Gokhan Akay[1], Mutlu Yuksel[2]

DEMAND FOR SKILLED AND UNSKILLED LABOR: EVIDENCE FROM MANUFACTURING FIRMS IN GHANA

The purpose of this study is to calculate labor demand elasticities for Ghana manufacturing plants in industry and aggregate level. We use the unbalanced panel of plant-level data for manufacturing firms in Ghana during 1991-1997 in 4 industries (food-bakery, textiles-garments, wood-furniture and metal-machinery). The translog cost function is estimated within the ITSUR framework with the assumption of a fixed sector-specific effect for aggregated manufacturing industries and each individual sector. We find that all pairs of factors are substitute for one another in all 4 manufacturing industries. The own wage elasticities range from -0.65 to -0.89 for unskilled workers and from -0.88 to -0.92 for skilled ones. Our findings also suggest that capital-skill complimentary holds in aggregate level and all sectors in Ghana.

Keywords: *labor demand, elasticity of substitution, translog cost function.*

JEL Classifications: *J30, J31, L6.*

Гьокан Акай, Мутлу Юкшель

ПОПИТ НА КВАЛІФІКОВАНИХ І НЕКВАЛІФІКОВАНИХ ПРАЦІВНИКІВ: ЗА ДАНИМИ ВИРОБНИЧИХ ФІРМ У ГАНІ

У статті розраховано еластичність попиту на робітників промислових підприємств Гани і в цілому в усіх галузях. Використано незбалансовані панельні дані на рівні заводів для виробничих підприємств у Гані протягом 1991-1997 рр. у 4 галузях (харчова — хлібобулочні вироби, текстиль — одяг, дерево — меблі і металообробка — устаткування). Транслогова функція вартості оцінена за моделлю ITSUR з урахуванням фіксованого впливу галузі на промисловість в цілому і кожну окрему галузь. З'ясовано, що всі пари чинників взаємозамінні у всіх 4 досліджених галузях промисловості. Власні еластичності заробітної плати варіюються від -0,65 до -0,89 для некваліфікованих робітників і від -0,88 до -0,92 — для кваліфікованих. Результати також показали, що співвідношення "капітал-навик" присутнє на агрегованому рівні у всіх галузях у Гані.

Ключові слова: *попит на робочу силу, еластичність заміщення, транслогова функція вартості.*

Табл. 4. Фор. 8. Літ. 19.

Гёкан Акай, Мутлу Юкшель

СПРОС НА КВАЛИФИЦИРОВАННЫХ И НЕКВАЛИФИЦИРОВАННЫХ РАБОТНИКОВ: ПО ДАННЫМ ПРОИЗВОДСТВЕННЫХ ФИРМ В ГАНЕ

В статье расчитаны эластичность спроса на рабочих по промышленным предприятиям Ганы и в целом по всем отраслям. Использованы несбалансированные панельные данные на уровне заводов для производственных предприятий в Гане с 1991 по 1997 гг. в 4 отраслях (пищевая — хлебобулочные изделия, текстиль — одежда, дерево — мебель и металлообработка — оборудование). Трансловая функция стоимости оценена по модели ITSUR с учетом фиксированного влияния конкретной отрасли на промышленность в целом отдельные отрасли. Выяснено, что все пары факторов

[1] Assistant Professor of Economics, Istanbul Kemerburgaz University, Turkey.
[2] Assistant Professor of Economics, Dalhousie University, Halifax, Nova Scotia, Canada.

взаимозаменяемы во всех 4 исследуемых отраслях. Собственные эластичности заработной платы варьируются от -0,65 до -0,89 для неквалифицированных рабочих и от -0,88 до -0,92 — для квалифицированных. Результаты также показали, что соотношение "капитал-навык" присутствует на агрегированном уровне во всех отраслях в Гане.

Ключевые слова: *спрос на рабочую силу, эластичность замещения, транслоговая функция стоимости.*

The estimation of labor demand for various countries or industries has increasingly received attention of both researchers and policy makers since it plays essential role in influencing labor market. Globalization and government activities influence labor market by changing employers' demand for workers. There are two major hypotheses proposed to explain these structural changes. One strand of literature investigates the standard Hecksher-Ohlin model of trade. These studies conclude that trade liberalization decreases the wage differential between skilled and unskilled labor in developing countries while increasing the wage disparity in developed countries. Therefore, the expansion of trade in labor-intensive goods has put downward pressure on unskilled wages in traded sector (Wood, 1994; Lawrence and Slaughter, 1993; Sachs and Schatz, 1994). Another well-known explanation is the skill biased technological change (Author, Katz and Krueger,1998). Capital accumulation caused by trade liberalization increases the wage differential in developing countries, caused by trade liberalization increases the wage differential in developing countries. When technological change is skill biased, the relative demand for skilled labor expands as the level of technology increases. It is crucial to identify elasticities since the magnitudes of elasticities show by how much a shock to input prices would alter the demand for those inputs. Rodrick (1997) emphasizes that more elastic factor demand can change income distribution, decrease the bargaining power of union, increase the volatility of employment and shifts non-wage labor costs toward labor. As pointed out by Fajnzylber and Maloney (2005), "changes in this one parameter can account for many of concerns surrounding globalization".

A large body of studies has calculated labor demand elasticities using a variety of methods and types of data (Hammermesh, 1993). Slaughter (2001) shows that own demand elasticities for production workers is -0.7 while that of non-production worker is -0.63 for the US manufacturing time series data for the years 1960-1990. Roberts and Skoufias (1997) estimated the labor demand for skilled and unskilled labor using panel data on Colombian manufacturing plants. They showed that output elasticities are 0.89 and 0.76 and own wage elasticities are -0.42 and -0.65. Teal (2000) used firm-level data for Ghana during the period 1991-1995. He shows that the own price elasticities of skilled and unskilled male labor are -0.44 and -0.52, respectively. Behar (2004) showed that capital and all occupation types are substitutes and own-price labor demand elasticities range from -0.56 to -0.8 for South African manufacturing. Fajnzylber and Maloney (2005) employed plant level data for Chile, Colombia and Mexico. They found that own wage elasticities range from -0.32 to -1.37 for blue collar workers and vary from -0.44 to -0.59 for white-collar workers.

The empirical estimates of the labor demand functions illustrate important adjustments in the employment of skilled and unskilled labors in response to differences in output and wages. Real wages in Ghana have decreased substantially after

economic reforms of the 1980s. According to Alderman (1991), real wages in 1985 were at 28% of their 1975 value. Teal (2000) presented that the real wage rate for unskilled workers declined by 25% while the real wage of skilled labor increased by 16% in manufacturing of Ghana during — 1992-1996. Gorg and Strobl (2002) showed that an increase in the relative wages of skilled labor in Ghana. They find that changes in technology through imports of technology-intensive capital goods or export activity.

We decidedto use the firm-level data for Ghanaian manufacturing during 1991-1997 in 4 industries (food-bakery, textiles-garments, wood-furniture and metal-machinery). The firm-level data offers some advantages over the estimates based on industry or aggregate level. First, as a consequence of simultaneity bias, microlevel estimates are more sensitive than aggregate studies. Second, individual firms usually face a perfectly elastic labor supply. Given exogenous wages, firms choose employment. In contrast, an entire economy faces a perfectly inelastic labor supply. Given exogenous quantities, wages are endogenously determined (Slaughter, 1999). However, the present study contains firm-level data offering several advantages. By using the available data on firm size, location, ownership and firm age as control variables, it is possible to reduce the bias due to omitted variables.

Teal (2000) used the same firm-level data for 1991-1995. He found that the elasticity of substitution between unskilled labor and capital is greater than the elasticity of substitution between skilled labor and capital by using fixed effects in aggregate level. We extend the previous research in Ghana through implementing industry-level estimation. We also add to the previous literature through using uniquely diverse and disaggregated firm-level data for the time period of 1991-1997 in Ghana. The translog cost function is estimated following the ITSUR framework with the assumption of a fixed sector-specific effect for aggregated manufacturing industries and each individual sector in Ghana. We find evidence suggesting relatively high degree of substitution between unskilled and skilled labor in Ghanaian manufacturing. The estimated elasticity of substitution shows that unskilled labor, skilled labor and capital are substitutes for one another for aggregated manufacturing industries and individual sectors. The own wage elasticities range from -0.65 to -0.89 for unskilled workers and vary from -0.88 to -0.92 for skilled workers. The results of own price elasticities show that demand for skilled labor is more elastic than the demand for unskilled labor.

The remainder of the paper is structured as follows. Section 2 presents the empirical model. Section 3 discusses the data and descriptive statistics. Section 4 describes the econometric methodology and presents the empirical results. Section 5 concludes.

2. Empirical Model. In order to estimate the labor demand elasticities one requires a functional form that is general enough to hold different elasticities of substitution. We use translog cost function suggested by Christensen et al. (1973)[3]:

$$(1)LnC = \alpha_o + \sum_{i=1} \alpha_i LnPi + \frac{1}{2}\sum_{i=1}\sum_{j=1} \gamma_{ij} LnPiLnPj + \alpha_y LnY + \frac{1}{2}\gamma_{yy}(LnY)^2 + \sum_{i=1} \gamma_{iy} LnPiLnY, \quad (1)$$

[3] Cost functions are more reliable with the analysis that wages are exogenous. Because of optimizing behavior, cost functions exhibit homogeneity of degree one in price. It improves estimates without making technological assumptions. Also cost functions are more consistent with the view that wages are exogenous.

where *i, j*= 1,....,N index the N different inputs considered and $\gamma_{ij} = \gamma_{ji}$, C represents total production cost, Y is the total output, and P_i's are the prices of factor inputs. Main conditions are required for cost function. It must be homogenous of degree one in prices. It implies that total cost must increase proportionally when all prices increase proportionally for a fixed level of output. Thus, following restrictions on equation (1) apply

$$\sum_{i=1} \alpha_i = 1, \tag{2}$$

$$\sum_{i=1} \gamma_{iy} = 0, \tag{3}$$

$$\sum_{i=1} \gamma_{ij} \sum_{j=1} \gamma_{ij} = \sum_{i=1} \sum_{j=1} \gamma_{ij} = 0 \tag{4}$$

According to Shephard`s Lemma, the optimal cost minimizing demand for an input can be derived through differentiation of the cost function with respect to its price. In case of the translog cost function, this equals to the cost share of input *j*, S_j.

$$\partial \text{Ln } C/\partial \text{Ln Pj} = \text{Pj/C } \partial C/\partial \text{Pj} = \text{PjVj/C} = \text{Sj}. \tag{5}$$

Vj measures the quantity of input *j*. Monotonicity of the partial derivatives require the LHS of (2) to be positive. For the inputs of capital, skilled and unskilled labor, differentiation of (1) with respect to ln Pj yields the following equation:

$$S_{it} = \alpha_i + \sum_{j=1} \gamma_{ij} LnP_{jt} + \gamma_{iy} LnY_t + \lambda_i + \varepsilon_{it}, \tag{6}$$

where S_{it} is the factor share of the i^{th} firm at time t and λ_i is the firm specific effect. Stochastic specification of the function is done through adding a random disturbance term to each cost-share equation. It is assumed that the vector of $\{\varepsilon_K, \varepsilon_S, \varepsilon_U\}$ is multivariate, normally distributed, with a mean vector of zero and with a constant covariance matrix. As the cost share equations sum up to one and only two of them are linearly independent, the sum of random errors adds up to zero for each observation. Due to these properties, the covariance matrix is singular and non-linear.

To overcome the problem of singularity, one of the 3 cost share equations from the system is dropped. Only 2 equations need to be directly estimated. The parameter estimates give the same result regardless which equation is dropped. In the case, where the cost-share equation of capital is dropped, after the imposition of symmetry and constant returns to scale, from the estimated coefficients of the system of equations in (6), Allen-Uzawa elasticities of substitution (Uzawa,1962) can be derived through calculating:

$$\sigma_{ij} = (\gamma_{ij} + S_i S_j)/(S_i S_j) \text{ and } \sigma_{ii} = (\sigma_{ii} + S_i^2 - S_i)/S_i^2 \quad i \neq j, \tag{7}$$

where $\sigma_{ij} > 0$ is the factors are substitutes, $\sigma_{ij} < 0$ is the factors are complements, and $\sigma_{ij} = 0$ is the factors have no relationship.

Own- and cross-price elasticities of demand are calculated according to:

$$\varepsilon_{ij} = (\gamma_{ij} + S_i S_j)/S_j \text{ and } \varepsilon_{ii} = (\gamma_{ii} + S_i^2 - S_i)/S_i. \tag{8}$$

3. Data. The empirical analysis is conducted using unbalanced panel data gathered from Ghanaian manufacturing firms. These data are drawn from the Regional Programs for Enterprise Development (RPED) data set provided by the Centre of

Studies of African Economies (CSAE) at the University of Oxford. This dataset is assembled from 7 annual surveys of Ghanaian manufacturing firms covering the period of 1991-1997. The total of 278 firms were sampled. The original sample of 200 firms, which were first surveyed in 1992, was drawn on the random basis from firms contained in the 1987 Census of Manufacturing Activities. Based on the information gathered from these firms, a broadly representative panel data on the size distribution of firms across the major sectors of Ghana's manufacturing industry was constructed. The dataset provides a wide range of information that enables us to calculate the capital stock, value added, and employment of firms. Another clear advantage of our data is associated with attrition of the sample. If firms shut down over the study period for any reason, they were replaced with firms of the same size, sector, and location rendering the sample size of our data unchanged.

The annual surveys cover the 4 main manufacturing sectors, i.e., the largest in terms of manufacturing value added and employment. These sectors are food processing and bakery (food-bakery), textile and garments (textile-garment), wood products and furniture (wood-furniture), and metal products and machinery (metal-machinery). Firms in the sample are also classified by size (i.e., the average number of employees) as micro (<5 employees), small (5-29 employees), medium (30-99 employees), and large (>100 employees). In addition, our data includes information on major industrials towns of Ghana: Accra, Kumasi, Takoradi, and Cape Coast.

The annual surveys collected comprehensive information on each firm's ownership, production costs, profit, value added, investment, capital stock, wages, export level, and human capital used in production. In our data, a firm's output is given by the value of goods a firm produces. To make output comparable between the years, a firm-specific price index (1991=100) is used to deflate the output. The value added is calculated as difference between firm's output and raw material input and indirect costs, and it is also deflated in a firm-specific manner. Capital stock is defined as the capital (e.g., machines, tools, and other equipment) used by the firm to produce output, deflated and adjusted for depreciation and investment. The price of capital has been calculated as the ratio of pretax profits to the value of capital stocks where the pre-tax profit is calculated from the data on value-added and costs (Teal, 2000). Total employment includes owner/manager, full-time workers, and part-time workers but excludes seasonal workers. Wages comprise both basic wages and allowances, and are deflated by the consumer price index for Ghana. Each firm was interviewed for the firm-level information. In addition, up to 10 workers of the firm, representative of the occupation categories in the firm, were interviewed in each year. Based on these interviews, our data reports the number of employees in each occupation category at the firm level. In the data, unskilled workers are defined as workers in occupational classifications of maintenance, production, masters and apprentices.

Table 1 presents the summary statistics for the variables. Our sample indicates that more than half of the firms in our sample are located in Accra, the capital city of Ghana. Moreover, 70% of the firms are privatly owned, while only 21% of them are owned by foreigners and multinational companies.

Table 1. **Summary Statistics**

VARIABLES	N	MEAN	STD
Real Average Skill Wage	505	689,594	461,635
Real Average Unskilled Wage	505	331,763	190,161
Value Added	1171	133	619
Capital	1133	512	2,630
Output	1171	362	1,420
Employment	1170	71.90	145.20
Value Added / Employment	1170	1.02	2.27
Capital / Employment	1132	3.09	8.24

4. Estimation Strategy and Empirical Results. The complete system of cost share equation provides seemingly unrelated regressions (SUR) and is estimated by using Zellner's SUR method in panel data. Each equation in the system is assumed to be stochastic and the stochastic terms are additive and joint normal distribution. To address the problem of singularity, we drop one equation as explained in the empirical model section. Hence, the SUR parameter estimates will not be invariant to the deleted equation, using the iterative Zellner efficient method (ISUR), we obtain the neutral parameter estimates.

In order to compute Allen-Uzawa partial elasticities of substitution, the cost function (1) and share equations (6) are estimated simultaneously by Zellner's seemingly unrelated regressions (SUR) method employed in panel data. 10 parameters are estimated directly using (1) and 5 parameters are calculated using equations (2),(3) and (4). Due to the structure of panel data, we also incorporate the sector-specific effects in our model. In particular, 4 sectors, 3 locations, union, export, 4 firm sizes, 6 years indicators are included in the estimation of total cost function. Since we use 6-year time span, it is plausible to assume that the technology parameters can be estimated under the Hicks-Neutrality assumption[4]. Table 2 shows the restricted estimates of cost function by allowing fixed effects.

Concavity requires that the own price elasticities for factors are negative. Indeed, Table 3 reveals that this condition holds in our estimation.

The own wage elasticities range from -0.65 to -0.89 for unskilled workers and from -0.88 to -0.92 for skilled ones. This shows that skilled labor demand is more responsive to wage changes in the wood-furniture industry, followed by the textile-garment, food-bakery and metal-machinery industry. It is obvious from the table that in all the industries, changes in wages and changes in the cost of using capital may not cause considerable responses by firms in the demand for these inputs. The results of own price elasticities show that demand for skilled labor is more elastic than the demand for unskilled one. According to this finding, a rise in skilled wage can decrease skilled employment more than a similar proportionate increase in unskilled wage can affect unskilled employment. Baffour and Betsey (2001) documented the same conclusion for their labor demand and productivity analysis for Ghana. This result contradicts the labor demand literature in developed countries (Hammermesh, 1993). On the other hand, for monotonicity, the cost function must be non-decreasing in input prices, which requires the fitted shares be positive at each observation. We find that the fitted shares are positive in all pairs and highly correlated with actual

[4] Hicks-Neutrality assumption suggests that technology advances that are caused by external factors do not change the relative price between factors.

shares. The parameter estimates for the model satisfy all regularity conditions[5]. The cross-price elasticities are important to understand how demand for skilled labor responds to changes in the price of unskilled labor or capital. Table 3 shows that the cross price elasticities are positive and less than one between all inputs. This result suggests that all inputs used in production are substitutes for each other. When the wage of skilled labor rises, more unskilled workers replaces the skilled labor lost due to wage increases. However, one should be cautious since the cross price elasticity estimates do not differ significantly from zero.

Table 2. **Translog Cost Function Estimation with Firm-Specific Fixed Effects**

Parameters	Food-Bakery	Wood-Furniture	Textile-Garment	Metal-Machinery	Aggregated
α_o	-5.859	1.858	-13.289	2.867	-1.781
	(4.598)	(3.891)	(7.411)*	(4.546)	(2.290)
α_s	0.109	0.157	0.765	0.442	0.244
	(0.125)	(0.087)*	(0.224)**	(0.109)**	(0.058)**
α_u	-0.108	0.238	0.631	-0.135	0.261
	(0.123)	(0.135)*	(0.318)*	(0.131)	(0.079)**
α_Y	1.677	0.551	1.507	0.474	0.745
	(0.404)**	(0.403)	(0.828)*	(0.458)	(0.229)**
γ_{ss}	-0.004	-0.006	-0.007	-0.006	-0.003
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
γ_{su}	0.026	0.025	0.011	0.024	0.019
	(0.005)**	(0.004)**	(0.006)*	(0.003)**	(0.002)**
γ_{uu}	-0.003	-0.006	-0.004	0.004	-0.006
	(0.001)**	(0.001)**	(0.001)**	(0.002)**	(0.001)**
γ_{yy}	-0.012	0.018	0.009	0.021	0.017
	-(0.009)	(0.011)*	(0.026)**	-(0.012)	(0.006)**
γ_{sy}	-0.015	-0.017	-0.039	-0.029	-0.017
	(0.006)**	(0.005)**	(0.013)**	(0.005)**	(0.003)**
γ_{uy}	-0.006	-0.011	-0.027	0.003	-0.012
	(0.006)*	(0.007)	(0.018)	(0.006)	(0.004)**
α_k	0.673	0.605	-0.395	0.693	0.495
	(0.193)	(0.152)	(0.340)	(0.160)	(0.095)**
γ_{sk}	-0.022	-0.019	-0.004	-0.018	-0.016
	(0.005)**	(0.002)**	(0.005)**	(0.003)**	(0.002)**
γ_{uk}	-0.023	-0.019	-0.007	-0.028	-0.013
	(0.005)**	(0.004)**	(0.005)**	(0.003)**	(0.002)**
γ_{kk}	0.045	0.038	0.011	0.036	0.029
	(0.007)**	(0.004)**	(0.008)*	(0.005)*	(0.003)**
γ_{ky}	0.021	0.028	0.066	0.026	0.029
	(0.008)*	(0.007)*	(0.021)	(0.007)*	(0.004)**
N	114	138	59	143	454

Notes: Numbers in parenthesis are standard error. Time, location, size, ownership structure, union and export dummies are included in all regressions. ** or * indicate the statistical significance at 1 or 5 %, respectively.

[5] Some studies employ the actual factor shares to estimate elasticities (Chung, 1994), but it is accurate to use the regression's predicted shares (Berndt, 1991). It is usual for studies to predict the shares using mean factor prices or factor quantities and calculate a single elasticity based on this point (Greene, 2003). However, this study predicts shares for each firm in the sample and calculates the elasticity for each firm in the sample for a better analysis.

Table 3. **Cross Price and Own Elasticities**

Industry	Cross Price Elasticities			Own Elasticities			
	N	ε_{SK}	ε_{SU}	ε_{UK}	ε_{KK}	ε_{SS}	ε_{UU}
Food-Bakery	114	0.103	0.346	0.094	-0.202	-0.891	-0.899
Wood-Furniture	138	0.085	0.190	0.329	-0.414	-0.927	-0.650
Textile-Garment	59	0.126	0.176	0.244	-0.370	-0.920	-0.761
Metal-Machinery	144	0.130	0.262	0.189	-0.335	-0.878	-0.748
Aggregated	454	0.113	0.219	0.214	-0.326	-0.884	-0.791

Allen-Uzawa partial elasticities of substitution are in Table 4. The elasticity of substitution estimates summarized in Tables 4 suggest that skilled workers, capital and unskilled workers are substitutes for one another for each individual sector and at the aggregate level.

Table 4. **Allen-Uzawa Elasticity of Substitution**

Industry	σ_{SK}		σ_{UK}		σ_{US}	
	Actual	Fitted	Actual	Fitted	Actual	Fitted
Food-Bakery	0.772	0.784	0.977	0.977	1.026	1.026
Wood-Furniture	0.702	0.696	0.981	0.981	1.025	1.025
Textile-Garment	0.952	0.951	0.993	0.993	1.011	1.011
Metal-Machinery	0.824	0.814	0.972	0.972	1.024	1.024
Aggregated	0.816	0.815	0.987	0.987	1.019	1.019

The partial elasticity substitution between skilled labor and capital range from 0.69 to 0.95 and the partial elasticity substitution between unskilled labor and capital range from varies from 0.97 to 0.99. We also find that the degree of substitution between unskilled labor and skilled labor are unit elastic for all manufacturing sectors. Using the US manufacturing data, Griliches (1969) found evidence suggesting that capital equipment was more substitutable for unskilled than skilled labor. Our findings provide evidence suggesting that the capital-skill complementarities holds in aggregated manufacturing industries and all sectors. The existence of capital-skill complementarity hypothesis is vital for developing countries for two reasons. First, if there is capital-skill complementarities, capital accumulation may explain a larger fraction of demand increase for skilled labor in a developing country. The second reason is related to trade liberalization. Openness may stimulate investment in the country since an important portion of equipment in a developing country has to be imported rather than produced by country's own technology. Thus, if capital-skill complementary hypothesis holds, trade may increase the relative demand for skilled labor through this process as well.

5. Conclusion.

In this paper, we analyze the estimation of cost function along with the associated cost share equations to estimate factor substitution. We use the annual firm-level data on the manufacturing sector in Ghana during the period of 1991-1997. The translog cost function is estimated following the ITSUR framework with the assumption of a fixed sector-specific effect for aggregated manufacturing and each individual sector in Ghana.

The results show that the own wage elasticities range from -0.65 to -0.89 for unskilled workers and from -0.88 to -0.92 for skilled one. We find that skilled labor demand is more responsive to wage changes in the wood-furniture industry, followed by the textile-garment, food-bakery and metal-machinery industry. It is obvious from

the table that in all the industries changes in wages and changes in the cost of using capital may not cause considerable responses by firms in the demand for these inputs. The results of own price elasticities demonstrate that demand for skilled labor is more elastic than the demand for unskilled labor. According to this finding, a rise in skilled wage can decrease skilled employment more than a similar proportionate increase in unskilled wage can affect unskilled employment.

The elasticity of substitution estimates suggests that skilled workers, capital and unskilled workers are substitutes for one another for each individual sector and at the aggregate level. The partial elasticity substitution between skilled labor and capital range from 0.69 to 0.95 and the partial elasticity substitution between unskilled labor and capital range from varies from 0.97 to 0.99. We also find that the degree of substitution between unskilled labor and skilled labor are unit elastic for all manufacturing sectors. Our findings provide evidence suggesting that the capital-skill complementarities hold in aggregated manufacturing industries and all sectors.

The estimation of labor demand is important to understand the underlying mechanisms behind the upsurge in relative wages of skilled workers in the recent decades. We believe that more research has to be conducted to further comprehend the effects of capital accumulation and trade on labor demand elasticities.

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Стаття надійшла до редакції 05.09.2012.