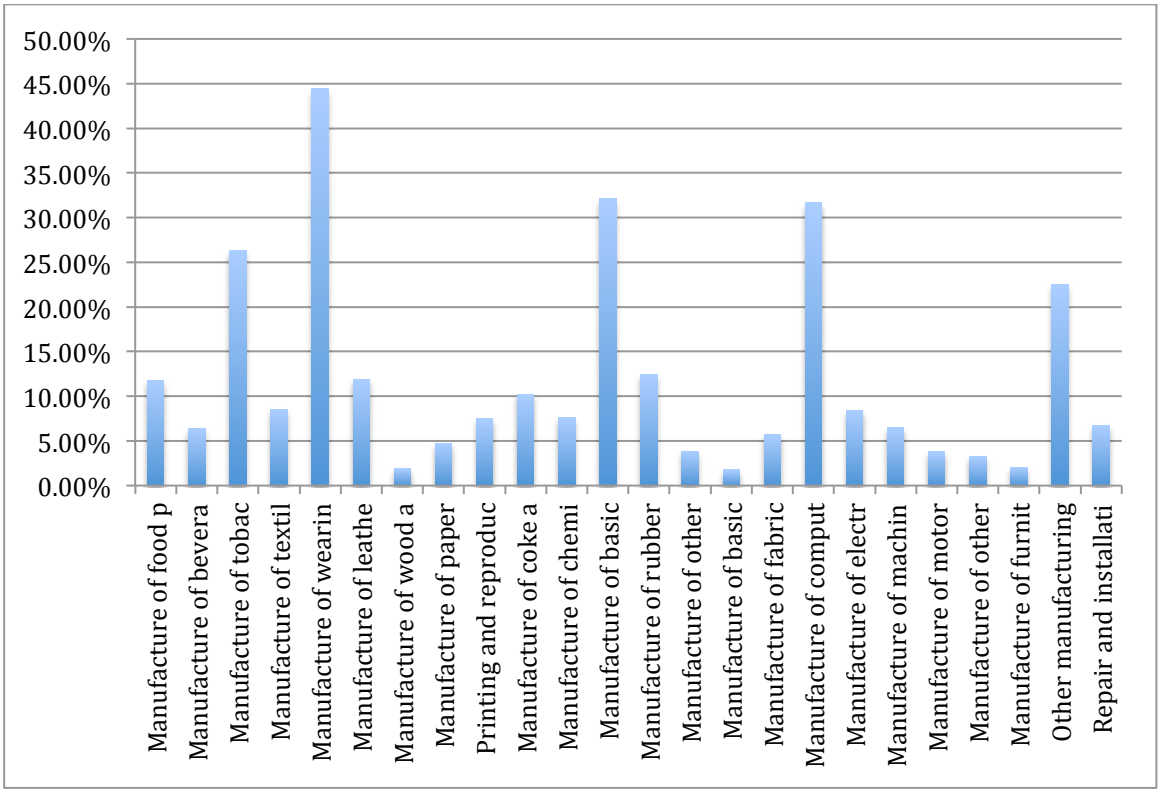


Figure 6 shows the percent of female workers by industry from total industry workers. The differences in the distribution of females among industries are remarkable. Manufacture of wearing apparel has the maximum value, followed by Manufacture of basic pharmaceutical products and pharmaceutical preparations, Manufacture of computer, electronic and optical products. While Manufacture of basic metals has the lowest value. This may suggest that female's share is higher in high tech industries.

Figure 6: Percent of female workers by industry from total industry workers



Looking at female employment in different industries according to the degree of technological intensity. I followed the classification of industries proposed by Eurostat that classified the industries in the manufacturing sector according to the technological intensity into four main groups: High technology (HT), Medium High technology (MHT) and Low technology (LT) and Medium low technology (MLT)[1]. Figure 7 confirmes that the percent of female workers by industry from total industry workers is highest in the high-technology HT industries group followed by the low-technology LT group. Moreover the difference is noticeable as it is almost higher 3 times in the HT group compared to the LT group.

[1] Details of the aggregation are available in Appendix 1.

Figure 7: Percent of female workers by industry from total industry workers according to technological intensity of the industry

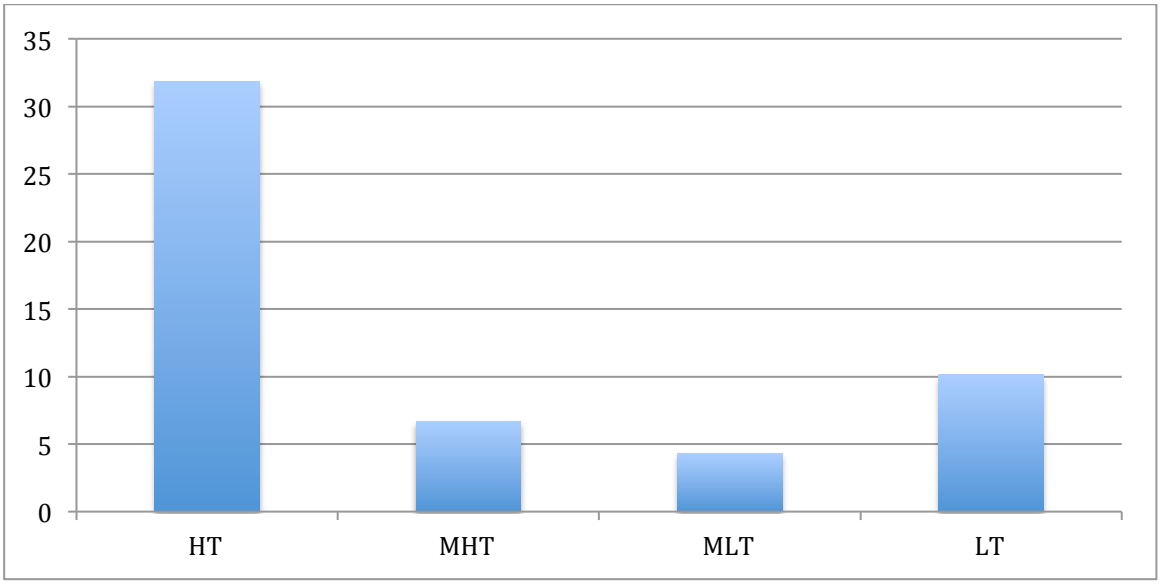
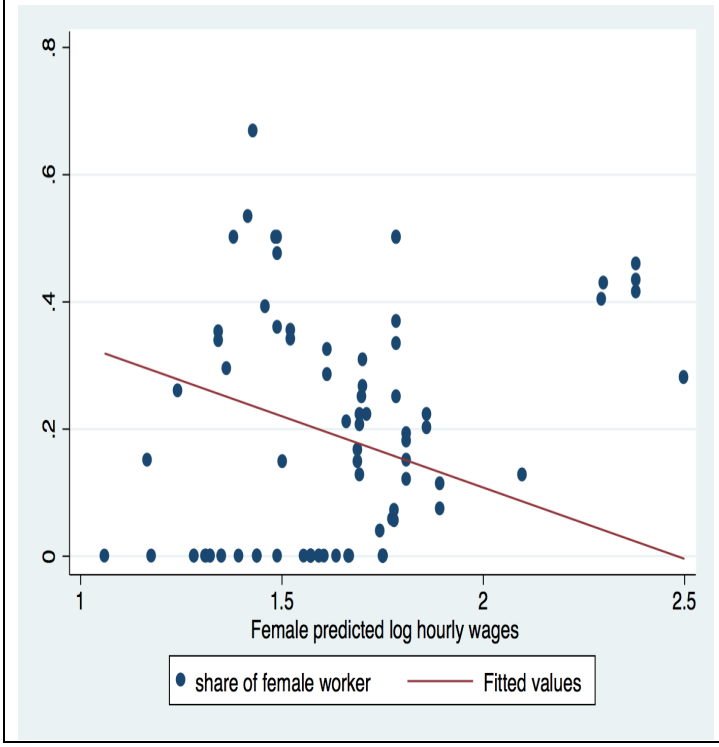
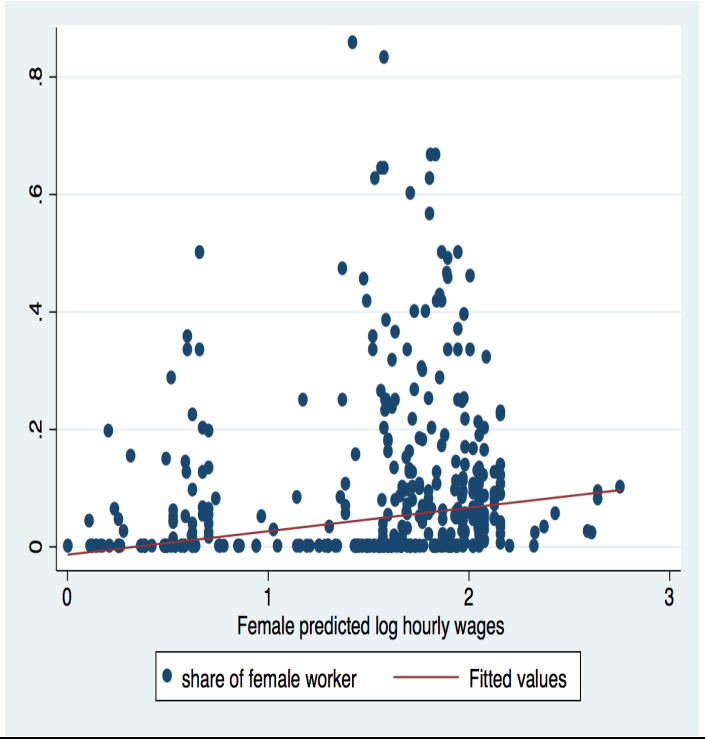


Figure 8: Share of female workers and females wage rates by industry group

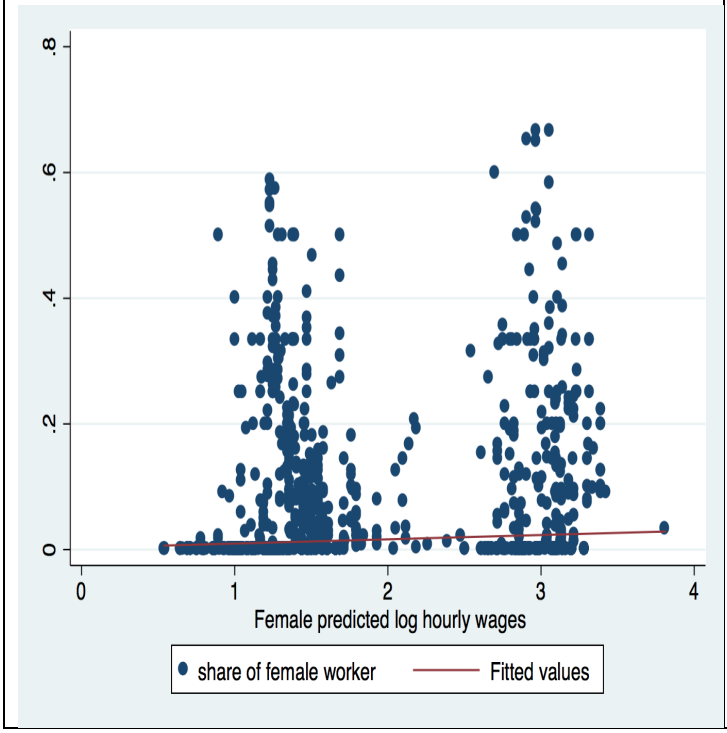
8-a: HT



8-b: MHT



8-c: MLT



8-d: LT

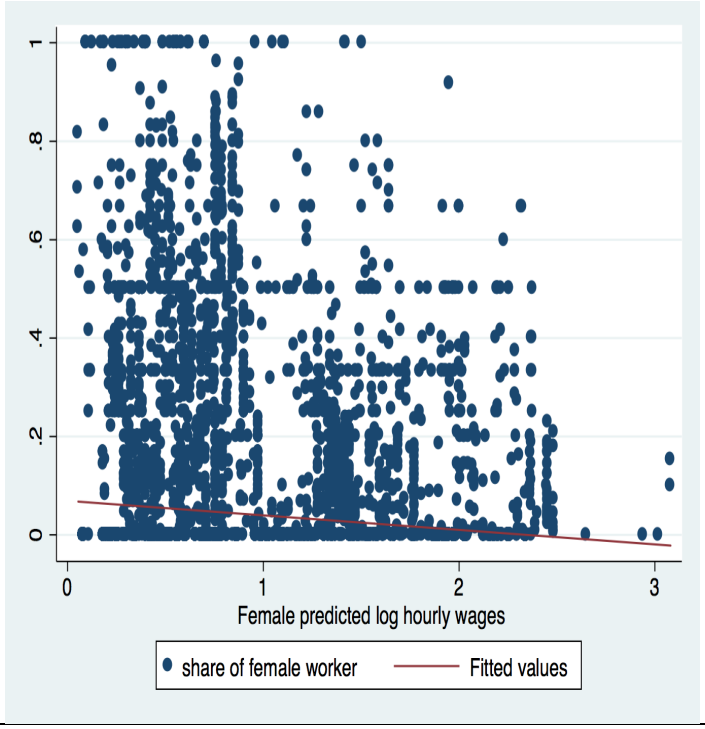


Figure 8 shows a negative strong association between the share of females from total firm's worker and females' wage rate in the high technology HT and to a lesser extend in the Low technology industry group while there is a positive one in the middle high and middle low technology groups.

5- Estimated Results

Three versions of the model has been estimated, the first Model (1) included only firm characteristics without occupations, the second model (2) added shares of males and females in each occupation while the third model (3) included the governorates and industries dummies.

Table (2) display the results. As expected when comparing the R-square for the three versions of the model it is obvious that the explanatory power of the model significantly moving from the first model to the second one including occupations to the third including location and industries. The R square increased from 43% to 66% to 80% respectively. Moving from model (1) to model (2) increased the explanatory power by 23 percentage points. While moving from model (2) with no location and industry effects to model (3) the explanatory power increased by 13.9 percentage points. This accounts for the variation in the share of females due to observed and unobserved characteristics at the governorate and industry levels.

Moreover accounting for occupations, location and industry changed the direction and the significance of the association between some factors and female employment. As expected output has a positive and significant relationship with female employment in the first two models however it turned to be insignificant in the third model after accounting to location and industry effects.

Capital has a positive significant association indicating complementarity with female labor but only in the first model. It lost its significance in the other two models.

Surprisingly Female wages has a positive significant relationship in all models. One possible explanation could be the exclusion of education variable from the model – to the extent that some sector demand skilled women, these would be associated with higher wages. In an attempt to shed more light on this issue I estimated four separate models for the 4 groups of technological intensity industries. Results showed a positive relationship with female's wage for the High technology (HT) and the low technology (LT) industries groups and a negative one for the Medium High Technology (MHT) and the low medium technology (LMT) groups. However it is only significant for the HT group. This may confirm the role of education and other human capital variables excluded from the model[1].

Male wages has a positive significant relationship indicating that as male wages increase there will be an increase in female employed which may point to a possible substitution effect and goes in line with what we saw in the raw data. Capital labor ratio had a negative and significant association only in the first model.

In line with the raw data, demand for female employment is higher for formal firms compared to informal ones. However this relationship faded away when accounting for the location and the industry effects in the third model. Contrasting the raw data when accounting for occupation, location and industry effects demand for female employment is less for firms that export compared to those having zero exports. Concerning the effect of firm size the results shows that in the first model compared to firms with 1 to 3 employees females' employment is less in firms with 4-7 and 8-10 employees while it is higher for other sizes. However after accounting for the location and industry effects the results shows that compared to firms with 1-3 employees females employment is higher in firms in all categories with less than 100 employees. While it is insignificant for those over 100 employees this could be due to the fact that the share of firms with more than 100 employees from total firms is very small about 0.5%. In line with what we saw in the raw data females employment is less in individual owned firm compared to the others forms of ownership, however when accounting to the location and industry effect this relationship was reversed.

The rate of capacity utilization has no significant relationship in the first two models and a week positive one in the third model. This could be due to the fact that the maximum rate of capacity utilization in the sample is relatively low 27%. Firm age has no significant association with demand for females' employment. This could be due to the fact that around 82% of the firm in the

[1] Detailed output of the regression is available in Appendix 3.

sample are less than 20 years old. It is worth noting that using other specification of age like age groups turned also insignificant compared to the young firms category of 1-3 years old. This goes in line with the literature that showed that it is young firms or micro-startups of less than 4 years old that dominate Job creation in MENA (World Bank 2015).

Concerning number of females and males by occupation, in the second model both the share of females and males in all three occupation has a positive association with the share of females employed with the exception of share of males blue collars that had a negative relationship. However after accounting to location and industry effects the share of males and the share of females in the professional and managers occupation turned to an insignificant relationship and the share of males white collars changed to a negative association with share of females employed.

Looking at the governorates dummies, compared to Cairo, demand for female labor is significantly higher in all governorates with the exception of Port Said.

Concerning industries dummies, compared to Manufacture of food products, demand for female labor is significantly less in most of the industries with the exception of four industries those are Manufacture of tobacco products, Manufacture of wearing apparel, Manufacture of leather and related products and Manufacture of machinery and equipment. Comparing the results with the raw data we notice that with the exception of Manufacture of wearing apparel the three other industries that had the highest ratio of female employed according to the raw data has lower share of female employed compared to manufacture of food product according to our model. One possible explanation could be that the raw data results is due to firm characteristics in those industries not due to industry characteristics hence after controlling for the firm characteristics results are different.

It is worth noting that as a robustness check I performed the same regression but using the aggregated technology intensity grouping of industries as industries fixed effects instead of the 2 digit industries classification[1]. Similar results were reached. As compared to the LT group demand for female labor is significantly less in the HT and MLT groups while it was insignificant for the MHT group. The result for the HT group contradict the row data, which support the explanation, that raw data results is due to firm characteristics in those industries not due to industry characteristics.

Table 2: Estimation results

VARIABLES	(1) log share of	(3) log share of	(4) log share of

[1] Detailed output of the regression is available Appendix 4.

	female worker	female worker	female worker
Log Value added	0.0527***	0.0156***	0.00443
	(0.00615)	(0.00477)	(0.00560)
Log Capital	0.122***	0.0137	-0.0202
	(0.0129)	(0.0100)	(0.0223)
Log Female hourly wages	0.0360***	0.0184***	1.154***
	(0.00921)	(0.00712)	(0.271)
Log Male hourly wages	0.392***	0.221***	6.816***
	(0.0267)	(0.0208)	(0.615)
Log capital labor ratio	-0.126***	-0.0107	0.0357
	(0.0142)	(0.0110)	(0.0261)
Formality (reference informal)			
Formal	0.0765***	0.0292**	0.0131
	(0.0154)	(0.0119)	(0.00938)
Firm size: (reference 1-3 employees**)**			
4-7 employees	-0.0906***	0.0469***	0.0776***
	(0.0201)	(0.0156)	(0.0213)
8-10 employees	-0.0823***	0.123***	0.162***
	(0.0299)	(0.0232)	(0.0332)
10- 100 employees	0.238***	0.273***	0.187***
	(0.0352)	(0.0274)	(0.0389)
100-1000 employees	0.947***	0.214***	-0.153
	(0.0662)	(0.0520)	(0.111)
Over 1000 employees	1.116***	-0.187**	-0.407
	(0.108)	(0.0859)	(0.240)
Firm exports: (reference: does not expo			
Export	0.0156	-0.262***	-0.180***
	(0.0416)	(0.0325)	(0.0548)
Individual owned firms	-0.0554***	-0.0140	0.0197**
	(0.0164)	(0.0128)	(0.00784)
Rate of Capacity utilization	0.000170	0.000149	0.000328***
	(0.000168)	(0.000130)	(0.000101)
Firm age	0.000436	-0.000473	-0.000331
	(0.000436)	(0.000338)	(0.000310)
Log share of males workers	0.233***	0.358***	-1.069***
	(0.0283)	(0.0300)	(0.121)
Log share of females in managers and professionals		0.0447**	0.000948
		(0.0195)	(0.0466)
Log share of females in white collars		0.775***	0.478***
		(0.0119)	(0.0428)
Log share of females in blue collars		0.450***	0.132**
		(0.00895)	(0.0522)
Log share of males in managers and professionals		0.745***	0.229
		(0.0578)	(0.160)
Log share of males in white collars		0.0732*	-0.276***
		(0.0440)	(0.0885)

Log share of males in blue collars	-0.415***	-0.554***
	(0.0303)	(0.0602)
Governorates: (reference: Cairo)		
Alex		1.264***
		(0.0887)
Port Said		-0.0916
		(0.0814)
Suez		0.473***
		(0.0343)
Damietta		2.089***
		(0.109)
Dakahlia		1.841***
		(0.0989)
Sharkia		2.610***
		(0.180)
Kalyoubia		2.809***
		(0.160)
Kafr-elsheikh		2.024***
		(0.100)
Gharibya		2.767***
		(0.155)
Menoufia		2.430***
		(0.124)
Behera		2.517***
		(0.134)
Ismailia		2.654***
		(0.182)
Giza		1.292***
		(0.0895)
Beni-Suef		1.641***
		(0.0876)
Fayoum		3.205***
		(0.170)
Menia		1.639***
		(0.0846)
Asyout		3.226***
		(0.172)
Suhag		0.169***
		(0.0480)
Qena		3.001***
		(0.169)
Aswan		2.317***
		(0.122)
Luxor		0.873***
		(0.0502)
Industries: (reference: Manufacture of food products)		
Manufacture of beverages		-0.571
		(0.404)
Manufacture of tobacco products		1.225***

	(0.253)
Manufacture of textiles	-0.955***
	(0.291)
Manufacture of wearing apparel	0.676***
	(0.144)
Manufacture of leather and related products	3.905***
	(0.624)
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-2.731***
	(0.422)
Manufacture of paper and paper products	-0.00976
	(0.314)
Printing and reproduction of recorded media	-3.316***
	(0.395)
Manufacture of coke and refined petroleum products	-4.838***
	(0.203)
Manufacture of chemicals and chemical products	-2.036***
	(0.317)
Manufacture of basic pharmaceutical products and pharmaceutical preparations	-2.536***
	(0.273)
Manufacture of rubber and plastics products	-2.245***
	(0.693)
Manufacture of other non-metallic mineral products	-1.122***
	(0.256)
Manufacture of basic metals	-3.143***
	(0.223)
Manufacture of fabricated metal products, except machinery and equipment	-1.013***
	(0.216)
Manufacture of computer, electronic and optical products	-6.408***
	(0.342)
Manufacture of electrical equipment	-1.744***
	(0.376)
Manufacture of machinery and equipment n.e.c.	5.882***
	(0.484)
Manufacture of motor vehicles, trailers and semi-trailers	-3.256***
	(0.248)
Manufacture of other transport equipment	-3.949***
	(0.280)
Manufacture of furniture	-1.243***
	(0.124)
Other manufacturing	-0.527

			(0.427)
Repair and installation of machinery and equipment			-6.998***
			(0.549)
Constant	-1.090***	-0.479***	-11.26***
	(0.0727)	(0.0566)	(0.815)
Observations	12,476	12,476	12,476
R-squared	0.430	0.660	0.799

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6- Conclusion

In Egypt micro data unavailability lead to neglecting demand side factors when addressing Labor markets outcome. The current study takes advantage of the newly available economic census for Egypt C13 in an attempt to fill in this gap in the literature and study demand for female labor in Egyptian manufacturing sector. In this context the study utilizes the information provided in the C13 together with data from the ELMPS2012 to estimate wage rate by gender in the C13 and then estimating a labor demand function for females. Determinants included in the analysis covered firm characteristics as well as industry and location fixed effects.

Raw data investigation showed a large gender gap in employment at the firm level. The average share of females employed is 3.6% per firm while it is 96.4% for males Average real hourly wages for females is less than that of males; moreover the variation for females is higher than for males. In addition while the maximum wage rate is higher for females the minimum wage rate is lower for females indicating that for the minimum females earn relatively less. Raw data also shows noticeable variation in the average ratio of female workers per firm by governorate and industry suggesting an important impact for both.

Results confirmed the important role played by industries in determining female labor demand. Moreover once accounting for location and industry effects, capital - in absolute as well as relative to labor utilized- and formality losses their significant impact. As confirmed in the literature firm size has an important impact with firms with 100 employees or less increasing demand for females while bigger firms has no significant impact. Given the low average capacity utilization in Egypt, and its positive but very weak impact on demand for female labor reached by the current study, efforts to increase rate of capacity utilization is recommended.

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Appendix 1: Eurostat High-tech classification of manufacturing industries: Based on NACE Rev. 2 2-digit level

Technological group	**NACE Rev. 2** **2-digit level**	
High-technology (HT)	21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
	26	Manufacture of computer, electronic and optical products
Medium-high technology (MHT)	20	Manufacture of chemicals and chemical products
	27 to 30	Manufacture of electrical equipment, machinery and equipment n.e.c., motor vehicles, trailers and semi-trailers, other transport equipment
Medium-low technology (MLT)	19	Manufacture of coke and refined petroleum products
	22 to 25	Manufacture of rubber and plastic products; Manufacture of other non-metallic mineral products; Manufacture of basic metals; Manufacture of fabricated metals products, excepts machinery and equipment
	33	Repair and installation of machinery and equipment
Low technology (LT)	10 to 18	Manufacture of food products, beverages, tobacco products, textile, wearing apparel, leather and related products, wood and of products of wood, paper and paper products, printing and reproduction of recorded media
	31 to 32	Manufacture of furniture; Other manufacturing

Appendix 2: Variables Definition and Construction

Variable	Definition	Construction
Log share of females workers Dependent Variable (l_{fij})	Total female workers paid and unpaid per firm at end of year	Measured by dividing total number of females' workers per firm by total number of workers. Then taking the log.
Log share of males workers	Total male workers paid and unpaid per firm at end of year	Measured by dividing total number of males' workers per firm by total number of workers. Then taking the log.
Log Value added (y)	Consists of the value of finished products and by-products, value of semi-finished products and byproducts, receipts for work done for others and other receipts.	Computed by subtracting Intermediate inputs cost (Fuel oils, lubricants+ Purchased electricity+ Other commodities + Other expenses) from total output. Then taking the log. The value added is expected to have positive impact on employment due mainly to nature of derived demand for labor.
Log Capital (*K*)	Capital stock	Measured as log of the net book value of fixed assets after depreciation at the end of the year (fixed assets comprise machinery, vehicles, and equipment as well as land and buildings).
Log Female hourly wages (w_{fij})	Predicted female hourly wage	Measured as log value
Log Male hourly wages (w_{mij})	Predicted male hourly wage	Measured as log value
Log capital labor ratio		
Formal	Firms are considered formal if holding accounting statement and/or commercial Registration-License Number	Dummy variable equal 1 if formal zero other wise
Firm size	6 group	Categorical variable of 6 groups: "1-3 employees" "4-7 employees" "8-10 employees" "10-100 employees" "100-1000 employees" "Over 1000 employees" With the 1-3 employee group as reference.
Firm exports:	Whether the firm export or not during the survey period	Dummy variable equal 1 if the firm is exporting, zero other wise
Rate of Capacity utilization	The percentage of capacity utilization	
Firm age	Firm's age in 2013	Computed by subtracting date of beginning to practice current activity from 2013
Firm legal form	Whether the firm is individually owned or not	Dummy variable equal 1 if the firm is individually owned, zero other wise
Log share of females in	The share of females in the managers	Measured by dividing number of

managers and professionals	and professionals occupation from total workers in this occupation by firm	females in this occupation by the total number of workers in this occupation then taking the log
Log share of females in white collars	The share of females in the white collars occupation from total workers in this occupation by firm	Measured by dividing number of females in this occupation by the total number of workers in this occupation then taking the log
Log share of females in blue collars	The share of females in the blue collars occupation from total workers in this occupation by firm	Measured by dividing number of females in this occupation by the total number of workers in this occupation then taking the log
Log share of males in managers and professionals	The share of males in the managers and professionals occupation from total workers in this occupation by firm	Measured by dividing number of males in this occupation by the total number of workers in this occupation then taking the log
Log share of males in white collars	The share of males in the white collars occupation from total workers in this occupation by firm	Measured by dividing number of males in this occupation by the total number of workers in this occupation then taking the log
Log share of males in blue collars	The share of males in the blue collars occupation from total workers in this occupation by firm	Measured by dividing number of males in this occupation by the total number of workers in this occupation then taking the log

Appendix 3: Regression Output for each of the technology intensity industry groups

VARIABLES	HT log share of female worker	MHT log share of female worker	MLT log share of female worker	LT log share of female worker
Log Value added	0.0783*	0.0222	0.00791	0.0107**
	(0.0380)	(0.0242)	(0.0105)	(0.00448)
Log Capital	-0.0143	0.217**	0.108**	-0.0206**
	(0.225)	(0.0966)	(0.0452)	(0.00920)
Log Female hourly wages	1.196**	-0.00920	-0.0210	0.0391
	(0.543)	(0.0486)	(0.0143)	(0.0263)
Log Male hourly wages	-0.152	0.136**	0.350***	0.568***
	(0.429)	(0.0611)	(0.0598)	(0.0930)
Log capital labor ratio	-0.00337	-0.241**	-0.0938	0.0226***
	(0.196)	(0.108)	(0.0560)	(0.00726)
Formality (reference informal)				
Formal	0.325**	0.0695	0.00882	0.0343**
	(0.119)	(0.0590)	(0.0232)	(0.0125)
Firm size: (reference 1-3 employees**)**				
4-7 employees	0.0766	-0.103	-0.0588	0.0948***
	(0.286)	(0.0640)	(0.0406)	(0.0231)
8-10 employees	-0.0154	-0.0886	-0.110	0.182***
	(0.541)	(0.147)	(0.0675)	(0.0371)
10- 100 employees	0.0799	-0.0354	0.0679	0.307***
	(0.690)	(0.160)	(0.0904)	(0.0455)
100-1000 employees	-0.623	-0.0171	-0.0532	0.225**
	(1.354)	(0.316)	(0.180)	(0.0991)
Over 1000 employees	-1.184	-0.880*	-0.396	0.191*
	(1.968)	(0.493)	(0.683)	(0.106)
Firm exports: (reference: does not export				
Export	-0.224	0.0746	-0.286**	-0.314***
	(0.146)	(0.171)	(0.113)	(0.0959)
Individual owned firms	0.0338	0.0668	-0.0223	-0.0179
	(0.207)	(0.0715)	(0.0255)	(0.0164)
Rate of Capacity utilization	0.00348	0.000938	0.000156	6.44e-05
	(0.00299)	(0.000710)	(0.000373)	(0.000193)
Firm age	-0.00338*	0.000711	-0.000298	-0.000786
	(0.00177)	(0.00200)	(0.000588)	(0.000506)
Log share of males workers	0.488*	0.282**	1.301***	0.258***
	(0.273)	(0.134)	(0.260)	(0.0552)
Log share of females in managers and professionals	0.258	0.0176	0.0449	0.0535
	(0.150)	(0.0532)	(0.186)	(0.0462)
Log share of females in white collars	0.557***	0.759***	0.865***	0.650***
	(0.154)	(0.0941)	(0.0600)	(0.0570)

Log share of females in blue collars	0.237	0.102*	0.363***	0.558***
	(0.166)	(0.0552)	(0.122)	(0.0290)
Log share of males in managers and professionals	-0.486	0.364	0.699***	0.762***
	(0.389)	(0.429)	(0.222)	(0.194)
Log share of males in white collars	0.0699	0.998***	0.562***	-0.0444
	(0.342)	(0.262)	(0.0704)	(0.0971)
Log share of males in blue collars	-0.199	-0.655***	-0.888***	-0.348***
	(0.390)	(0.168)	(0.205)	(0.0474)
Governorates: (reference: Cairo)				
Alex	-0.0475	0.0272	0.0534**	0.0746**
	(0.132)	(0.0355)	(0.0247)	(0.0287)
Port Said		0.384***	0.00318	-0.0685***
		(0.100)	(0.0261)	(0.0186)
Suez		-0.171*	-0.103***	-0.0277
		(0.0861)	(0.0304)	(0.0211)
Damietta		-0.148***	0.0497	0.0759***
		(0.0485)	(0.0330)	(0.0215)
Dakahlia	0.223	0.0789**	0.152***	0.0919***
	(0.146)	(0.0373)	(0.0392)	(0.0208)
Sharkia	-0.344	0.0201	0.176***	0.197***
	(0.298)	(0.0278)	(0.0369)	(0.0340)
Kalyoubia	0.198**	-0.0828**	0.249***	0.246***
	(0.0667)	(0.0356)	(0.0229)	(0.0362)
Kafr-elsheikh	0.174	-0.00451	0.123***	0.168***
	(0.165)	(0.0387)	(0.0343)	(0.0194)
Gharibya	0.487*	0.0181	0.177***	0.149***
	(0.241)	(0.0295)	(0.0481)	(0.0292)
Menoufia	0.198	-0.0419	0.202***	0.175***
	(0.167)	(0.0454)	(0.0311)	(0.0219)
Behera	0.474***	-0.00606	0.241***	0.128***
	(0.0929)	(0.0575)	(0.0599)	(0.0266)
Ismailia		0.481***	0.199***	0.101**
		(0.119)	(0.0356)	(0.0384)
Giza	0.107	-0.0115	0.0569***	0.0615**
	(0.123)	(0.0351)	(0.0129)	(0.0288)
Beni-Suef		1.048***	0.0802**	0.0544***
		(0.104)	(0.0334)	(0.0173)
Fayoum		0.113**	0.0549	0.180***
		(0.0439)	(0.0408)	(0.0323)
Menia	0.316	-0.0814	0.121***	0.0856***
	(0.313)	(0.0667)	(0.0281)	(0.0176)
Asyout	0.0916	0.208**	0.110***	0.154***
	(0.128)	(0.0997)	(0.0299)	(0.0323)
Suhag	-0.129	-0.159**	0.0206	-0.0611***
	(0.139)	(0.0637)	(0.0257)	(0.0153)
Qena	0.225	0.110	0.179***	0.160***
	(0.392)	(0.0745)	(0.0444)	(0.0316)
Aswan		0.0507	0.136***	0.160***
		(0.0800)	(0.0308)	(0.0267)

Luxor		-0.151**	0.0671**	-0.0114
		(0.0688)	(0.0260)	(0.0182)
Constant	-2.388***	-0.475*	-0.831***	-0.947***
	(0.707)	(0.250)	(0.214)	(0.168)
Observations	107	705	2,998	8,666
R-squared	0.768	0.752	0.740	0.640

Appendix 4: Regression Output using technology intensity industry groups as fixed effects

VARIABLES	(1) log share of female worker
Log Value added	0.0172***
	(0.00584)
Log Capital	0.0119
	(0.0154)
Log Female hourly wages	0.0212
	(0.0146)
Log Male hourly wages	0.392***
	(0.0511)
Log capital labor ratio	-0.0109
	(0.0183)
Formality (reference informal)	
Formal	0.0370**
	(0.0144)
Firm size: (reference 1-3 employees**)**	
4-7 employees	0.0474**
	(0.0200)
8-10 employees	0.120***
	(0.0365)
10- 100 employees	0.268***
	(0.0449)
100-1000 employees	0.194*
	(0.114)
Over 1000 employees	-0.156
	(0.261)
Firm exports: (reference: does not expo	
Export	-0.239***
	(0.0636)
Individual owned firms	-0.0208
	(0.0133)
Rate of Capacity utilization	0.000152
	(0.000130)
Firm age	-0.000409
	(0.000376)
Log share of males workers	0.322***
	(0.0741)
Log share of females in managers and professionals	0.0426
	(0.0565)
Log share of females in white collars	0.765***

	(0.0400)
Log share of females in blue collars	0.440***
	(0.0580)
Log share of males in managers and professionals	0.748***
	(0.158)
Log share of males in white collars	0.0872
	(0.0842)
Log share of males in blue collars	-0.416***
	(0.0498)
Governorates: (reference: Cairo)	
Alex	0.0422**
	(0.0163)
Port Said	-0.0554***
	(0.0180)
Suez	-0.0428**
	(0.0172)
Damietta	0.0404**
	(0.0146)
Dakahlia	0.0820***
	(0.0164)
Sharkia	0.149***
	(0.0184)
Kalyoubia	0.186***
	(0.0193)
Kafr-elsheikh	0.139***
	(0.0175)
Gharibya	0.115***
	(0.0221)
Menoufia	0.143***
	(0.0138)
Behera	0.124***
	(0.0186)
Ismailia	0.0657***
	(0.0193)
Giza	0.0619***
	(0.0180)
Beni-Suef	0.0463***
	(0.0132)
Fayoum	0.110***
	(0.0218)
Menia	0.0655***
	(0.0130)
Asyout	0.0909***
	(0.0218)
Suhag	-0.0445***
	(0.0113)
Qena	0.116***
	(0.0234)
Aswan	0.108***
	(0.0171)

Luxor	-0.00501
	(0.0146)
Industries: (reference: low technology industries)	
High technology	-0.459***
	(0.0932)
Medium high technology	0.0363
	(0.0367)
Medium low technology	-0.0459*
	(0.0229)
Constant	-0.767***
	(0.131)
Observations	12,476
R-squared	0.666