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Abstract

This paper attempts to investigate crucial questions of labor demand related to how firms respond to changes in wages, how this responds to changes according to skill levels. This is reached through estimating own wage elasticities of demand for labor, and elasticities of substitution among different labor inputs disaggregated according to skill level in Egypt. Based on micro establishment level data obtained from Egypt enterprise survey 2008 conducted by the World Bank. Though skill can be described by education level, the present study use occupation to define skills. As such it identifies four occupations professionals, skilled production workers, unskilled production workers and non-production workers.

JEL Classifications: J1

Keywords: Labor demand; education; skill level; Egypt

ملخص

تحاول هذه الورقة التحقيق في المسـائل الحاسـمة المتعلقة بالطلب على العمالة المتعلقة بكيفية اسـتجابة الشـركات للتغيرات في الأجور، وكيف يستجيب هذا للتغيرات وفقا لمستويات المهارة. ويتم التوصل إلى ذلك من خلال تقدير مرونة الأجور الخاصـة بالطلب على اليد العاملة، ومرونة الاسـتبدال بين مدخلات العمل المختلفة المصـنفة حسـب مسـتوى المهارات في مصـر. اسـتنادا إلى بيانات مسـتوى المنشآت الصغيرة التي تم الحصول عليها من مسح المؤسسات المصرية 2008 الذي أجراه البنك الدولي. على الرغم من أن المهارة يمكن وصـفها حسـب مسـتوى التعليم، فإن الدراسـة الحالية تسـتخدم المهنة لتحديد المهارات. وعلى هذا النحو فإنه يحدد أربعة المهن المهنيين، عمال الإنتاج المهرة، عمال الإنتاج غير المهرة والعمال غير الإنتاج.

1. Introduction

Egypt has been facing an alarming challenge for decades now. Mainly how to create enough jobs for its booming labor force (Radwan 1998). This problem became even more serious since the cease of migration to the Gulf countries in 1991. The stabilization program adopted in the 1990s, - despite being successful in macro-economic terms - was not adequate in terms of job creation (Fergany 1998). Skilled people were trapped in low wage jobs or were unemployed due to low capacity of the economy to create jobs (Pissaridaes 1993). In recent years the problem persisted, even during periods of high growth rates (2007-2010) the unemployment rate remained high (8.6 and 9 percent).

Throughout the 1990s and until 2005, the Egyptian economy went through economic cycles, major structural changes, various shocks, and several employment promotion plans. However, the unemployment rate persisted at excessive levels hovering between 8% and 11%. During the first half of the 1990s economic reforms implemented by the government raised growth rates. However, the effect of that increasing growth on employment was weak, and youth started facing high unemployment rates. In the early 2000s unemployment deteriorated as economic growth stagnated (Hassan and Sassanpour 2008).

From 2005 and as a result of the economic reform program implemented in 2004, investment and growth improved significantly. Meanwhile, the international economy offered additional help. The improvement in growth rates was reflected in higher overall employment. Between the end of 2004 and March 2008, new jobs increased by about 2.5 million and the unemployment rate –although still high- fell from 10.5% to around 8.7 % (CAPMAS). Yet, the problem of youth unemployment persisted. With the financial crises in 2008 unemployment rate started to increase again and reached 9.4% in 2009. Starting from 2011 and after the 25th of January revolution overall unemployment increased massively to reach 13.4% in 2014 while unemployment rate among the youth reached 29%.

This persistence of unemployment for a long period has caused many problems both at the economic and political fronts. Job creation is considered to be one of the key challenges facing Egypt in this concern (Ibrahim 2013). On one side this could be attributed to demography or to the supply side of labor. As the majority of Egypt's population is youth, each year a big number of young individuals enter the labor market seeking first jobs. On the other side, it could be explained by insufficient labor demand. During the past period, performance of the economy was imbalanced, but even when there were high growth rates, it was not reflected in high job creation that can absorb those entering the labor market (Hassan and Sassanpour 2008). In this context, a major concern of the Egyptian economic policy in fighting unemployment is the factors that affect demand for labor and its growth (Ibrahim 2013). The review of the empirical literature for Egypt reveals that labor demand was an understudied subject, mainly due to absence of required micro data at the establishment level.

Considering the importance of the unemployment problem in Egypt on the one hand and the scarcity of studies covering the subject in Egypt on the other hand, this paper attempts to investigate crucial questions of labor demand related to how firms respond to changes in wages, how this responds to changes according to skill levels. This is reached through estimating own wage elasticities of demand for labor, and elasticities of substitution among different labor inputs disaggregated according to skill level in Egypt. Based on micro establishment level data obtained from Egypt enterprise survey 2008 conducted by the World Bank. Though skill can be described by education level, the present study use occupation to define skills. As such it identifies four occupations professionals, skilled production workers, unskilled production workers and non-production workers.[1].

This paper can be considered to be the first attempt to estimate labor demand functions for the Egyptian case at that level of disaggregation. Accordingly, it adds to the literature on Egypt in many ways. First, it looks at static labor demand, which provides significant intuitions into the labor market and serve quite well the objective of the study. Static labor demand theory permits studying long run equilibrium in the labor market where the economy has fully responded to exogenous shocks (Hamermesh 1993 and Lichter et. al 2012). Thus, it provides an appropriate framework to examine how the relative and absolute quantities of labor inputs and its types respond to exogenous changes in labor prices (Hamermesh 1993). Moreover, static labor demand theory enables studying the determinants of elasticities and provide insights about how different inputs can substitute others in the long run (Lichter et. al 2012).

Second, another value added of the study to the available labor demand literature in Egypt is the use of firm level data, hence analyzing labor demand at a micro level. This is a point that is missing in the previous studies. Micro data is advantageous in various aspects. It provides more accurate estimations for demand functions, enable considering factor as exogenous and allow accounting for unobserved heterogeneity (Fajnzylber and Maloney 2001). Hence this study by making use of the Egypt enterprise survey conducted by the World Bank -which is an establishment level data-, offers the most possible reliable estimations.

Third a review of the international literature on static labor demand shows vast heterogeneity concerning the choice of the cost function used in the estimation and most importantly its specification. This study utilizes the translog cost function and constructs a framework that permits relatively robust results regarding the empirical specification.

Moreover, results reached in this paper can be useful for policies targeting labor demand as well as elevating poverty and reducing inequality. For instance, if the own wage elasticity of unskilled labor is proved to be high, policies aiming at decreasing unemployment of that type of labor by increasing their real wage can instead decrease their demand and hence does not accomplish its objective. Similarly, if it is evidence that demand for skilled workers is more inelastic, probable rises in skilled workers supply might be accompanied by severe drops in their wages.

2. 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 present study comes under the first type.

Static labor demand models investigate the impacts of an exogenous shock in long run. In other words, it examines the outcomes of the shock after the labor markets fully adjust to the shock. Hence adjustment costs is not considered and it does not allow for analyzing the pathway of employment to the equilibrium (Lichter et al. 2012).

The standard static labor demand theory emphasizes how firms choose the amount of labor used in production and how changes in the demand for the product and in the prices of factors of production affect those choices. It is basically a branch of production theory, that study the

[1] It is worth noting that for the Egyptian case one may argue that using occupations is not really equivalent to examining labor demand for skills among workers. As For example, the ILO *School-to Work Transition Survey* for Egypt in 2012 shows that fully one-third of workers are overqualified for that they do. However, that was unavoidable given that the survey data used only include wages classified by occupations and not by education.

mechanism through which shocks in product market and input markets transmit to employment and wages. Where the structure of production is a crucial element of this mechanism. Accordingly, most progress achieved simply reflects progress made in production theory (Addison et al. 2014).

The basis of labor demand theory is an illustrative firm aiming at profit maximizing (cost minimizing) that modifies the amount of the labor input used at no cost. By solving the firm optimization problem in the long run, one can drive conditional and unconditional demand functions. This involves specifying a production function, which is assumed to be strictly increasing and strictly concave. Different specifications have been used in this regard advancing from the regular Cobb-Douglas production function, to the CES, towards the generalized Leontief or translog functions. The estimated labor demand curve is then used to estimate the parameters of concern mainly labor demand elasticity and the elasticities of substitution among inputs involving diverse categories of labor (Addison et al. 2014).

A review of the international empirical literature reveals that compared to short-run dynamic analysis long run static models have been estimated by numerous studies. Until the 1980s, studies focused on demand for homogenous labor and examined the impact of high labor costs on unemployment mainly by estimating constant output elasticities of demand for homogenous labor (Lichter et al. 2012; Kirkpatrick 1982; Symons and Layard 1984; Franz and Konig 1986; Hall 1991; Black and Kelejian 1970; Drazen et. al 1984; Dhrymes 1969; Hamermesh 1983; Chow and Moore 1972; Nickell 1981; Coen and Hickman 1970; Schott 1978; Browm and deCani 1963; Berndt and Khaled 1979 and Morrison and Brendt 1981). Another group of fewer studies estimated elasticities for homogenous labor when output varies (Ashenflter and Ehrenberg 1975; Freeman 1975; Sosin and Fairchild 1984 and Waud 1968)[2].

In the 1990s, labor heterogeneity was included in the analysis thanks to the gradual availability of micro data. This heterogeneity could be distinguished on two lines heterogeneity according to occupational particularly, skilled against non-skilled labor, and according to nationality (immigrants against citizens). Thus, empirical literature provided proof of the replacement among skilled and non-skilled workers and citizens and immigrant workers (Addison et al. 2014). Hence, starting from the 1990s most of the studies tackling labor demand primarily focused on three topics: first, the substitution among different skilled labor types and capital; second, the substitution among different labor types themselves (by skill or by nationality), third, the impact of technological, innovational or organizational progress on labor demand (Lichter et al. 2012).

Evidence is inconclusive regarding the relationship between capital and different types of labor. While some studies found that elasticities of substitution between unskilled labor and capital is higher than that between highly skilled labor and capital (FitzRoy and Funke 1995; FitzRoy and Funke 1998; Bergstroe and Panas 1992; Betts 1997) other studies found only weak support for this proposition (Falk and Koebel 2004 and Behar 2004).

Most of the studies considered at the relationships between different labor types in terms of skills. Again, results were inconclusive regarding the degree of substitution between different skills (Bellmann, Bender, and Schank 1999; Dunne and Roberts 1993; Addison et al. 2005; Lichter et al. 2012; Mellander 1999; Riley and Young 1999 and Bernal and Cardenas 2003). For example, Bellmann, Bender, and Schank (1999) confirm complementarity between unskilled and skilled labor, while they found no significant association between wages and skilled and highly skilled workers employment. Recently marginally employed workers are included as a labor input. Jacobi and Schaffner (2008) found a strong substitution relation between the marginally employed and skilled and highly skilled workers. Freier and Steiner

[2] For a detailed survey on these studies see Hamermesh (1989).

(2010) confirm the same outcome but for males only whereas for females, the opposite was found.

Other studies tackled the argument over the effect of immigration on the employment and wages of citizens by estimating the elasticity of substitution between the two of them. Most of those studies indicated a slight frequently negative effect (Grossman, 1982; Borjas 1987; 2001 and 2003; Ottaviano and Peri 2012; Ottaviano et al. 2013; Card 1990; Card 2001; Lalond and Topel 1991; Pischke and Velling 1997; Schoeni 1997; Angrist and Krueger 1999; and Borjas, Freeman and Katz 1997).

Concerning the impact of technological change (TC) on labor demand, several studies found evidence favoring the positive effect of skill biased technical change on the rise in the demand for skilled workers (De Ferranti et al. 2002; Zimmermann 1991; Falk and Koebel 2004; Acemoglu, 2002 and Krusell et al. 2000). In contrast, other studies found weak effect of technological change on the share of the unskilled labor while different factors such as labor costs; innovations and organizational change were found to be more important (Steiner and Wagner 1997; Kolling and Schank; 2002; Ribiero and Jacinto 2008 and Addison et al. 2005).

In the same line, a series of studies examined the hypotheses of the positive association between IT capital and high-skilled labor employment. Earlier studies confirmed this positive association (Falk and Seim 1999; 2001a, 2001b; Kaiser 2000; Autor et al. 1998; Machin and Van Reenen 1998; Ruiz-Arranz 2001; Berman, Bound and Griliches 1994; Hansson 1996, and 1999; Machin 1996; Berman, Bound, and Machin 1998 and Mellander 1999). Other fewer studies found little support of the substitutability between IT capita and unskilled workers (Falk and Koebel 2004). Whereas others more recent studies using a higher disaggregation level of labor input reached a stronger proposition. Where highly skilled workers and new technologies are complements to each other however they are substitutes for semi-skilled workers, while there is no significant relationship between them and low-skilled work[3] (Autor et al. 2008; Autor and Dorn 2009 and 2000).

Finally, some studies in the course of both static and dynamic models were dedicated to analyzing the effect of specific fundamental issues on labor demand, two of which could be identified. First some studies consider explicitly the impact of regulations like labor legislation, related firings costs and min wage legislation on labor demand (Bernal and Cardenenas 2003; Jacobi and Schaffiner 2008; Saavedra and Torero 2004; Micevska 2008 and Buscher et al 2005). The majority of these studies confirmed a significant relationship. Second a relatively huge body of literature addressed the effect of different features of globalization on labor demand. A group of studies examined the impact of trade liberalization on labor demand elasticity, however results were inconclusive (Slaughter 2001; Fajnzylber and Maloney 2005; Mitra and Shin 2012; Lichter et al. 2013; Addison et al. 2005; Hijzen and Swaim 2008; Hasan et al. 2007; Fukase 2012; Jenkins 2004; and 2006; Krishna et al. 2001; Kien and Heo 2009 and McCaig 2011). Another group of studies analyzed the effect of foreign ownership or Multinationals on employment. The empirical evidence is mostly in favor of the existence of a positive relationship, but not universally so. Some examples in favor are studies by Bergin et al. (2009); Levasseur (2010); Fabbri et al. (2003); Senses (2010). However, studies analyzing a wider range of industries and including services in addition to manufacturing do not always reach this result (Buch and Schlotter 2013; Navaretti et al. 2003). Merikull and Room (2014) and Nguyen (2013) showed that the institutional environments of the subsidiaries of foreign-owned multinationals home country and host countries and adopting outward-oriented reforms

[3] These results goes along with Hamermesh's (1993) call for more relevant disaggregation of labour input. According to him the simple skilled versus non-skilled clasification may be too broad. Hamermesh (1993) pointed out the possible capital-skill complementarity and called for measuring parameters of interset based on disaggregated data that classify labor into groups which account for skills, and proper measures of the capital input (Addison et al. 2014).

determine whether labor demand of those subsidiaries will be more or less elastic than in domestic enterprises. While Gorg et al. (2006) highlighted that labor demand in multinationals could be less elastic if the firm has backward linkages with the domestic economy.

In Egypt, there exists a relatively huge empirical literature that investigates employment, unemployment and their determinants (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 and Dessus and Suwa-Eisenmann 1999). 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 employment and its determinant.

Accordingly, labor demand is a relatively overlooked matter in empirical labor economics literature in Egypt. This could be mainly due to the scarcity of micro data at the establishments level. To my knowledge no documented empirical study at that micro level of disaggregation as well as using a proper technological illustration of labor demand elasticities in Egypt exists.

In this context, the main aim of this study is to fill this gap by estimating the own wage elasticities of labor demand, in addition to the elasticities of substitution between diverse labor inputs disaggregated according to skill in Egypt. Based on micro establishment level data obtained from Egypt enterprise survey 2008 conducted by the World Bank. This paper is considered the first attempt to estimate labor demand functions for the Egyptian case at that level of disaggregation.

3. Conceptual Framework and Methodology

The theoretical framework to be adopted is based on a typical firm that can choose between diverse labor inputs under free substitution between them. Accordingly, workers will be notionally classified into four skill categories; professionals, skilled production workers, unskilled production workers and non-production workers[4].

The study follows common practice to estimate the demand for heterogeneous labor by embracing the dual approach and cost minimization conditional on output (Hamermesh 1993; Litcher et al. 2012). This approach assumes cost-minimizing and a flexible specification of the cost function. The duality between production and costs permit deriving the conditional labor demand functions -conditional on output –given the specification of the technology of an industry. In other words, conditional demand equations for different labor types is derived from a cost function that exists if the production function satisfies some regularity conditions and firms minimize variable costs (Freier and Steiner 2010).

Various functional forms that can be used for the estimation is found in the literature (Bernal and Cardenas 2003). The Cobb Douglas production function was commonly used but the underlying assumptions of homogeneity and separability it conveys are excessively restraining. Moreover, restricting the Elasticity of Substitution to one completely outwits one of the main goals of the present study. The Constant Elasticity of Substitution functions (CES) besides estimating factor demand equations that produce easily estimable elasticities between factors avoid the restriction of Elasticity of Substitution equal to one by allowing the Elasticity of Substitution to be different than unity, however it is constant between all input pairs, again this is a key constraint (Behar 2004).

There exist other more flexible functional forms that allow for a possibly more precise illustration of the underlying technology by not imposing separability of factor inputs or homotheticity assumptions. Furthermore, those functional forms allow elasticities to differ

[4] The level of disaggregation of labor is restricted by data availability on the relevant sub-groups and on on the respective wages.

along the sample. This group includes two functions the Generalized Leontief function (Berndt 1991) and the translog function (Christensen, Jorgenson and Lau 1973). Hence if the main concern is the changes in the elasticity of substitution, which is our case, one of those two specifications in the group of flexible functional form is a common choice. The Egyptian literature does not include any related application of either of these function forms to heterogeneous labor. Accordingly, this study will use a translog cost function, that may be deduced as a linear second order Taylor Approximations to an unknown underlying technology i.e. arbitrary cost function (Behar 2004).

In this framework and because of the difficulty in constructing firm level measures of capital cost we follow Addison et al. (2005) and Ribeiro and Jacinto (2008) and consider capital as a quasi-fixed factor[5]. Based on this assumption the analysis is only concerned with the optimal choice of variable inputs, thus the capital stock is used as a regressor in the labor demand functions instead of its user cost [6].

The Translog cost function of a firm measuring its costs C, given a particular level of output Y takes the following form:

$$\ln C(w_i \ ,Y) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ ln\, w_i + 0.5 \sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_{ij} \ln w_i \ln w_j + \beta_k \ln K + \beta_y \ln Y + \sum_{i=1}^{n} \beta_{iy} \ln w_i \ln Y + 0.5\, \beta_{YY} \ (\ln Y)^2 + 0.5\, \beta_{kk} \ (\ln K)^2 + \sum_{i=1}^{n} \beta_{ik} \ln w_i \ln K + 0.5\, \beta_{YK} \ln Y \ln K \qquad (1)$$

Where w_i is the price of variable factor i, K is the capital stock. To fulfill an essential condition for optimizing behavior, cost functions have to be homogenies of degree one with regards to prices, this could be enforced with no remedy of technological restrictions (Behar 2010)[7]. Therefore, for consistency with cost minimizing behavior (Berndt and Khaled, 1979), I impose Slutsky symmetry or symmetry of price effects condition that requires $\alpha_{ij}=\alpha_{ji}$ and linear price homogeneity which requires

$$\sum_{i=1}^{n} \alpha_i = 1 \qquad \sum_{i=1}^{n} \alpha_{ij} = \sum_{j=1}^{n} \alpha_{ij} = 0 \qquad \sum_{i=1}^{n} \beta_{iy} = 0 \qquad (2)$$

While labor demand equations cannot be directly estimated from the *translog* form, wage elasticities and cross elasticities can be estimated using on a system of equations acquired from Shephard's lemma, which yield equations for the share S_i of the variable cost of inputs *i*. (Ribeiro and Jacinto 2008). Shephard's lemma implies that the demand for a particular input or factor, $X_i = \frac{\partial C}{\partial w_i}$ could be produced through the first derivative of the cost function with regard to the price of this particular factor. Since the cost function is logarithmized therefore $\frac{\partial \ln C}{\partial \ln w_i} = \frac{\partial C}{\partial w_i} \frac{w_i}{C}$, one can obtain the cost shares for input i as:

$$S_i = \frac{w_i X_i}{C} = \frac{\partial \ln C(w_{i,} Y)}{\partial \ln w_i} = \alpha_i + \sum_{j=1}^{n} \alpha_{ij} \ln w_j + \beta_{iy} \ln Y + \beta_{ik} \ln K \qquad (3)$$

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[5] Capital is modeled as quasi-fixed input factors in the production, while labor is considered to adjust instantaneously to their long-run equilibrium, capital as a quasi-fixed input is believed to adjust only partially within one period, due to adjustment costs (Freier and Steiner 2010).

[6] Justification of this approach in the context of labor demand estimation is due to Bond and Reenen (2006) (Addison et al. 2005). Moreover, results reached by Behar (2010) confirmed that if lack of data prevents the use of costs of capital, omitting capital would not affect the estimates badly.

[7] After testing for it, Technological assumptions can be enforced on both the cost function and the share equations. It can be shown that $B_{iy} = 0\ \forall i$ implies homotheticity (referring to the independence of returns to scale of factor prices) by differentiating the cost function with respect to log *Y*. If the cost function is homothetic, then it is homogeneous of degree *r* if $B_y = 0$, with $r = \frac{1}{\alpha_y} . \alpha_y = 1$ corresponding to constant returns to scale (Behar, 2010).

Labor demand elasticities can then be calculated directly from the cost share. First the constant-output elasticity of factor demand (μ_{ij}) is the respond of the amount of factor i to a change in the price of another factor j, keeping output and prices of all other factors constant. Hence:

Own-wage elasticities are:

$$\mu_{ii} = \frac{\alpha_{ii} - \hat{s}_i + \hat{s}_i \hat{s}_i}{\hat{s}_i} \quad (4)$$

And cross-wage elasticities are:

$$\mu_{ij} = \frac{\alpha_{ij} + \hat{s}_i \hat{s}_j}{\hat{s}_i} \quad (5)$$

Second, The Allen elasticities of substitution which is the respond of the relative demand for factor i to changes in the relative price of factor j are given by:

$$\sigma_{ij} = \frac{\alpha_{ij} + \hat{s}_i \hat{s}_j}{\hat{s}_i \hat{s}_j} \quad (6)$$

$$\sigma_{ii} = \frac{\alpha_{ii} + \hat{s}_i + \hat{s}_i \hat{s}_i}{\hat{s}_i \hat{s}_i} \quad (7)$$

It is clear that, the relationship between the conditional elasticities of factor demand and the elasticities of substitution for a certain output level is $\mu_{ij} = S_j \, \sigma_{ij}$ (Litcher et al. 2012).

Own wage elasticities is expected to be negative and to decrease with skill level. While for the elasticities of substitution they are excepted to be either negative or positive, according to whether the groups of labors are complements or substitutes (Ribeiro and Jacinto 2008).

4. Estimation

The previous section showed how the elasticities of substitution and of factor demand are calculated using the parameters a and B of the translog cost function and the corresponding share equations. This section explains the estimation method of the parameters used in the current study. It also provides implication on the calculated elasticities constructed by those estimates.

A disturbance term ε_i is added to each of the cost and the i^{th} share functions. The resulting disturbance vector $\varepsilon = \{\varepsilon_1, \dots \dots \dots, \varepsilon_n\}$ is assumed to be multivariate and normally distributed, with mean vector zero and constant covariance matrix. Since by construction, the ai coefficients across the share functions add up to one for every observation. Thus, the residual cross product and disturbance covariance matrices are singular which prevent estimation (Berndt, 1991). A standard solution is to enforce homogeneity on both the cost function and the share equations using restrictions in (2) and the relation $S_i = 1 - \sum_{j \neq i} S_j$. Using the first restriction in equation (2), let $S_1 = 1 - \sum_{i=2}^{4} S_i$. Hence the unskilled labor equation is dropped and the rest of the share equations for other labor inputs are estimated as:

$$S_i = \alpha_i + \sum_j \alpha_{ij} \, ln \frac{w_i}{w_1} + \beta_{iy} \ln Y + \beta_{ik} \ln K + \varepsilon_i$$

where ε_i is a stochastic error term.

Assuming four different types of labor inputs, omitting the unskilled workers cost share equation and adding the subscripts *l for* establishment, the system of share equations to be estimated is as follows:

$$S_{2l} = \alpha_2 + \alpha_{22} \ln\left(\frac{w_{2l}}{w_{1l}}\right) + \alpha_{23} \ln\left(\frac{w_{3l}}{w_{1l}}\right) + \alpha_{24} \ln\left(\frac{w_{4l}}{w_{1l}}\right) + \beta_{2Y} \ln Y_l + \beta_{2K} \ln K_l + \varepsilon_{2l}$$

$$S_{3l} = \alpha_3 + \alpha_{32} \ln\left(\frac{w_{2l}}{w_{1l}}\right) + \alpha_{33} \ln\left(\frac{w_{3l}}{w_{1l}}\right) + \alpha_{34} \ln\left(\frac{w_{4l}}{w_{1l}}\right) + \beta_{3Y} \ln Y_l + \beta_{3K} \ln K_l + \varepsilon_{3l}$$

$$S_{4l} = \alpha_4 + \alpha_{42} \ln\left(\frac{w_{2l}}{w_{1l}}\right) + \alpha_{43} \ln\left(\frac{w_{3l}}{w_{1l}}\right) + \alpha_{44} \ln\left(\frac{w_{4l}}{w_{1l}}\right) + \beta_{4Y} \ln Y_l + \beta_{4K} \ln K_l + \varepsilon_{4l} \quad (8)$$

Since the unskilled workers cost share equation is omitted as mentioned before to account for the restriction that the labor cost shares in variable costs must add up to one be constant. The coefficients of this equation that are not estimated can be acquired using the theoretical restrictions, namely (Ribeiro and Jacinto 2008):

$$\alpha_{23} = \alpha_{32}$$

$$\alpha_{12} = \alpha_{21} = -(\alpha_{22} + \alpha_{23} + \alpha_{24})$$

$$\alpha_{13} = \alpha_{31} = -(\alpha_{32} + \alpha_{33} + \alpha_{34})$$

$$\alpha_{14} = \alpha_{41} = -(\alpha_{42} + \alpha_{43} + \alpha_{44})$$

$$\alpha_{11} = -(\alpha_{12} + \alpha_{13} + \alpha_{14}) = \alpha_{22} + \alpha_{33} + \alpha_{44} + 2\alpha_{23} + 2\alpha_{24} + 2\alpha_{34} \quad (9)$$

The cost share equations in (8) are a system of equations to be estimated using iterated Seemingly Unrelated Regression (ISURE) method. The ISURE is an extension of the Zellner Seemingly Unrelated Regression (SURE) model (Zellner 1962). Though using ordinary least squares (OLS) to estimate the equations separately still produce consistent estimates, SURE and ISURE is more efficient. An important advantage is that they exploit correlations between error terms in each of the share equations, which improve efficiency (Litcher et al. 2012).

First, SURE obtains the covariance matrix of the error terms, Ω using equation-by-equation OLS. Then the system of equations is estimated by feasible generalized least squares (FGLS), conditional on Ω (see Greene (2008)). The (ISURE) method to be adopted in this paper iterates SURE steps till the changes in the estimated parameters and in Ω become arbitrarily small. Since, only according to particular conditions the estimated parameters and standard errors are independent of the choice of the dropped share function. The ISURE method assures that the results are not related to the choice of the dropped cost share equation (Litcher et al. 2012).

This empirical model specification has several estimation issues that are worth noting. **First**, industry-specific shocks are expected to change labor demand for the industry in the same direction. Therefore, not accounting for those shocks while estimating labor demand equations may yield biased estimates. Hence, conditional labor demand functions (conditional on output) is estimated to control for those shocks. As the presence of output in the conditional labor demand functions is expected to account at least partially to the product demand shocks hence decreasing biasness (Hasan et al. 2007 and Fajnzylber and Maloney 2005, Nazier 2013).

Second, endogeniety of wages is one identification problem in estimating equation (8). As changes in labor demand may affect wages since labor demand and labor supply both depends on real wage. This result in a correlation between wage and the disturbance term in the estimated equation, thus resulting in biased estimates. Considering the estimation of equation (5) as an estimation of a labor demand function requires assuming that labor supply facing each unit of analysis, which is the firm, is perfectly elastic, so that wages are exogenous. This assumption seems strong however it can be defended based on two theoretical arguments. First, according to Nickell and Symons (1990) because labor supply and labor demand depends on two relatively different real wages hence the identification problem does not exist. On one side, firm values productivity at the industry's output price hence labor demand depends on nominal wages deflated by the producer price. On the other side, consumers concern is their real income in terms of 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) argued that the suitability of this assumption hangs on the degree of disaggregation of the data. Compared to the whole economy wages for the majority of individual firms are given and exogenous, consequently they face perfectly elastic labor supplies. Since the data utilized by this study is at the firm level thus their labor supply is closer to perfectly elastic than perfectly inelastic[8].

In calculating the elasticities, the present study has two advantages. First to calculate elasticities estimates in equations 4 to 7 it uses the regression's predicted shares instead of using the estimated coefficients and actual factor shares this is considered to be more accurate (Berndt, 1991). Second, it is common in the literature to compute the shares using the mean of the factor prices and quantities of factors hence reaching a one-value elasticity based on this point. Nevertheless, this ignores one main advantage of the translog function compared to other functional forms, precisely the possibility of the variation of elasticity estimates over the sample (Behar, 2004). Therefore, this study uses the estimated parameters and the characteristics of each firm to compute elasticities per observation. This enable presenting the median of the estimated elasticity as well as showing how elasticities differ over the sample.

To examine the significance of coefficients and test the assumptions of homogeneity, technological conditions, and separability, the study follows the main stream and uses the Wald tests but with caution as it might not be valid if the residuals are not multivariate normally distributed. However, the literature seems to support the assumption of normality. Moreover figure 1 in the appendix shows that residual in our sample follows a normal distribution.

As for testing the significance of the estimated elasticities the study follows Behar (2010) and utilize an informal technique of inference that indicates whether 95% of firms estimated elasticity have the same sign. This informal way is required because a statistically significant coefficient does not imply significant elasticities (Anderson and Thursby, 1986). Testing for the significance of the elasticities is difficult because the elasticity estimates are non-linear combinations of the coefficients and data. One way to overcome this is to utilize non-linear approximation techniques as the Delta method (see Greene, 2003). However, they are especially sensitive to non-normality. Anderson and Thursby specify conditions according to which elasticities of substitution asymptotically follow the normal or ratio-of-normal distribution. However, those conditions are not fitting many calculations methods used in the literature and cannot be used in the present study as it uses the predicted not actual factor shares while one of conditions is that the means of the actual factor shares are used.

The review of empirical studies addressing elasticities of substitution showed that some of them don't test significance or present confidence intervals (Hamermesh, 1993; Chung, 1994; Bergström and Panas, 1992; Teal, 2000). While a few others treat coefficient as the only variable with a confidence interval and consider factor shares to be fixed, and hence inaccurately use a t-statistic to test elasticities significance (Binswanger, 1974b and Behar 2008).

So, instead, this study follows Behar (2008 and 2010) and uses his informal approach that indicates how the elasticities vary along firms in the sample. This is advantageous in many aspects. First, it is considered much more useful to know the sign of the elasticity for most firms than just knowing the average. Additionally, estimated elasticity might be accurate at the center of the data, but not for the rest of it. Accordingly, the estimated coefficient and each firm's input quantity are used to compute the elasticity for per firm. Hence, I end up with a distribution of elasticities. Where roughly 95% of firms will have positive elasticities If elasticity is found to be positive to the 5th percentile, while if it is negative to the 95th percentile, this indicates that 95% of firms have a negative elasticity (Behar 2010).

[8] This approach is used broadly; according to Hammermesh's 1993 literature survey most of the studies at the industry-level regress quantities on prices and consider the results as labor demand only (Slaughter 2001).

5. Data and Variables Construction

The present study uses mainly the Egypt Enterprise Survey 2008 conducted by the World Bank. This study was conducted in Egypt between August and October 2008 as part of the Enterprise Survey initiative. The survey covered 1530 establishment. The manufacturing and services sectors are the main sectors of interest[9]. The survey is focused on Formal (registered) companies with 5 or more employees[10]. The manufacturing survey contains data for nine sectors. The nine sectors covered are: garments, textiles, Machinery and Equipment, chemicals, Electronics, Metal industries, non-metal industries, agro-industries and other industries. While services establishments include transport, restaurants, hotels, construction[11], retail, wholesale, storage, communications, and IT. This paper will focus on the manufacturing sectors. Hence our sample focuses on 1156 firms.

A main advantage of the used survey is that it includes very comprehensive information at the establishment level. This covers for each firm, firm characteristics, access to finance, sales, costs of inputs and labor disaggregated by four skill levels, workforce composition and gender, licensing, infrastructure, trade, crime, competition, capacity utilization, land and permits, taxation, informality, business-government relations, innovation and technology, and performance measures.

According to this dataset workers are divided into four occupation groups professional, skilled production workers, semi-skilled production workers (machinery operators) and unskilled (non-production workers). The data set includes wages and salaries for permanent workers only[12] hence we focus on permanent workers, excluding temporary workers.

The data set provides information for y_i, k_i, and w_i The price of different labor groups w_i is obtained from the data as the total compensation and salaries of all permanent workers differentiated by skill level. Then wages are deflated using the product price indices.

Our output measure Y_i is real value added, computed by subtracting materials cost from sales. As in most other firm-level data sets, our data does not contain firm-level price indices; hence only industry-level deflators can be used, following the best practice in the literature. Capital stock is measured as the net book value of fixed assets after depreciation (fixed assets comprise machinery, vehicles, and equipment as well as land and buildings). Capital will be deflated using aggregate price levels of capital services from the Penn World Tables.

The used data is a single cross section; hence it could sensitive to firm specific effects which may result in omitted variables bias. To account for that control variables are needed Providentially, our data contains a rich set of variables for this purpose. The model estimated in this study include variables like a dummy for whether the firm export or not, share of foreign ownership, firm size and age, and a dummy for whether the firm has a department specialized in research and development or not.

[9] Firms are classified according to the International Standard Industrial Classification of All Economic Activities (ISIC) codes 15-37(manufacturing), 45 (construction), 50-52 (whole sale and retail trade), 55(hotels and restaurants), 60-64(Transport, storage and communications), and 72 Computer and related activities) (ISIC Rev.3.1).

[10] Firms with 100% government/state ownership are not eligible to participate in an Enterprise Survey.

[11] Construction is included in the services establishments although one would argue it is considered a "production" industry along with mining and quarrying and it is more often included with manufacturing. However, the Egypt Enterprise Survey 2008 conducted by the World Bank and used in this paper include it in the services sector. This is because it follows firms' classification according to International Standard Industrial Classification of All Economic Activities (ISIC Rev.3.1) codes 15-37(manufacturing), 45 (construction), 50-52 (whole sale and retail trade), 55(hotels and restaurants), 60-64(Transport, storage and communications), and 72 Computer and related activities) (ISIC Rev.3.1). where construction is not included in manufacturing.

[12] Permanent workers are all paid long-term employees (those employed for one year or more) with guarantee of renewal of employment contract.

Table 1 shows summary statistics of the sample. After data cleaning and adjusting for non-response and outliers our sample consists of 1064 firms with an average age of 32 years in business, average sales of 67756.8 thousand Egyptian pounds and average total permanent employment of 238 workers per firm. The table also shows that in average the share of professional labor, skilled labor, semiskilled labor and unskilled labor from total employment in a firm is 18.7%, 47.6%, 24.3% and 9.4% respectively. Figure 1 confirms a well-known fact of the Egyptian economy that is the majority of firms are of small size compromising around 54% of total number of firms. Figure 2 shows that less than third of the firms in our sample has exported part or all of its sales. Similarly, less than third of the sample has an R&D department.

6. Results

This section starts with a brief discussion on the regressing of the cost function and the shares equation before turning to the results of the main parameters of interest, which are the elasticities. As mentioned before, I estimate the static model of the system of equation (8) together with the cost function in (1) using the SURE method omitting the equation for unskilled workers. Estimation yields a big number of parameters that are then used in order to construct elasticities. Table 2 displays the estimates for the cost function. The hypothesis that all α_{ij} = 0 is rejected. Nevertheless, the pseudo-R^2 is 0.75 indicating a good fit of the regression. Results reject the homotheticity assumption, so the restrictions are not imposed.

Since the variables controlling for firm-specific effects are not of direct interest to the analysis, I give a very brief discussion. Of the included variables that are significant, is firm age, as older firms seem to have higher costs, which may be expected. Costs decrease with firm size. Results also show that the higher the share of foreign ownership the higher the cost. This is an unexpected result however it could be explained by the fact that the number of foreign owned firms in the sample is only about 22 hence 96.62% of firms in the sample has zero foreign ownership. The insignificance of both whether the firm export or whether is has an R&D department could be due to the fact that the majority of firms does not export and have no R&D department as shown in the descriptive statistics section.

Since results for the share equations would provide very slight additional information. The analysis will focus on elasticities while the complete set of coefficient estimates is provided in the Appendix. However basic diagnostics for the system of equation estimated are demonstrated in Table 3. Remarkably, it shows that all the share equations are significant.

The own- and cross-wage elasticities of factor demand. are displayed in Table 4. As mentioned before, it is expected that the own wage elasticities would be negative and the higher the skill level the smaller is the magnitude, while cross-wage elasticity, could be positive or negative. The diagonal provides the own wage elasticities for the category being estimated, while the cross-wage elasticities are displayed outside the main diagonal.

Looking at own-wage elasticities, we find that first the signs of the own wage elasticities are negative as expected and inelastic. For example, holding output constant a 10% drop in unskilled wages would result in a 1.62% increase in unskilled employment. This result supports that employment outcomes are not only determined by shifts in labor supply. Since these are constant output elasticities the negative sign confirms that the estimates are consistent with cost minimizing behavior, and that scale effect is not what artificially created the negative sign (Behar 2010). Second, results show that in absolute values the highest elasticity is for skilled labor at 0.68 followed by semi-skilled at 0.43; professionals at 0.34 and the lowest is for the unskilled workers at 0.16. Hence the magnitude is higher the higher the skill level except for the highest skill level, which is professionals.

This result contradicts our theoretical expectation. However, it could have two explanations. First, high levels of elasticities for low-skilled workers are commonly justified by globalization and the underlying international competition from countries with low wages that devastate jobs for unskilled workers. This could be true for industrial countries not for a middle-income country like Egypt. Second, for Egypt in specific the unemployment rate is highest among the university and above university graduate hence this could be reflected in a higher own wage elasticity for the skilled well-educated labor as compared to the unskilled low educated labor whose unemployment rate is much lower. Moreover, empirically this result is not surprising given that the empirical literature shows that the effect of competition and globalization on employment and wages in Egypt is relatively weak. In addition, the empirical evidence concerning the magnitude of the own wage elasticities for different skills is somewhat ambiguous. For example, Lichter et al. (2013) states that about 50% of studies on Germany, conclude that the absolute value of elasticities for high-skilled labor is greater than the that of the medium-skilled; while in the other 50%, it is less.

As for the cross-wage elasticities, in general results indicate that an increase in the wage of a labor category has negative impact on quantities employed of the other categories. For instance, a 10 % increase in wages of unskilled labor will lead to a decrease of 1.4% for semiskilled labor, 0.65% for skilled labor and 0.54% for professionals. This finding is true except for the unskilled (non-production) workers, where an increase in the wage of any of the other three labor types increase the unskilled workers employment holding output constant. This proves the value of disaggregation of labor type.

Table 5 presents the AES estimates. The asterisk indicates values of the same sign for a minimum of 95% of firms in the data. A positive coefficient indicates that the corresponding factors are substitutes. A decrease in one factor's cost relative to that of the other will cause an increase in the relative quantity of the later. While a negative coefficient represents complements. For instance, a 10% increase in wages of unskilled labor relative to that of semi-skilled labor will result in a 0.27% rise in the ratio of semi-skilled employment to unskilled employment. Generally, the elasticity estimates suggest similar conclusion as reached by the cross-wage elasticities estimates except for the effect of changes in unskilled labor wage on other types of labor; First unskilled workers and all other occupations are substitutes. Second, semi-skilled workers and unskilled workers are substitutes while they are complements with skilled and professional. Third, similarly skilled production workers are substitutes with unskilled workers while they are complements with semi-skilled production workers and professional. Finally, professional labor are substitutes with unskilled workers, but they are complements with semiskilled and skilled workers. This is an important result as it confirms the importance of using flexible cost function forms as studies considering two factors only or those adopting CES functions by construction consider skilled and unskilled labor as substitutes.

7. Conclusion

This paper analyzes essential issues of labor demand; how wages affect employers demand for labor and how this differs according to skill levels. Specifically, this study measures the own wage elasticities of the demand for labor, in addition to the elasticities of substitution between different labor inputs disaggregated according to skill in Egypt. Estimates of such phenomena at the firm level are rare for developing countries in general and for Egypt in specific, this paper happens to be the first in the Egyptian case.

Accordingly, a labor demand function with flexible technology is estimated. The evidence from the econometric analysis indicates that unskilled workers are substitute with all other labor types while all other three types- the semi-skilled production workers, skilled workers and professionals -are complements to each other. Results also indicate that skilled workers wage elasticities are higher than that for all other types of labor. We can also conclude that labor demand in Egypt in inelastic no matter the skill level.

This result is important both at the theoretical as well as the practical levels. At the theoretical level, it highlights the importance of disaggregation. By definition two-factor studies or CES ones, consider skilled and unskilled labor to be substitutes. While results reached in this study- which go in line with the literature- confirm that using only two factors can be very misleading.

At the practical level, through estimating disaggregated elasticities with a flexible cost function, several policy implications could be drawn. First results show that unskilled workers are substitute with all other labor types while all other three types are complements to each other. These elasticities imply that besides increasing demand for unskilled labor itself the impact of a wage subsidy for unskilled workers on demand for all other types would be negative. Second results concerning complementarity between semi-skilled, skilled and professional labor suggest that wage changes for one type, would change employment of that type as well as the other types. Thus, there are benefits from co- ordination in wage setting between labor types in the same industry compared to co- ordination between industries. This might explain why unions in one industry may bargain for wages for different skill types simultaneously. Since normally unions try to maintain wage differences, if they negotiate wages of each type of labor one at a time this will affect employment of other groups as well, but when negotiating simultaneously this make sure that the effect of changes in wage of one type on employment of another is offset by the change in wages of the later.

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Figure 1: Distribution of Firms by Size

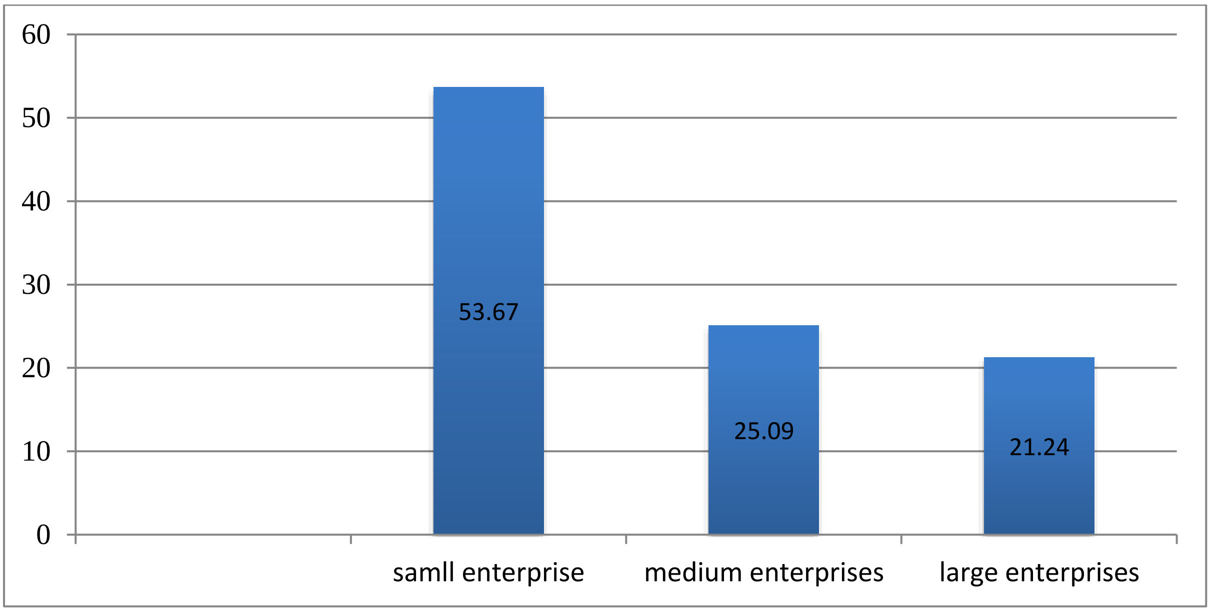


Figure 2: Percent of Firms Exporting and Have R&D Departments

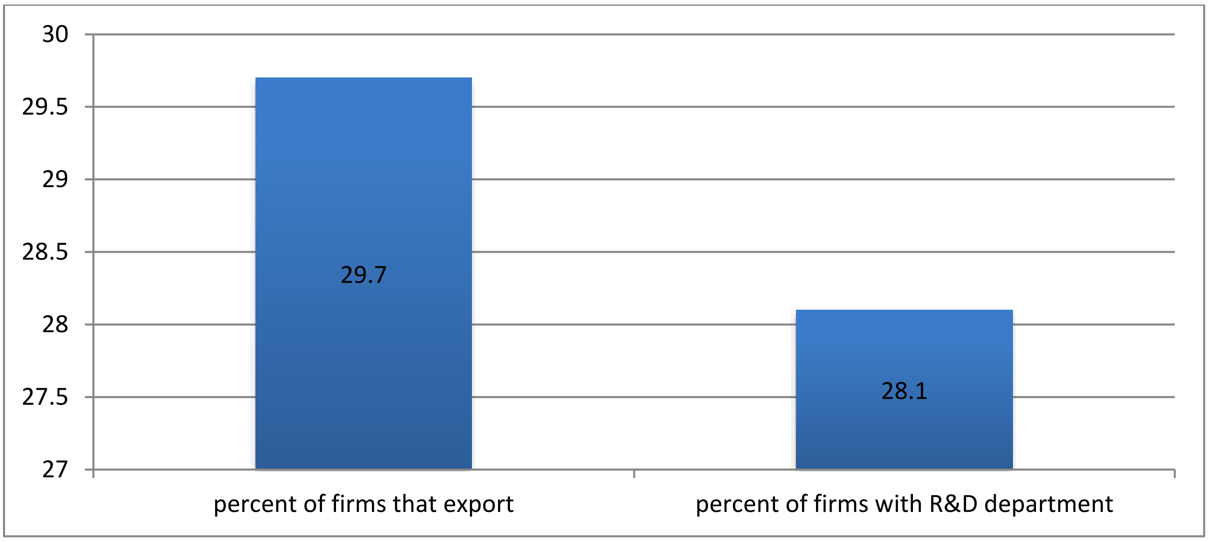


Table 1: Descriptive Statistics for the Sample by Firm

Variable	Obs	Mean	Std. Dev.	Min	Max
Share of professional labor from total employment	1062	18.7	13.2	0.0	80.0
Share of skilled labor from total employment	1062	47.6	20.8	0.0	100.0
Share of semiskilled labor from total employment	1062	24.3	18.1	0.0	100.0
Share of unskilled labor from total employment	1062	9.4	9.0	0.0	88.9
Total wages of unskilled labor	1064	2580.8	21100.9	0.0	513668.1
Total wages of semiskilled labor	1064	5468.3	32334.0	0.0	704873.1
Total wages of skilled labor	1064	8815.8	32283.8	0.0	447764.8
Total wages of professional labor	1064	7968.7	41240.5	0.0	643224.7
Total sales in thousands	1051	67756.8	466946.1	0.0	11700000.0
Capital in thousands	1043	159000.0	2330000.0	0.0	63200000.0
Share of firm's sales were exported	1063	11.2	25.0	0.0	100.0
Firm export or not	1064	0.3	0.5	0.0	1.0
Total employment	1064	237.7	643.6	2.0	8982.0
Firm size	1064	1.7	0.8	1.0	3.0
Firm age	1062	32.3	19.1	9.0	166.0
The Firm has a department specialized in R&D	1064	0.281015	0.4497062	0	1.0
Share of Foreign ownership	1064	2.097086	13.08679	0	100.0

Table 2: Cost Function Parameter Estimates

Variables		p-value	Variables		p-value
Constant	7.081***	0	0.5× (RVA)^2	0.00522	0.746
	(1.153)			(0.0161)	
Un.	0.649**	0.018	(RVA) × Un	0.0391	0.186
	(0.275)			(0.0295)	
Semi.	-0.609**	0.046	(RVA) × Semi	-0.0526	0.109
	(0.306)			(0.0328)	
Skil.	0.0693	0.805	(RVA) ×Skil	0.00415	0.866
	(0.280)			(0.0245)	
Prof.	0.0942	0.738	(RVA) ×Prof	-0.0228	0.43
	(0.282)			(0.0289)	
RK	-0.144	0.326	0.5× (RK)^2	0.0228*	0.051
	(0.146)			(0.0117)	
RVA	0.635***	0	(RK) × Un	-0.0594**	0.019
	(0.147)			(0.0253)	
0.5 ×Un^2	0.0506**	0.04	(RK) × Semi	0.0679**	0.019
	(0.0246)			(0.0289)	
Un ×Semi	-0.0250	0.547	(RK) × Skil	-0.0187	0.422
	(0.0416)			(0.0232)	
Un ×Skil	0.0403	0.22	(RK) ×Prof	-0.00126	0.962
	(0.0329)			(0.0264)	
Un ×Prof	-0.0661	0.103	(RVA) × (RK)	0.0170	0.461
	(0.0405)			(0.0231)	
0.5 ×Semi^2	0.0593	0.297	Does the firm export?	0.118	0.293
	(0.0569)			(0.113)	
Semi ×Skil	-0.00798	0.835	Firm size: Small	0.472**	0.011
	(0.0382)			(0.186)	
Semi ×Prof	-0.0177	0.735	Firm size: Medium	0.258*	0.077
	(0.0522)			(0.146)	
0.5 ×Skil^2	0.102**	0.043	Firm age	-0.0286***	0
	(0.0505)			(0.00625)	
Skil ×Prof	-0.0877**	0.037	Firm age square	0.000249***	0
	(0.0421)			(5.25e-05)	
0.5 ×Prof^2	0.189***	0.003	Has R&D department	0.107	0.342
	(0.0644)			(0.112)	
Observations	644[13]		Share of foreign ownership	0.00528*	0.091
R-squared	0.752			(0.00312)	
Homotheticity (p-value)		0.018			
Joint significance of *αij* (p-value)		0.0013			

Notes: Un: unskilled; Semi: semi-skilled; Skil: skilled; Prof: professional; RVA: Real Value added; RK: real capital. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[13] Correcting for non-response and outliers we are left with 1064 observations however since our wage variable included in the cost share equations in the regression is $\ln\frac{w_i}{w_1}$ it first yields missing values for all observations where $w_1 = 0$ before transformation to ln and then some other missing values are generated for all observations where $\frac{w_i}{w_1} = 0$ after taking the ln. This left us with only 644 observations in the regression.

Table 3: System Diagnostics

Share Equation	Obs.	RMSE	R^2	χ^2	P-value
lncost	644	1.14	0.75	2146.06	0.0000
Semi-skilled	644	0.07	0.25	212.48	0.00
Skilled	644	0.12	0.26	229.08	0.00
Professional	644	0.08	0.19	155.54	0.00

Table 4: Factor Demand Elasticities (% change in quantity of factor i in response to a 1% change in the price of factor j)

	Wages (j)			
Employment (i)	**Unskilled (non production workers)**	**Semi-skilled production workers (machinery operators)**	**Skilled production workers**	**Professional**
Unskilled (non production workers	-0.161*	0.136	0.109	0.054*
Semi-skilled production workers (machinery operators)	-0.139	-0.426	-0.188	-0.207
Skilled production workers	-0.065*	-0.045	-0.677*	-0.259*
Professional	-0.054*	-0.172	-0.286	-0.343

Source: Author's calculations. * Indicates consistent across at least 95% of firms in the sample.

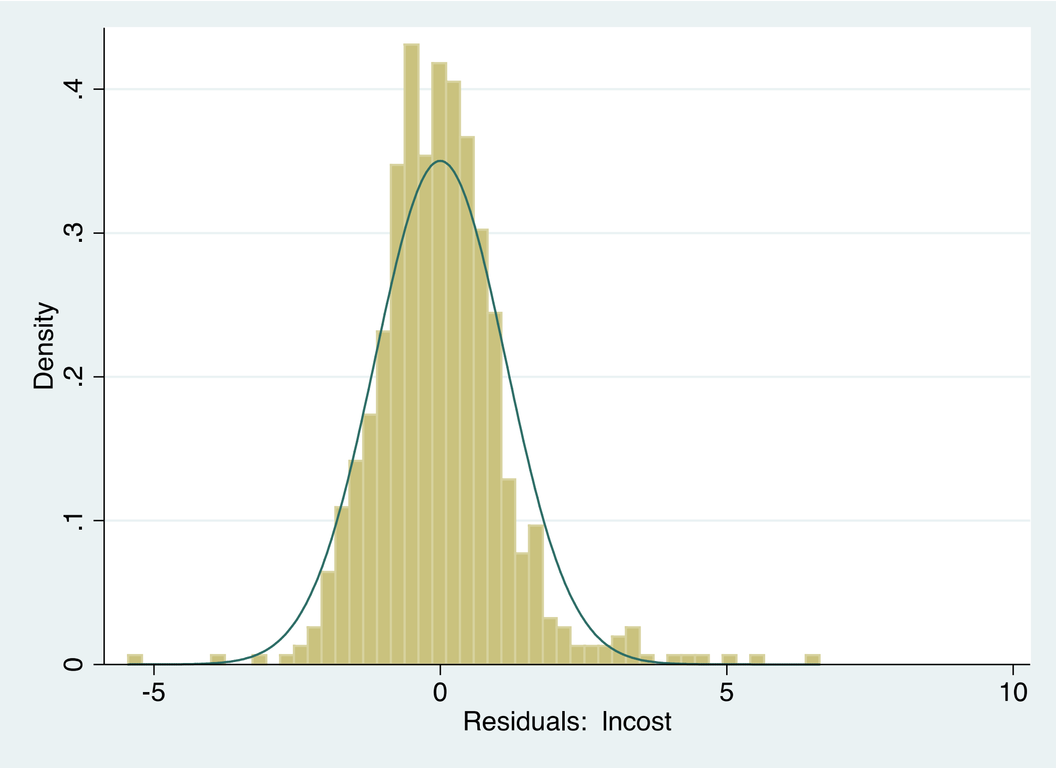
Table 5: Allen Elasticities of Substitution (% change in the ratio of factor quantities in response to exogenous change of 1% in relative factor prices)

	Wages (j)			
Employment (i)	**Unskilled (non production workers**	**Semi-skilled production workers (machinery operators)**	**Skilled production workers**	**Professional**
Unskilled (non production workers	0.009*	0.007	0.01478*	0.0041*
Semi-skilled production workers (machinery operators	0.0274*	-0.008	-0.148*	-0.001*
Skilled production workers	0.004*	-0.001	-0.045	-0.007
Professional	0.001*	-0.052	-0.101	-0.013

Source: Author's calculations. * Indicates consistent across at least 95% of firms in the sample.

Appendix 1

Figure 3: Histogram for Residuals of Cost Function Regression



Appendix 2: Estimated Parameters of the SURE model

Variables	Semi-skilled production workers	Skilled production workers	Professional
Semi-skilled production workers wages	0.0312***	-0.00692	-0.0118***
	(0.00312)	(0.00529)	(0.00352)
Skilled production workers wages	-0.0134***	0.0339***	-0.0210***
	(0.00268)	(0.00454)	(0.00302)
Professional wages	-0.0128***	-0.0261***	0.0330***
	(0.00313)	(0.00530)	(0.00353)
Real value added	-0.0116***	-0.0235***	-0.0129***
	(0.00171)	(0.00290)	(0.00193)
Real Capital	-0.00372**	-0.00859***	-0.00375**
	(0.00158)	(0.00267)	(0.00178)
Does the firm export?	-0.00933	-0.0187*	-0.00730
	(0.00660)	(0.0112)	(0.00745)
Firm size (Reference: Large enterprises)			
Small enterprises	-0.0513***	-0.0948***	-0.0578***
	(0.00969)	(0.0164)	(0.0109)
Medium enterprises	-0.0237***	-0.0471***	-0.0352***
	(0.00780)	(0.0132)	(0.00880)
Firm age	0.000681*	0.000692	0.000503
	(0.000366)	(0.000621)	(0.000413)
Firm age square	-4.81e-06	-5.61e-06	-3.99e-06
	(3.08e-06)	(5.23e-06)	(3.48e-06)
Does the firm have a department specialized in research and development?	0.00198	0.00486	0.000295
	(0.00658)	(0.0112)	(0.00742)
Share of foreign ownership	-1.69e-05	-0.000173	-0.000155
	(0.000183)	(0.000311)	(0.000207)
Constant	0.150***	0.288***	0.170***
	(0.0226)	(0.0383)	(0.0255)
Observations	644	644	644
R-squared	0.248	0.262	0.195

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1