Chapter 7
Relationship Between Skill, Technology and Input–Output Indicators

Abstract This chapter uses the data from the firm survey (2010) to examine skill indicators, their implications and relationships between skill, technology and input-output indicators at the micro/firm level. We illustrate the low skill levels – due to the excessive share of unskilled workers and the implications on skills mismatch, industrial performance indicators and productivity decline across firms. These results are consistent with the micro-macro findings in Chap. 5 above, which indicate the low share of high skilled in total population and employment – measured by both educational and occupational levels – and the serious implications on skills mismatch and the macro-micro duality with respect to upskilling efforts. We find that an increase in skill level and firm size lead to improved relationships between actual and required education, between actual education, experience and wages and between required education, experience and wages. Our results concerning the positive complementary relationships between skill, technology (ICT) and upskilling (ICT training) and between computers, telecommunications and ICT training are consistent with the findings in the new growth literature. We illustrate that an increase in skill level and firm size lead to an improvement in the complementary relationships between skill, upskilling and technology (ICT) at the micro level.

7.1 Introduction

Earlier findings in Chap. 5 show the serious implications of the deficient educational system and excessive use of low educated workers, and illustrate one surprising contradicting macro–micro view regarding the transfer of knowledge/external schooling effects. This surprising result from Chap. 5 motivates our research to attempt a more comprehensive analysis of skill problem and implications of unskilled workers at the micro level/across firms. Hence, the aim of this chapter is to broaden our earlier analysis in Chap. 5 by providing an indepth analysis of skill and technology indicators and the relationship between them and the implications of the prevalence

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of low-skilled workers at the micro level. In addition, we examine the relationships between: skill indicators (education/actual education and occupation/required education respectively and experience) and average wages; between skill, upskilling (spending on ICT training) and technology (spending on ICT); and between technology (spending on ICT) and input–output indicators across firms. We also compare the relevance of our results to the theoretical framework in Chap. 3 and the findings concerning these relationships in the new growth literature.

Prior to investigating the relationships between skill, upskilling, technology and input–output indicators across firms, it is convenient to begin with explaining the importance of the industrial sector across firms, because understanding the importance of the industrial sector from the perspective of the industrial firms can help in supporting the potential contribution of the industrial sector in enhancing economic development in Sudan. Beginning with the importance of the industrial sector for economic development in Sudan, our results from the firm survey (2010) imply that the respondent firms seem to be highly optimistic regarding the potential contribution of the industrial firms in achieving not only the traditional microeconomic aim of maximising private industrial profit but also in achieving the macroeconomic development aims, provided that the appropriate conditions for industrial development is created. For instance, the potential contribution of the industrial sector in: increasing output and income; increasing employment opportunities for present and future labour force (in response to potential population increase); satisfying domestic consumption and achieving self sufficiency by offering the basic and necessary goods for the Sudanese; achieving industrial profit; improving production relationships between workers; and enhancing local technological capability building by adaptation of imported technologies to fit with local needs. This is in addition to: contribution to economic growth through enhancing industrial linkages; reforming the structural imbalances in Sudan economy; decreasing imports; and enhancing optimal and full utilisation of natural resources and local raw materials; enhancing local capability; enhancing development of local technologies to fit with local development needs; supporting development and urbanisation of all regions in Sudan; enhancing local industrialisation using local raw materials; and enhancing economic growth by increasing industrial exports. Finally, meeting the needs and enhancing linkages with other sectors specially agriculture, are also mentioned but are of somewhat less importance (see Table 7.1 below).[1]

The rest of this chapter is organised as follows: Sect. 7.2 defines the variables used in our analysis and the general characteristics of firms; Sect. 7.3 presents our hypotheses and discusses differences in prevalent skill levels and requirements and the implications of low skill levels on skills mismatch, industrial performance

[1] As indicated by 97 %, 91 %, 84 %, 81 %, 81 %, 73 %, 67 %, 67 %, 67 %, 66 %, 63 %, 61 %, 57 %, 49 %, 49 % and 42 % of all the respondent firms respectively.

Table 7.1 The importance of the industrial sector for economic development in Sudan (2008)

Economic development aims	All firms	Industry				Size		
		Chemical	Food	Metal	Textile	Large	Medium	Small
Increasing output and income	97 %	97 %	96 %	100 %	100 %	100 %	96 %	100 %
Increasing employment opportunities for present and future labour force (in response to potential population increase)	91 %	89 %	93 %	90 %	100 %	88 %	92 %	100 %
Satisfying domestic consumption and achievement of self sufficiency by offering basic and necessary goods for Sudanese	84 %	92 %	82 %	60 %	80 %	84 %	85 %	84 %
Achieving industrial profit	81 %	75 %	86 %	100 %	60 %	81 %	85 %	74 %
Creation of improved production relationships between workers	81 %	86 %	75 %	80 %	80 %	81 %	85 %	84 %
Enhancing local technological capability building by adaptation of imported technologies to fit local needs	73 %	78 %	64 %	70 %	100 %	91 %	65 %	63 %
Enhancing economic growth by enhancing industrial linkages	67 %	61 %	71 %	70 %	80 %	69 %	58 %	84 %
Contribution to reform structural imbalances in Sudan economy	67 %	69 %	68 %	50 %	80 %	72 %	62 %	74 %
Contribution to economic growth by decreasing imports	67 %	72 %	54 %	80 %	80 %	59 %	77 %	63 %
Supporting the optimal and full utilisation of natural resources and local raw materials	66 %	69 %	68 %	40 %	80 %	69 %	65 %	63 %
Enhancing local capability	63 %	72 %	50 %	50 %	100 %	78 %	54 %	58 %
Enhancing local technological capability building and reducing technological dependence by development of local technologies	61 %	61 %	57 %	80 %	40 %	72 %	46 %	68 %
Supporting development and urbanisation of all regions in Sudan	57 %	64 %	54 %	60 %	20 %	66 %	54 %	53 %

(continued)

Table 7.1 (continued)

Economic development aims	All firms	Industry				Size		
		Chemical	Food	Metal	Textile	Large	Medium	Small
Enhancing economic growth by local industrialisation of local raw materials that was earlier exported in the form of raw materials	49 %	44 %	54 %	30 %	100 %	63 %	46 %	32 %
Enhancing economic growth by increasing industrial exports	49 %	56 %	46 %	40 %	40 %	53 %	42 %	47 %
Enhancing economic growth by meeting the need and enhancing linkage with other sectors especially agriculture	42 %	44 %	46 %	30 %	20 %	53 %	35 %	37 %
Number of respondents	79	36	28	10	5	32	26	19

Source: Own calculation based on the firm survey (2010)

indicators and productivity decline across firms; Sect. 7.4 examines the relationships between actual and required education, experience and wages; Sect. 7.5 shows the relationships between skill, technology (spending on ICT) and upskilling (spending on ICT training) and between technology (ICT) and input–output indicators; Sect. 7.6 concludes.

7.2 Data, Definition of Variables and General Characteristics of Firms

Before commencing with the empirical analysis, it will be useful to briefly explain the data used in our analysis and the general characteristics of firms.

7.2.1 Data and Definition of Variables

Our analysis in this chapter uses the data from the firm survey (2010), which provides us with three sets of micro variables.[2] The first set includes skill variables,

[2] All data, information and analysis in this chapter are based on the results covering 45 firms obtained from the firm survey (2010).

while the second and third sets include both technology and input–output and performance related variables respectively. We define skill variables by educational attainment, occupational level (measured by the required qualifications/schooling years) and average years of experience.[3] We use the total spending on machinery and equipment to define "old technology" and also we use the total spending on ICT[4] to define "new technology", the share of spending on ICT training as a percentage of total spending on ICT to define "upskilling", total sales value to define "output", total profit and total value added to define "performance", in addition we use economic, productivity, activity and profitability indicators to define industrial performance indicators, and total employment and net worth to define "labour" and "capital" inputs, respectively.[5]

We use the first set of skill variables in Sect. 7.3 to discuss hypotheses 3.b. and 4.a. in Chap. 1 above regarding the implications of unskilled workers across firms. We use input–output and performance indicators to illustrate the decline in industrial performance and productivity indicators and ratios. Next, in Sect. 7.4, we test hypothesis 4.b. in Chap. 1 above about the relationships between actual and required education and experience and wages. In Sect. 7.5, we use the first and second sets of variables including skill, ICT and the share of spending on ICT training to test hypothesis 4.c. in Chap. 1 above regarding the relationship between skill, technology (ICT) and upskilling. Next, we use the second and third sets of technology and input–output variables to test the fifth hypothesis in Chap. 1 above about the relationship between technology (ICT) and input–output indicators.[6]

[3] We classify the educational qualifications of workers into three groups: high skilled (H) with postgraduate, university and diploma degree (more than 12 years of schooling), medium skilled (M) with secondary education (12 years of schooling) and low skilled (L) with less than secondary education (less than 12 years of schooling). We define the occupational status according to five categories, including: white collar high (managers, professionals, management executives, scientists, technicians and engineers); white collar low (clerical and administrative); blue collar high (skilled craftsmen); blue collar low (plant machinery operators, assemblers and elementary occupation); and other workers. We define the required qualifications by required years of schooling including: postgraduate/Ph.D. (19–20 years); professional, MSc/postgraduate (18 years); university graduate (16 years); diploma (14 years); higher secondary schooling (12 years); and less than secondary schooling (less than 12 years). We measure the average wages by average monthly wages (in Sudanese Pounds), and average years of experience by both actual and required average years of experience for both educational and occupational definition respectively.

[4] ICT is the sum of total expenses on computers, telecommunications, Internet, training, maintenance and other related items.

[5] We measure output by the total sales value because the measurement units of sales value is unified (in local currency) across firms, while the measurement units of output in physical terms (tonnes, litres, etc.) varies enormously across firms.

[6] We use few observations in the estimated equations, due to limited availability of reliable data covering these indicators, because some of the respondent firms were particularly reluctant to provide adequate reliable quantitative data covering these indicators.

7.2.2 General Characteristics of Firms

Table 7.2 presents the main general characteristics of firms and economic indicators such as the share of firms in total employment, capital, profit and output (total sales value), and their differences defined by firm size and industry level. We observe that the market size or structure (defined by the share in total employment, raw materials, profit, fixed capital and value added) seems biased toward large size and chemical and food firms respectively. For instance, on average, the large size and chemical firms respectively employ 74 % and 50 % of total workers, absorb 99 % and 73 % of total raw materials, and therefore, it is not surprising that they constitute 99 % and 72 % of total profit. While small size and food industries absorb 99 % and 99 % of total capital, large size and food industries absorb 84 % and 83 % of total fixed capital in the form of machinery and equipment, hence, it is not surprising that they constitute 84 % and 84 % of total value added respectively.[7] In addition, medium size and food industries constitute 63 % and 75 % of total output (total sales value). These differences in market size leads to several implications, as we explain below and in the next sections.

From Table 7.2 we observe the limited contribution of public sector and high share of private sector in the metal, food, chemical and textile industries and medium, small and large size firms respectively. We also note the high share of local ownership and also a limited share of foreign and mixed ownership, which implies the limited dependency on foreign capital and foreign workers. We find that the share of firms in local ownership decreases and so the share in foreign ownership increases with firm size and to some extent with industry level. But despite the presence of foreign capital, there is limited contribution of multinational companies; however, such contribution is diversified as the sources of foreign capital of multinational companies originates from different countries and increases to some extent with industry level and to less extent with firm size. We also observe limited changes in the general structure of firms during the period 2005–2008, which may indicate a lack of dynamism, particularly with respect to the distribution of economic indicators, i.e. total employment, capital and output/sales value across firms. The reported change since establishment in ownership, nationality of main owner and length of years in operation (age) varies across firms and generally increases with firm size and industry level; it was observed only in some of the chemical industries and large and small size firms. In addition, the geographical

[7] We believe that our results should be interpreted carefully, notably when explaining our results related to the share of firms in total capital, which indicate the large share of small size and food industries that absorb 99 % and 99 % of total capital. In particular, we interpret these results due to the relative availability of information and quantitative data covering these financial indicators, notably, due to relatively more response to provide information and quantitative data covering these financial indicators for small size and food industries as compared to other firms, particularly because some of the firms seem to be more reluctant to provide adequate reliable information and quantitative data covering these financial indicators for medium and large size, chemical, metal and textile firms.

Table 7.2 Main characteristics of firms in the Sudan (2005–2008)

Main indicators (2005–2008)[a]		No. of respondent firms	Chemical	Food	Metal	Textile	Large	Medium	Small
Share in employment (%)	2005	85	45 %	37 %	4 %	13 %	71 %	18 %	10 %
	2006	85	52 %	32 %	4 %	13 %	73 %	17 %	10 %
	2007	85	51 %	25 %	4 %	20 %	76 %	16 %	9 %
	2008	85	52 %	22 %	4 %	22 %	77 %	16 %	7 %
	Average 2005–2008	85	50 %	29 %	4 %	17 %	74 %	17 %	9 %
Share in capital (%)	2005	83	0.4 %	99.3 %	0.2 %	0.1 %	0.5 %	0.5 %	99 %
	2006	83	0.4 %	99.1 %	0.4 %	0.1 %	0.5 %	0.5 %	99 %
	2007	83	0.4 %	99.0 %	0.5 %	0.1 %	0.5 %	0.5 %	99 %
	2008	83	0.4 %	99.1 %	0.3 %	0.01 %	0.5 %	0.5 %	99 %
	Average 2005–2008	83	0.4 %	99.2 %	0.3 %	0.1 %	0.5 %	0.5 %	99 %
Share in machinery and equipment (%)	2005	45	2 %	94 %	2 %	2 %	95 %	0.5 %	4.5 %
	2006	45	9 %	79 %	7 %	4 %	84 %	0.5 %	15.5 %
	2007	45	12 %	79 %	9 %	0 %	78 %	1 %	20 %
	2008	45	11 %	80 %	8 %	0 %	80 %	1 %	19 %
	Average 2005–2008	45	9 %	83 %	7 %	2 %	84 %	1 %	15 %
Share in raw materials (%)	2005	45	1 %	96 %	2 %	1 %	97 %	0.5 %	2.5 %
	2006	45	96 %	3 %	1 %	0 %	99 %	0.5 %	0.5 %
	2007	45	95 %	4 %	0 %	0 %	99 %	0.5 %	0.5 %
	2008	45	98 %	2 %	0 %	0 %	100 %	0.5 %	0.5 %
	Average 2005–2008	45	73 %	26 %	1 %	0 %	99 %	0.5 %	0.5 %
Share in profit (%)	2005	45	1 %	90 %	12 %	0 %	99 %	0.5 %	0.5 %
	2006	45	95 %	5 %	0 %	0 %	99 %	0.5 %	0.5 %
	2007	45	95 %	3 %	1 %	0 %	99 %	0.5 %	0.5 %
	2008	45	96 %	2 %	2 %	0 %	99 %	0.5 %	0.5 %
	Average 2005–2008	45	72 %	25 %	4 %	0 %	99 %	0.5 %	0.5 %
Share in output (total sales value) (%)	2005	45	0 %	99 %	1 %	0 %	22 %	78 %	1 %
	2006	45	27 %	72 %	1 %	0 %	36 %	59 %	6 %
	2007	45	30 %	67 %	2 %	0 %	40 %	59 %	1 %
	2008	45	36 %	62 %	2 %	0 %	45 %	54 %	1 %
	Average 2005–2008	45	23 %	75 %	2 %	0 %	36 %	63 %	2 %

(continued)

Table 7.2 (continued)

Main indicators (2005–2008)[a]		No. of respondent firms	Chemical	Food	Metal	Textile	Large	Medium	Small
Share in value added (%)	2005	45	5 %	94 %	1 %	0 %	99 %	0.5 %	0.5 %
	2006	45	2 %	92 %	5 %	1 %	90 %	0.5 %	9.5 %
	2007	45	5 %	77 %	17 %	1 %	76 %	4 %	20 %
	2008	45	8 %	74 %	18 %	1 %	71 %	6 %	22 %
	Average 2005–2008	45	5 %	84 %	10 %	1 %	84 %	3 %	13 %
Share in wage (%)	2005	45	1 %	92 %	2 %	5 %	97 %	0.5 %	2.5 %
	2006	45	4 %	66 %	12 %	18 %	86 %	0.5 %	13.5 %
	2007	45	9 %	77 %	14 %	0 %	80 %	1 %	19 %
	2008	45	10 %	80 %	9 %	0 %	82 %	2 %	17 %
	Average 2005–2008	45	6 %	79 %	9 %	6 %	86 %	1 %	13 %
Share in spending on ICT (%)	Average 2005–2008	54	23 %	53 %	11 %	13 %	48 %	21 %	30 %
Share in spending on ICT training (%)	Average 2005–2008	8	2 %	73 %	12 %	13 %	75 %	18 %	7 %
Share of private firms (%)	2008	87	89 %	94 %	100 %	80 %	89 %	97 %	90 %
Share of ownership (%)[b]	Local – 2008	87	86 %	92 %	68 %	88 %	80 %	84 %	95 %
	Foreign- 2008	87	15 %	8 %	32 %	12 %	20 %	16 %	5 %
Share of main owners (%)	Local – 2008	87	79 %	87 %	62 %	80 %	69 %	83 %	90 %
	Foreign – 2008	87	8 %	3 %	23 %	0 %	9 %	14 %	0 %
	Mixed – 2008	87	13 %	10 %	15 %	20 %	23 %	3 %	10 %
Affiliation to multinational	2008	87	11 %	6 %	8 %	0 %	9 %	10 %	5 %
Change after establishment[c]	2008	87	8 %	0 %	0 %	0 %	6 %	0 %	5 %
Main location (%)	Khartoum – 2008	87	26 %	23 %	38 %	0 %	26 %	24 %	29 %
	Khartoum North-2008	87	58 %	68 %	46 %	80 %	57 %	62 %	71 %
	Omdurman – 2008	87	16 %	10 %	15 %	20 %	17 %	14 %	0 %
Branches other than main location (%)	2008	87	3 %	10 %	15 %	0 %	14 %	3 %	0 %
Average age/operation years	2008	87	18	17	14	16	19	14	17
Average rate of diversification	Sales – 2008	86	1.50	1.47	1.52	1.23	1.57	1.36	1.54
	Employment – 2008	63	1.40	1.31	1.55	1.17	1.47	1.19	1.44

Source: Firm Survey (2010)

[a]All indicators are calculated from the firm survey (2010); some refer to observations over only one year (2008) and others use observations over 4 years (2005–2008).

[b]Some of the respondent firms reported a mixed share of local and foreign ownership.

[c]Change after establishment refers to changes in ownership, management and structure (e.g. expansion; opening new branches or merger with other firms).

distribution of firms indicates that most are clustered in two main locations and only a few of the chemical, food and metal industries and large and medium size firms have branches in cities other than the main location, though the probability of clustering to some extent increases with firm size and industry, and the probability of having branches increases with firm size but to lesser extent increases with industry. Moreover, we realise the limited scope for diversification as measured by sales and employment indices across firms.[8] The average diversification index increases to some extent with firm size but only to a lesser extent increases with industry; this implies that metal and chemical industries and large size firms have more interest in diversification, whereas food and textile industries and medium size firms have less interest in diversification and more interest in concentration and specialisation. As expected, large size firms reported more interest in diversification than medium and small size firms. Somewhat surprising and in contrast to our expectations, the findings across firms indicate that metal firms reported more interest in diversification more than chemical, food and textile firms, moreover, somewhat surprising was that small size firms indicated more interest in diversification than medium size firms.

7.3 Differences in Skill Level and Requirements and the Implications Across Firms

Our earlier findings in Chap. 5 indicate that the share of high skilled workers in total employment, the total number of full time equivalent researchers (FTER), R&D and ICT expenditure, patent, product and process innovations are higher within large size and chemical firms when compared to medium and small size and food, metal and textile firms. Our result with respect to R&D and chemical sector is consistent with the standard classification developed by the OECD in the mid-1980s, which distinguishes between industries in terms of R&D intensity (cf. OECD 1997). For instance, in the mid-1980s, the OECD classification distinguished between industries in terms of R&D intensity, considering pharmaceutical and ICT as high-technology, chemical and vehicle as medium-technology and food and textile as low technology (cf. OECD 1997). Our findings with respect to firm size are consistent with the literature and the Schumpeterian hypothesis, which indicates that large size/market concentration is conducive to R&D investment (cf. Braga and Willmore 1991). For instance, Kumar and Saqib (1994) suggest that the probability of undertaking R&D increases with firm size only up to a certain

[8] We use a modified definition of the diversification index developed by Utton (1979). We define the diversification index by output/ sales diversification $Di = [[P1 + 2\ P2 + 3P3 + 4P4] - 1/\ 2]$, where Pi refers to the percentage share of diversified sale product in total sale products within firms. Ranked from large to small, when $Di = 1$, $Di = 4$ and $1 < Di < 4$, it implies complete specialisation, complete diversification and some degree of diversification respectively. We apply the same definition for employment diversification index. Cf. Utton (1979), pp. 15-16, 104–105.

level, while R&D intensity increases with it linearly. However, one should also expect that these results could imply a possibility for reversed causality, mainly because R&D is a fixed cost that requires high financial capacity, which is most likely to be strong amongst large size firms.

In addition to earlier findings, we observe that skill levels and requirements (actual and required education and experience) and skills mismatch are not homogenous across firms and vary with industry and size. As we explained in Sect. 7.3, these findings can be used to test the hypotheses 3.b. and 4.a. in Chap. 1 above that, irrespective of these differences, high skill requirements and low skill levels – due to high share of unskilled workers – lead to skills mismatch and also contribute to industrial performance indicators and productivity decline across firms. In Sects. 7.4 and 7.5, we then examined hypotheses 4.b. and 4.c. in Chap. 1 above that an increase in skill levels and firm size lead to improved relationships between actual and required education and experience, between actual education, experience and wages and between skill, upskilling and technology (ICT). Finally, in Sect. 7.5, we also investigated the fifth hypothesis in Chap. 1 above concerning the relationships between technology (the use of ICT) and input–output indicators at the micro/firm level.

7.3.1 *Differences in Skill Level and Requirements (Education and Experience) Across Firms*

Prior to investigating the first hypothesis on the extended implications of low skill levels as presented above, it is convenient to begin with explaining differences in skill levels and requirements across firms because understanding why and how they vary with industry and firm size can help in investigating both the first and second hypotheses.

In Figs. 7.1, 7.2, and 7.3 below we explain differences in skill levels and requirements and low skill levels (defined by education and occupation groups) across firms (defined by size and industry).[9] Figures 7.1 and 7.2 show the low share of high skilled – high educated and white collar – workers, differences in skill levels according to education and occupation definitions and differences across firms. For instance, Fig. 7.1 indicates that for 55 % of all respondent firms, the share of high skilled (educated) represents 1–30 % of total employed workers. For a further 20 % of all respondent firms, the share of high skilled (educated) represents 31–50 % of total employed workers, but for the remaining 25 % the share is more than 50 % of the workforce. Figure 7.2 shows, for example, that for 66 % of all respondent firms,

[9] In Figures 7.1–7.3, the horizontal axis defines firms, industry, size (chemical, food, metal and textile, large, medium and small), and skill level (high (H), medium (M) and low (L)). The vertical axis defines the intensity/share of H, M and L across firms. The information in the right margin defines the distribution of workers in Figures 7.1–7.2, and the average required years of education in Figure 7.3.

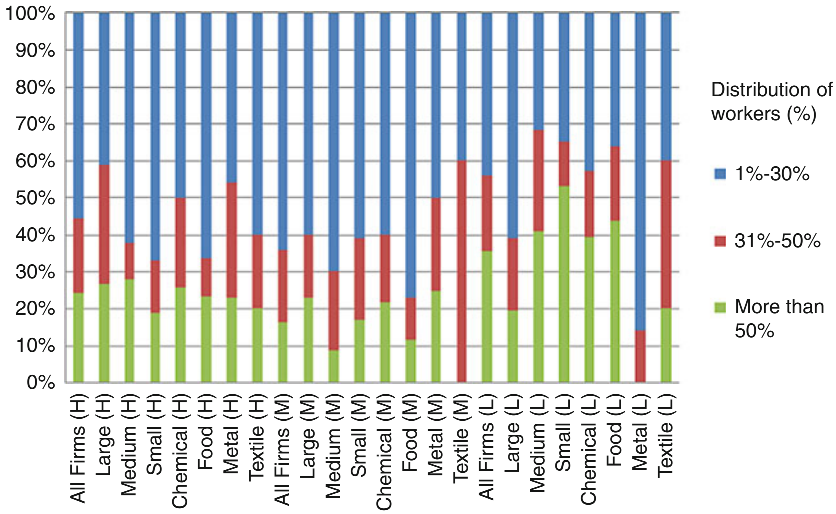

Fig. 7.1 Differences in the distribution of workers by educational level across firms (% share) 2008 (Source: Firm Survey (2010))

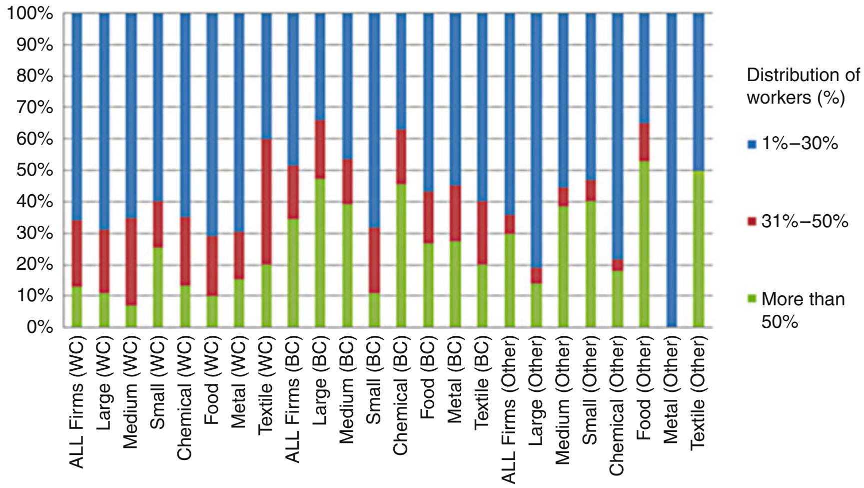

Fig. 7.2 Differences in the distribution of workers by occupational level across firms (% share) 2008 (Source: Firm Survey (2010))

the share of white collar (WC) represents 1–30 % of total employed workers; for 21 % of all respondent firms the WC share is 31–50 % and for 13 % the figure stands at 50 % of total employed workers. The results show that the incidence of high educated and white collar workers constituting more than half of total employment is observed only within 25 % and 13 % of all respondent firms respectively. They also indicate that the share of high skilled – measured by education – is less than

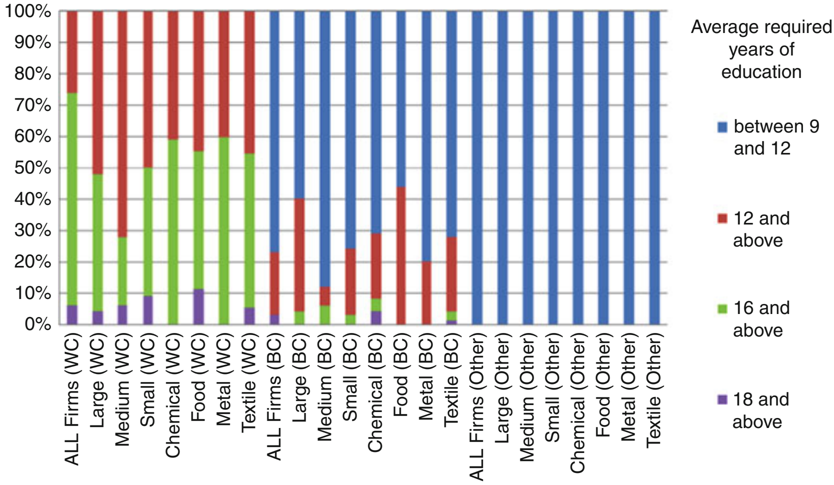

Fig. 7.3 Differences in the educational requirements by occupational level across firms (% share) 2008 (Source: Firm Survey (2010))

one third of total workers for 55 % of all firms and the share of high skilled – white collar measured by occupational level – is less than one third of total workers for 66 % of all firms. That means that across all firms the share of high educated and white collar respectively are less than one third and two thirds; therefore, the majority of employed workers are low and medium skilled.

Figures 7.3 and 7.4 show that skill requirements – average required years of schooling – vary and increase with occupational level across firms.[10] For instance, Fig. 7.3 indicates that for 26 % of all respondent firms the average required years of education for white collar (WC) is 12 and above; 68 % of all respondent firms require an average of 16 years; whilst 6 % of all respondent firms put this figure at 18 and above. Moreover, Fig. 7.4 indicates that for 16 % of all respondent firms the average required years of education for white collar high (WCH) is 14 years (diploma degree), for 47 % the requirement is 16 years (university degree) and for 37 % the requirement is 17–19 years and above (postgraduate degree). The figures show that the university degree is the major preferred required qualification only within the first and second occupational groups, while for the other occupational groups either a diploma or secondary or less than secondary schooling is required.

Figure 7.5 below indicates the variation in skill requirements (required years of experience), defined by educational and occupational levels. For instance, for 36 % of all respondents firms the average required years of experience for high education is 2–5 years; for 39 % the experience requirement stands at 5–10 years, for 17 % the experience requirement stands at 10–15 years and for 8 % the figure is 16 years

[10] White collar (WC) includes white collar high and low. Blue collar (BC) includes blue collar high and low.

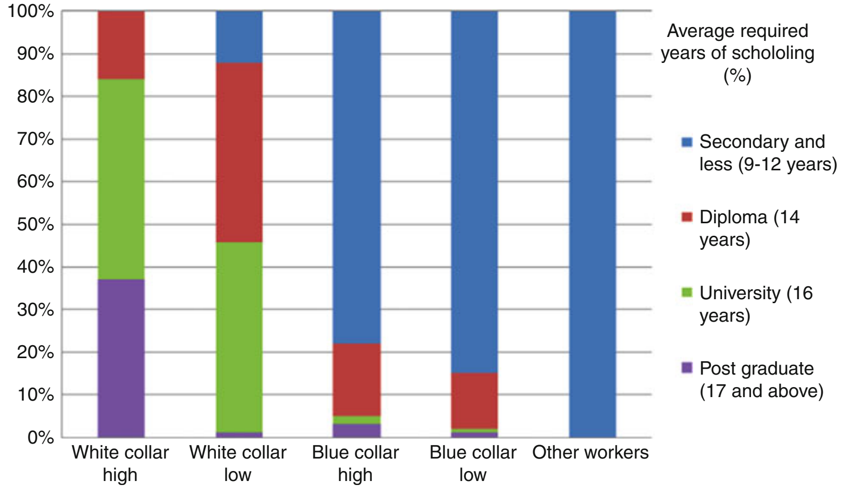

Fig. 7.4 Average required years of schooling defined by occupation classes across firms (2008) (Source: Firm Survey (2010))

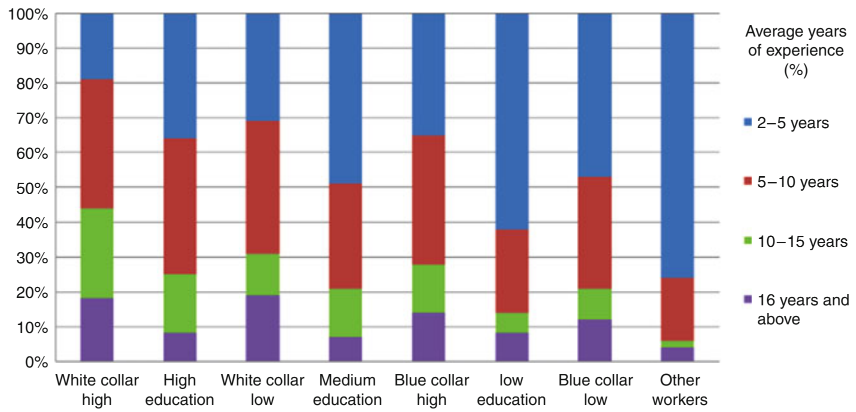

Fig. 7.5 Average years of experience defined by education and occupation classes across firms (2008) (Sources: Firm Survey (2010))

and above. Moreover, for 19 % of all respondent firms the average required years of experience for white collar high (WCH) is 2–5 years, for 37 % the experience requirement stands at 5–10 years, for 26 % the experience requirement stands at 10–15 years and for 18 % the figure is 16 years and above. Figure 7.5 illustrates that average years of experience are increasing in educational and occupational levels respectively. In the next section, we explain the relationships between required education/actual education, occupation/required education and experience and wages across firms.

7.3.2 The Implications of Low Skill Levels Across Firms

In this section we examine the first hypothesis that, irrespective of the observed differences in skill levels and requirements and as we explained above, the low skill levels – due to high share of unskilled workers – lead to skills mismatch and probably contribute to industrial performance indicators and productivity decline across firms.

7.3.2.1 Low Skill Levels and Skills Mismatch (Differences in Required and Attained Education)

When comparing the required schooling with the actual/attained schooling, we find that differences in schooling requirements across firms have caused considerable variations between the required and actual/attained schooling for high, medium and low skilled groups. When we interpret the required schooling as the demand for skills and the actual/attained schooling as the supply of skills, we observe that the inconsistency between the required and actual/attained schooling indicates an inconsistency between the demand for and supply of skills, which can be interpreted as skills mismatch.[11] For instance, Fig. 7.6 below illustrates the differences between the required and actual/attained schooling across firms, defined by firm size and industry level and skill levels. We observe that the inconsistency between the demand for and supply of skills, or skills mismatch, is particularly higher/serious within both

[11] Our definition of actual education refers to educational attainment classified under three groups: high (post secondary) educational attainment: university degree and above (16 years of schooling); medium educational attainment: secondary education (12 years of schooling); and low educational attainment: less than secondary education (9 years of schooling). We define the required education by the translated merged required qualifications for each occupation group defined by average years of schooling. The occupational classification includes the following five categories/ groups: (1) managers, professional, management executive, scientific, technical and engineers; (2) clerical and administrative; (3) skilled craftsmen; (4) plant machinery operators, assemblers and elementary occupation; and (5) other workers. We translate the required qualifications associated with each occupational class into average years of schooling and group them in the following way: (1) PhD/postgraduate (19–20 years); (2) professional, MSc/ postgraduates (18 years); (3) university graduates (16 years); (4) Diploma (14 years); (5) higher/ secondary schooling (12 years); and (6) less than secondary schooling (9 years). We then merge the required qualifications into three groups, assuming that the high occupation group includes both the first and second occupation categories, the medium occupation group includes both the third and fourth occupation categories and, finally, the low occupation group includes the fifth occupation category. We then use this definition to compare between the required education for each occupation class and actual/attained education, and we assume that the difference between these indicates the presence of skills mismatch between jobs requirements and educational attainment.

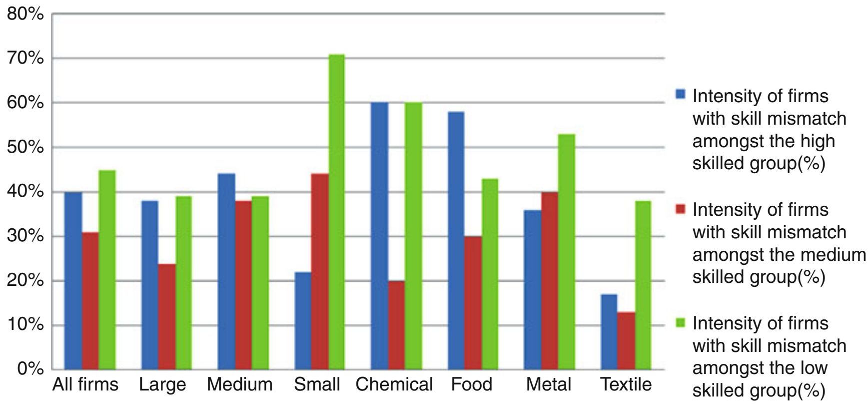

Fig. 7.6 Skills mismatch defined by high medium and low skill levels across firms (%) (2008) (Source: Firm Survey (2010))

high and low skilled groups respectively and across medium, small, chemical, food and metal firms respectively. We find mismatch amongst all employment categories, especially within high, medium and low skilled labour; for instance, we observe that for all firms, on average, the intensity of mismatch for high, medium and low skill groups accounts for 40 %, 31 % and 45 % respectively. This implies that the educational attainment amongst high, medium and low skilled labour does not match the required skills/educational level for high, medium and low skilled jobs across approximately 40 %, 31 % and 45 % of total respondents firms respectively. The mismatch is highest for high, medium and low skills, probably because of both insufficient educational attainment and high educational requirements for high, medium and low skills (see Fig. 7.3 above). Moreover, the intensity of mismatch is more prevalent across small size and medium size and chemical, metal and food firms compared to large size and textile firms. For instance, for medium size firms, on average the mismatch intensity for high, medium and low skill groups accounts for 44 %, 38 % and 39 % respectively, while for small size firms the figures are 22 %, 44 % and 71 % respectively, whereas for large size firms the figures are 38 %, 24 % and 39 % respectively. Moreover, for the chemical industries, on average the mismatch intensity for high, medium and low skill groups accounts for 60 %, 20 % and 60 % respectively, while for food industries the figures are 58 %, 30 % and 43 % respectively, whereas for metal industries the figures are 36 %, 40 % and 53 % respectively, while for textile industries the figures are 17 %, 13 % and 38 % respectively. Hence, our results in this section concerning the presence of serious skills mismatch due to the excessive share of unskilled foreign workers at the micro level are consistent with our earlier findings in Chap. 5 above, which indicates the presence of serious skills mismatch at the macro level.

7.3.2.2 Low Skill Levels and the Declining Trend of Labour Productivity (Output/Labour Ratio)

The low skill levels may contribute to productivity decline across firms.[12] Table 7.3 below illustrates considerable variation in the value and trend of labour productivity (total output/labour ratio) in physical term, in particular, considerable decline in labour productivity (output/labour ratio) for numerous firms over the period 2005–08.[13,14,15]

The declining labour productivity across many firms may not be surprising since the majority of employed workers are low skilled/educated workers – see our result above – and a low skill level may lead to further decline in productivity. For instance, Table 7.3 below shows that over the periods 2005–2006, 2006–2007 and 2007–2008, the declining trend of labour productivity is reversed across 8 out of 37 (22 %) of all respondent firms and the increasing trend continues across 16 out of 37 firms (43 %); however, the increasing trend turns into a declining one across 11 out of 37 firms (30 %), or the declining trend continues across 2 out of 37 (5 %) of all respondent firms. Hence, for the majority 24 out of 37 (65 %) of all respondent firms either the declining trend turns into an increasing one or the increasing trend continues, but for the remaining 13 out of 37 (35 %), i.e. for more than one third of all firms either the increasing trend turns into a declining one or the declining trend continues. For chemical firms over the periods 2005–2006, 2006–2007 and 2007–2008, the declining trend of labour productivity is reversed across 5 out of 18 (28 %) of the chemical firms and the increasing trend continues across 9 out of 18 firms (50 %); however, the increasing trend turns into a declining one across 2 out of 18 firms (11 %), or the declining trend continues across 2 out of 18 (11 %) of the chemical firms. Thus, for the majority 14 out of 18 (68 %) of the chemical firms either the declining trend turns into an increasing one or the increasing trend continues, but for the remaining 4 out of 18 (22 %), i.e. for more than one fifth of the chemical firms either the increasing trend turns into a declining one or the declining trend continues. For food firms over the periods 2005–2006,

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[12] Productivity is measured in physical terms (tonnes, litres, etc.) for selected firms according to availability of data.

[13] The results from the firm survey (2010) indicate that the declining labour productivity seems to be more sensitive to industry level and less sensitive to firm size as reported by 35 %, 22 %, 42 %, 67 %, 50 %, 47 %, 20 % and 33 % of all firms, chemical, food, metal, textile, large, medium and small size firms respectively.

[14] Due to the small number of observations on the declining trend of labour productivity, our results should be interpreted carefully as probably this may not be the only case; other possible explanations are either the steady or increasing trends amongst the non-respondent firms.

[15] In Table 7.3 we limit our analysis of the productivity decline to compare only the change in labour productivity over the periods 2005–2006, 2006–2007 and 2007–2008 across 42 of the respondent firms. Since our data only reflects skill levels for the year 2008, but does not reflect the change in skill levels over the period 2005–2008. That means we cannot compare the change in productivity with the change in skill levels, so as to attribute the declining trend in productivity over the period 2005–2008 to the declining trend in skill levels.

Table 7.3 Assessment of industrial performance: labour productivity: output/labour ratio measured in physical term across firms (2005–2008)

Variables		Value (2005–2008)				Trend (2005–2008)				Growth rate (2005–2008)			
Average ratio of prod/lab	Group of firms	2005	2006	2007	2008	2005–2006	2006–2007	2007–2008	2005–2008	2005–2006	2006–2007	2007–2008	2007–2008
Chemical	Small	104727.27	119172.41	119172.41	199384.62	+		+	+	14		67	90
		40088.065	59703.806	108426.95	123457.95	+	+	+	+	49	82	14	208
		36000000	32000000	16666667	16666667	–	–		–	−11	−48	0	−54
		2222222.2	2666666.7	3125000	3500000	+	+	+	+	20	17	12	58
		66666.667	71428.571	100000	111111.11	+	+	+	+	7	40	11	67
		57500	63333.333	70000	76666.667	+	+	+	+	10	11	10	33
					25452.475			+	+				
	Medium	1	1	1	8			+	+			700	700
		34379.275	45957.464	33308.435	19848.217	+	–	–	–	34	−28	−40	−42
				18700	36083.333		+	+	+				
		3555.5556	3384.6154	6000	6666.6667	–	+	+	+	−5	77	11	87
	Large		57.915058	61.776062	34.749035	+	+	–	+		7	−44	
				31500	69443.925		+	+	+			120	
		2632.9588	2840.8	2535.7143	3392.3077	+	–	+	+	8	−11	34	29
		78750	70000	120000	133333.33	–	+	+	+	−11	71	11	69
		26557.053	23979.592	20715.596	14434.783	–	–	–	–	−10	−14	−30	−46
			42.857143	41.25	41.257778	+	–	+	+		−4		
				156393.16	179986.3		+	+	+			15	
		78026.433	77137.71	85601.63	90375.527	–	+	+	+	−1	11	6	16
Food	Small	6666.6667	18181.818	36000	1500000	+	+	+	+	173	98	4067	22400
					3055555.6			+	+				
			166.66667	233.33333	400	+	+	+	+		40	71	
		13437500	1.875E + 09	15625000	15000000	+	–	–	+	13853	−99	−4	12
	Medium			60023.543	63433.078		+	+	+			6	
		68432.523	87238.779		17700.333	+	–	+	–	27	−100		−74
		673043.48	673043.48	673043.48	673043.48								
		17.763158	20	24.193548	29.824561	+	+	+	+	13	21	23	68
			4122.75	6369.5918	14983.607	+	+	+	+		54	135	
		7812.5	8531.25	10000	7995.5156	+	+	–	+	9	17	−20	2

(continued)

Table 7.3 (continued)

Variables		Value (2005–2008)				Trend (2005–2008)				Growth rate (2005–2008)			
Average ratio of prod/lab	Group of firms	2005	2006	2007	2008	2005–2006	2006–2007	2007–2008	2005–2008	2005–2006	2006–2007	2007–2008	2007–2008
	Large	172413793	155172414	181034483	65517241	–	+	–	–	−10	17	−64	−62
		96	100.46512	105.36585	109.36709	+	+	+	+	5	5	4	14
		84975.92	97098.257	123589.7	78070.618	+	+	–	–	14	27	−37	−8
		1600	1750	1987.1795	1826.9231	+	+	–	+	9	14	−8	14
Metal	Small				600000			+	+				
		29500	43500	54666.667	5909.0909	+	+	–	–	47	26	−89	−80
		67045455	123456790	79069767	283333333	+	–	+	+	84	−36	258	323
	Medium				538461.54			+	+				
	Large	166.66667	200	235.29412	218.18182	+	+	–	+	20	18	−7	31
Textile	Small	937.5	1187.5	1615.3846	1538.4615	+	+	–	+	27	36	−5	64
	Medium	54110.855	75207.851	47192.489	65621.116	+	–	+	+	39	−37	39	21
	Large			45	450.23333		+	+	+			901	
		251845.94	8436724.6	69963.713	64541.195	+	–	–	–	3250	−99	−8	−74

Source: Own calculation based on the firm survey (2010)

2006–2007 and 2007–2008, the declining trend of labour productivity is reversed across 1 out of 12 (8 %) of the respondent firms and the increasing trend continues across 6 out of 12 firms (50 %); however, the increasing trend turns into a declining one across 5 out of 12 firms (42 %). Therefore, for more than half or the majority 7 out of 12 (58 %) of the food firms either the declining trend turns into an increasing one or the increasing trend continues, but for the remaining 5 out of 12 (42 %), i.e. for more than one third and near to one half of the food firms either the increasing trend turns into a declining one or the declining trend continues. For metal firms over the periods 2005–2006, 2006–2007 and 2007–2008, the declining trend of labour productivity is reversed across 1 out of 3 (33 %) of the metal firms; however, the increasing trend turns into a declining one across 2 out of 3 (67 %) of the metal firms. Hence, for the majority 2 out of 3 (67 %), i.e. for more than two third of the metal firms the increasing trend turns into a declining one, but for the remaining 1 out of 3 (33 %) the declining trend turns into an increasing one. For textile firms over the periods 2005–2006, 2006–2007 and 2007–2008, the declining trend of labour productivity is reversed across 1 out of 4 (25 %) of the textile firms and the increasing trend continues across 1 out of 4 firms (25 %); however, the increasing trend turns into a declining one across 2 out of 4 firms (50 %). Thus, for the first half (2 out of 4 or 50 %), i.e. for one half of the textile firms either the declining trend turns into an increasing one or the increasing trend continues, while for the other half (2 out of 4 or 50 %) the increasing trend turns into a declining one For large size firms over the periods 2005–2006, 2006–2007 and 2007–2008, the declining trend of labour productivity is reversed across 4 out of 15 (27 %) of the large size firms and the increasing trend continues across 4 out of 15 firms (27 %); however, the increasing trend turns into a declining one across 6 out of 15 firms (40 %), or the declining trend continues across 1 out of 15 (7 %) of the large size firms. Thus, for the majority 8 out of 15 (53 %), i.e. for more than one half of the large size firms either the declining trend turns into an increasing one or the increasing trend continues, but for the remaining 7 out of 15 (47 %) either the increasing trend turns into a declining one or the declining trend continues. For medium size firms over the periods 2005–2006, 2006–2007 and 2007–2008, the declining trend of labour productivity is reversed across 3 out of 10 (30 %) of the medium size firms and the increasing trend continues across 5 out of 10 firms (50 %); however, the increasing trend turns into a declining one across 2 out of 10 (20 %) of the medium size firms. Thus, for the majority 8 out of 10 (80 %) of the medium size firms either the declining trend turns into an increasing one or the increasing trend continues, but for the remaining 2 out of 10 (20 %), i.e. for one fifth of the medium size firms the increasing trend turns into a declining one. For small size firms over the periods 2005–2006, 2006–2007 and 2007–2008, the declining trend of labour productivity is reversed across 1 out of 12 (8 %) of the small size firms and the increasing trend continues across 7 out of 12 firms (58 %); however, the increasing trend turns into a declining one across 3 out of 12 (25 %) of the small size firms, or the declining trend continues across 1 out of 12 (8 %) of the small size firms. Thus, for the majority 8 out of 12 (67 %) of the small size firms either the declining trend turns into an increasing one or the increasing trend continues, but for the remaining 4 out of 12 (33 %), i.e. for one third of the small size firms either the increasing trend turns into a declining one or the declining trend continues.

Therefore, our results in this section concerning the declining labour productivity are consistent with our results regarding the declining industrial performance indicators that we measure by three sets of economic-productivity, activity and profitability indicators at the micro level as we show in the next section (see Tables 7.4 and 7.5 below).

7.3.2.3 Low Skill Levels and the Declining Trend of Other Industrial Performance Indicators

The low skill levels may contribute to the decline of industrial performance indicators across firms. The trend of these indicators show considerable variation across firms and in most cases seem to be more sensitive to differences in firm size, industry and sector, in particular, the average performance ratio for different indicators for numerous firms show a considerable decline over the period 2005–2008. Tables 7.4 and 7.5 below illustrate an assessment of the value and trend of industrial performance indicators across firms over the period 2005–2008, which we measure by three different sets of economic and productivity indicators, activity indicators and profitability indicators. Using Al-Quraishi's (2005) definition of industrial performance, first we measure the first set of economic indicators by three indicators including first the degree of industrialisation that is indicated by the ratio of total value added as a percentage of total output measured by total sales value, and second the capital intensity level indicators that we measure by the ratios of capital and fixed capital – measured by total spending in machinery and equipment – as percentages to total labour respectively. We define the third economic indicator by a set of productivity indicators that we measure by: labour productivity indicator measured by the ratio of total value added as a percentage to total labour; capital productivity indicator measured by the ratio of total output measured by total sales value as percentages of total capital; fixed capital productivity indicator measured by the ratio of output measured by total sales value as a percentage of fixed capital or machinery and equipment; wage productivity indicator that we measure by the total output measured by total sales value as a percentage of total wage; and raw materials productivity indicator measured by the ratio of total output measured by total sales value as a percentage to total spending on raw materials. Second, we measure the second set of activity indicators or ratios by first the fixed capital turnover ratio that we measure by the ratio of total sales value as a percentage of fixed capital, and second the capital turnover ratio that we measure by the ratio of total sales value as a percentage of total capital. Third, we measure the third set of profitability indicators by three indicators including first the rate of return on labour that we measure by profit/labour ratio, second the rate of return on capital that we measure by the ratio of profit as a percentage to capital and third profit margin indicator that we measure by the ratio of profit as a percentage to total sales value (Al-Quraishi 2005: 249–277).

Table 7.4 Assessment of the value, trend and growth rates of industrial performance: economic, activity, labour productivity, output/labour and capital/labour ratios and other productivity indicators across firms (2005–2008)

Variables	Group of firms	Value (2005–2008)				Trend (2005–2008)				Growth rate (2005–2008)			
Average ratio of		2005	2006	2007	2008	2005–2006	2006–2007	2007–2008	2005–2008	2005–2006	2006–2007	2007–2008	2005–2008
1. Economic indicators													
The degree of industrialization = value added/output (sale value)	Chemical	20.071384	0.1006944	0.1102117	0.121095	–	+	+	–	−99	9	10	−99
	Food	5.59262	5.7751745	7.4236966	7.7370768	+	+	+	+	3	29	4	38
	Metal	0.0309524	0.0166667	0.1135593	0.0888889	–	+	–	+	−46	581	−22	187
	Textile	0.1262011	0.1229581	0.1379861	0.1255524	–	+	–	–	−3	12	−9	−1
	Large	25.063934	0.0877692	0.0970537	0.1137513	–	+	+	–	−100	11	17	−100
	Medium	7.4804304	7.243592	7.4348101	7.7427771	–	+	+	+	−3	3	4	4
	Small	0.0627458	0.0632965	0.1214039	0.1166114	+	+	–	+	1	92	−4	86
	Private	12.28653	2.6815389	3.1682737	3.3004401	–	+	+	–	−78	18	4	−73
	Mixed	0.0727273	0.0725	0.075	0.0733333	–	+	–	+	0	3	−2	1
	All firms	6.4552894	1.5038734	1.9463634	2.0181533	–	+	+	–	−77	29	4	−69
2. Activityand labourproductivity	indicators												
Capital/labour	Chemical	35065602	27590847	20278975	16777192	–	–	–	–	−21	−27	−17	−52
	Food	7.16E + 09	6.10E + 09	6.68E + 09	7.52E + 09	–	+	+	+	−15	9	13	5
	Metal	30876818	74171574	81460349	104421212	+	+	+	+	140	10	28	238
	Textile	10757338	11308723	9320350.8	9304595.7	+	–	–	–	5	−18	0	−14
	Large	18022260	44082391	7016133	11853455	+	–	+	–	145	−84	69	−34
	Medium	716288.06	540146.61	4118685.8	2901363.1	–	+	–	+	−25	663	−30	305
	Small	4.59E + 09	5.01E + 09	5.50E + 09	5.83E + 09	+	+	+	+	9	10	6	27
	Private	2.39E + 09	2.28E + 09	2.08E + 09	2.29E + 09	–	–	+	–	−4	−9	10	−4
	Mixed	153115039	212744727	108623182	117178164	+	–	+	–	39	−49	8	−23
	All firms	1.809E + 09	1.553E + 09	1.697E + 09	1.912E + 09	–	+	+	+	−14	9	13	6
Fixed capital (machinery and equipment)/Labour	Chemical	17324619	14756079	13091702	11310615	–	–	–	–	−15	−11	−14	−35
	Food	296053860	68495853	59997873	63588812	–	–	+	–	−77	−12	6	−79
	Metal	32035906	39615035	41916373	102960921	+	+	+	+	24	6	146	221
	Textile	2866267.3	2503114.8	37533.295	39332.76	–	–	+	–	−13	−99	5	−99
	Large	260069994	51927232	41157115	47809051	–	–	+	–	−80	−21	16	−82
	Medium	84350.355	60784.395	3060039.9	1746163.8	–	+	–	+	−28	4934	−43	1970
	Small	24976660	28926310	27914835	44197977	+	–	+	+	16	−3	58	77
	Private	3438151.1	3258447.2	4053537.4	10617005	–	+	+	+	−5	24	162	209
	Mixed	760056666	283521984	249015472	273580008	–	–	+	–	−63	−12	10	−64
	All firms	87070163	31342520	28760870	44474920	–	–	+	–	−64	−8	55	−49
Raw materials/labour	Chemical	2871098.1	97839439	100277944	107446906	+	+	+	+	3308	2	7	3642
	Food	88134391	9517892.2	26412145	14109863	–	+	–	–	−89	177	−47	−84
	Metal	9684090.9	37673071	15697858	27849382	+	–	+	+	289	−58	77	188

(continued)

Table 7.4 (continued)

Variables	Group of firms	Value (2005–2008)				Trend (2005–2008)				Growth rate (2005–2008)			
Average ratio of		2005	2006	2007	2008	2005–2006	2006–2007	2007–2008	2005–2008	2005–2006	2006–2007	2007–2008	2005–2008
	Textile	1472742.7	8473466	9432995.2	1311518.5	+	+	–	–	475	11	−86	−11
	Large	78630305	116823438	141977429	153140881	+	+	+	+	49	22	8	95
	Medium	526713.27	653338.89	4091163.3	2391839.4	+	+	–	+	24	526	−42	354
	Small	5617402.1	15395691	8733551.6	10354531	+	–	+	+	174	−43	19	84
	Private	5518075	60875381	64930925	67173818	+	+	+	+	1003	7	3	1117
	Mixed	213506237	6285777.8	54637414	22482133	–	+	–	–	−97	769	−59	−89
	All firms	25540581	38375967	37955236	37679417	+	–	–	+	50	−1	−1	48
Wage/labour	Chemical	629661.54	691335.32	1107005.7	1202982.3	+	+	+	+	10	60	9	91
	Food	19795120	4465405.3	5182546.5	5001834	–	+	–	–	−77	16	−3	−75
	Metal	2795004.4	7412864.2	7561777.4	8655813.8	+	+	+	+	165	2	14	210
	Textile	1123823.6	1174157	10385.944	7701.6136	+	–	–	–	4	−99	−26	−99
	Large	17960782	4505029.2	3964134.6	4244171.8	–	–	+	–	−75	−12	7	−76
	Medium	53597.363	68865.449	416449.87	258538.56	+	+	–	+	28	505	−38	382
	Small	1290975.4	2367999.3	2820244.4	4674367.5	+	+	+	+	83	19	66	262
	Private	1827576.6	1953272.4	2047724.2	2477402.8	+	+	+	+	7	5	21	36
	Mixed	44890563	7038915.8	7394609.9	9456880.8	–	+	+	–	−84	5	28	−79
	All firms	6085902.4	3435940.5	3465428.9	3717082.9	–	+	+	–	−44	1	7	−39
Sales value (output)/labour	Chemical	2965521.1	62897297	50687940	55577289	+	–	+	+	2021	−19	10	1774
	Food	948316463	882596205	729683552	623900429	–	–	–	–	−7	−17	−14	−34
	Metal	65918758	43718037	101317367	120345041	–	+	+	+	−34	132	19	83
	Textile	1667595	3069766.2	956358.61	1035369.3	+	–	+	–	84	−69	8	−38
	Large	143338675	119495935	110775961	116574335	–	–	+	–	−17	−7	5	−19
	Medium	1.15E + 09	893753071	735194023	578678320	–	–	–	–	−22	−18	−21	−50
	Small	9459741.1	168685305	9030811.2	23463531	+	–	+	+	1683	−95	160	148
	Private	337535170	361251148	267733421	250215178	+	–	–	–	7	−26	−7	−26
	Mixed	316187014	60302554	57519586	43154592	–	–	–	–	−81	−5	−25	−86
	All firms	254717084	248070326	220661304	200214532	–	–	–	–	−3	−11	−9	−21
Value added/labour	Chemical	2551317.2	955660.37	1313488.7	1058510.2	–	+	–	–	−63	37	−19	−59
	Food	34483247	5451257.3	5644107.6	4247107.3	–	+	–	–	−84	4	−25	−88
	Metal	1477272.7	1851851.9	7790697.7	23333333	+	+	+	+	25	321	200	1479
	Textile	316276.81	285201.47	444191.11	482803.84	–	+	+	+	−10	56	9	53
	Large	36327013	6253965	6471635.7	4749855.5	–	+	–	–	−83	3	−27	−87
	Medium	3795.4275	4626.0202	1069155.8	762380.47	+	+	–	+	22	23012	−29	1987
	Small	1495991.8	1884495.9	2709645.6	5814842.9	+	+	+	+	26	44	115	289
	Private	1486836.5	859713.02	1576540.1	2743335.1	–	+	+	+	−42	83	74	85
	Mixed	68965517	12500000	12931034	9482758.6	–	+	–	–	−82	3	−27	−86
	All firms	9707028.4	2135992.8	3798121.3	7280438.6	–	+	+	–	−78	78	92	−25

Source: Firm Survey (2010): own calculation from the firm survey (2010)

Table 7.5 Assessment of the value, trend and growth rates of industrial performance: Activity, other productivity and profitability indicators across firms (2005–2008)

Variables	Group of firms	Value (2005–2008)				Trend (2005–2008)				Growth rate (2005–2008)			
Average ratio of		2005	2006	2007	2008	2005–2006	2006–2007	2007–2008	2005–2008	2005–2006	2006–2007	2007–2008	2005–2008
3. Activity and other productivity indicators													
Fixed capital turnover ratio = sale/sale value/fixed capital (machinery and equipment)	Chemical	2.8912123	495.92478	308.19507	366.82629	+	–	+	+	17053	−38	19i)	12588
	Food	3.1793517	189.03297	146.05162	114.63459	+	–	–	+	5846	−23	−22	3506
	Metal	0.408299	0.8018738	0.648209	0.8518113	+	–	+	+	96	−19	31	109
	Textile	101.48658	60.764981	61.229179	87.570441	–	+	+	–	−40	1	43	−14
	Large	1.8379	673.70374	449.75099	451.41571	+	–	+	+	36556	−33	0	24461
	Medium	3.4770759	2.9621226	3.2838275	134.22139	–	+	+	+	−15	11	3987	3760
	Small	30.012525	160.39301	126.72865	116.94158	+	–	–	+	434	−21	−8	290
	Private	17.22597	353.64104	242.29702	273.28094	+	–	+	+	1953	−31	13	1486
	Mixed	0.1603258	0.3773134	0.4740032	0.496713	+	+	+	+	135	26	5	210
	All firms	26.991361	186.63115	129.03102	142.47078	+	–	+	+	591	−31	10	428
Capital turnover ratio = sale value/capital	Chemical	42.418878	40.067628	3.634055	59.389793	–	–	+	+	−6	−91	1534	40
	Food	412.50789	498.51296	499.94462	255.81401	+	+	–	–	21	0	−49	−38
	Metal	0.4260684	0.4852564	0.4158425	0.6116496	+	–	+	+	14	−14	47	44
	Textile	0.1639614	1.1928782	3.3614254	8.2609911	+	+	+	+	628	182	146	4938
	Large	67.82426	60.273972	6.1373149	44.09251	–	–	+	–	−11	−90	618	−35
	Medium	573.8511	462.21815	444.30504	259.79308	–	–	–	–	−19	−4	−42	−55
	Small	1.0437791	68.812585	0.8258962	0.6976534	+	–	–	–	6493	−99	−16	−33
	Private	167.38012	194.48088	145.13254	111.76126	+	–	–	–	16	−25	−23	−33
	Mixed	2.6348545	0.5323247	3.8765243	11.515423	–	+	+	+	−80	628	197	337
	All firms	113.8792	135.06468	126.83899	81.019111	+	–	–	–	19	−6	−36	−29
Wage productivity ratio = output/(sale value)/wage	Chemical	8.3525744	8.1943495	7.3845158	361.40226	–	–	+	+	−2	−10	4794	4227
	Food	428.41408	552.93182	400.66736	344.83311	+	–	–	–	29	−28	−14	−20
	Metal	4.9500291	5.7200371	5.9344161	12.735474	+	+	+	+	16	4	115	157
	Textile	523.82575	315.64078	506.53952	548.33265	–	+	+	+	−40	60	8	5
	Large	9.4032343	10.088306	9.3580525	9.8078386	+	–	+	+	7	−7	5	4
	Medium	10.118612	14.996222	8.6892371	511.03983	+	–	+	+	48	−42	5781	4950
	Small	496.53461	614.09712	557.16857	538.03343	+	–	–	+	24	−9	−3	8
	Private	242.53064	253.70029	205.28462	379.92113	+	–	+	+	5	−19	85	57
	Mixed	2.4749747	4.802963	4.7386977	3.6878688	+	–	–	+	94	−1	−22	49
	All firms	241.38561	220.62175	230.13145	316.82587	–	+	+	+	−9	4	38	31
Raw materials productivity ratio = output/(sale value)/raw materials	Chemical	1.472792	1.5531448	1.3339254	366.07809	+	–	+	+	5	−14	27344	24756
	Food	6.8706046	1523.3263	157.43672	132.15185	+	–	–	+	22072	−90	−16	1823
	Metal	1.5252941	1.3110383	73.819865	2.4578007	–	+	–	+	−14	5531	−97	61
	Textile	2.0123894	2.0076766	4.1239329	2.1136204	–	+	–	+	0	105	−49	5
	Large	1.8617158	2.8742128	2.3465453	2.0572816	+	–	–	+	54	−18	−12	11
	Medium	2.5102906	2.0460816	154.59166	758.66946	–	+	+	+	−18	7455	391	30122
	Small	5.4970686	1521.3296	18.090003	4.4274845	+	–	–	–	27575	−99	−76	−19
	Private	3.8347064	549.06214	53.093879	255.13267	+	–	+	+	14218	−90	381	6553

(continued)

Table 7.5 (continued)

Variables / Average ratio of	Group of firms	Value (2005–2008) 2005	2006	2007	2008	Trend (2005–2008) 2005–2006	2006–2007	2007–2008	2005–2008	Growth rate (2005–2008) 2005–2006	2006–2007	2007–2008	2005–2008
	Mixed	0.6954618	4.7421652	4.0867543	1.1633541	+	–	–	+	582	−14	−72	67
	All firms	2.97027	382.04954	59.178611	125.70034	+	–	+	+	12762	−85	112	4132
4. Profitability indicators													
Rate of return on labour = profit/labour	Chemical	325003.77	97520339	93381463	89415111	+	–	–	+	29906	−4	−4	27412
	Food	16073000	16556605	15371532	8457780.9	+	–	–	–	3	−7	−45	−47
	Metal	25195354	10424630	42266973	45856265	–	+	+	+	−59	305	8	82
	Textile	928346.78	512349.74	226633.83	237267.99	+	+	–	+	−45	−56	5	−74
	Small	14843443	3943959.6	1559333	7393518.3	+	–	+	+	−127	−60	374	−150
	Medium	246042.07	280699.08	261740.38	377443.01	+	–	+	+	14	−7	44	53
	Large	30615658	107746075	119654268	116398986	+	+	–	+	252	11	−3	280
	Private	1343693.4	56024755	59488296	55206716	+	+	–	+	4069	6	−7	4009
	Mixed	62279128	10959241	10342936	8606965	–	–	–	–	−82	−6	−183	−114
	All firms	10166253	30997306	37698334	35872972	+	+	–	+	205	22	−5	253
Rate of return on capital = profit/capital	Chemical	7.202629	6.792908	5.1351797	8.9627444	–	–	+	+	−6	−24	75	24
	Food	2.2030291	10.639528	10.380229	15.224402	+	–	–	–	383	−2	−247	−791
	Metal	0.0336182	0.0365385	0.0194139	0.0901709	+	–	+	+	9	−47	364	168
	Textile	0.358709	2.3015254	0.2610921	0.2539136	–	+	–	–	−742	−111	−197	−171
	Large	10.3743	9.2316877	7.0692848	8.0630912	–	–	+	–	−11	−23	14	−22
	Medium	13.761543	10.120505	9.8050205	7.547615	–	–	–	–	−26	−3	−177	−155
	Small	6.6239792	0.6008153	0.0492431	0.0834129	+	–	+	+	−109	−92	69	−101
	Private	4.3952252	6.8602373	6.0800742	0.1484943	+	–	–	–	56	−11	−102	−103
	Mixed	0.3483543	0.0733435	1.231029	1.2917988	–	–	+	+	−121	1578	−205	271
	All firms	2.4494963	3.7918623	3.9489787	1.6063501	+	+	–	–	55	4	−141	−166
Profit margin = profit/sale	Chemical	4.9863121	4.0622007	2.6593402	2.4372959	–	–	–	–	−19	−35	−8	−51
	Food	4444.0867	4000.932	4000.7488	3334.3731	–	–	–	–	−10	0	−17	−25
	Metal	0.0272396	0.1014987	0.1787782	0.2703077	+	+	–	–	−473	76	−251	892
	Textile	3.7304507	2.0300487	0.0842857	0.2035356	+	+	–	+	−46	−104	−341	−95
	Large	471.82625	0.9103777	0.4437194	0.3052073	–	–	–	–	−100	−51	−31	−100
	Medium	10.019226	6.4150969	5.6685649	4.5480634	–	–	–	–	−36	−12	−20	−55
	Small	3998.7518	4000.0724	3636.4011	3333.2799	+	–	–	–	0	−9	−8	−17
	Private	1741.3817	1430.6505	1178.2029	1054.1797	–	–	–	–	−18	−18	−11	−39
	Mixed	3.8074523	0.0536275	0.0249647	0.0988276	+	–	+	+	−101	−53	296	−103
	All firms	1111.3288	1000.7664	1000.9178	834.08414	–	+	–	–	−10	0	−17	−25

Source: Own calculation based on the firm survey (2010)

Beginning with the first set of economic indicators, we find that for all firms the trend of value and growth rate of the economic indicator as measured by the degree of industrialisation as measured by the value added/sales value (output) ratio, showed a negative decreasing trend over the periods 2005–2006 and 2005–2008 but that again turned into a positive increasing trend over the periods 2006–2007 and 2007–2008. In particular, we find that the economic indicator as measured by the degree of industrialisation as measured by the value added/sales value (output) ratio varied across firms over the period 2005–2008, for instance, either the declining trend continued or the increasing trend turned into a declining trend for metal and textile industries, small size and mixed firms, while by contrast either the increasing trend continued for food industries or the declining trend turned into an increasing trend for all firms, chemical industries and medium size and large size and private firms. Moreover, as for the second economic indicator of capital intensity and productivity indicator as measured by capital/labour productivity indicator or ratio, we find that for all firms the trend of value and growth rate of capital/labour ratio showed a negative decreasing trend over the period 2005–2006 that turned into a positive increasing trend over the periods 2006–2007, 2007–2008 and 2005–2008. In particular, we find that the capital intensity and productivity indicator measured by capital/labour ratio varied across firms over the period 2005–2008, for instance, either the declining trend continued for the chemical industries or the increasing trend turned into a declining trend for textile industries and medium size firms, whereas by contrast either the increasing trend continued or the declining trend turned into an increasing trend for all firms, food and metal industries and small size and large size and private and mixed firms. Moreover, we find that for all firms the trend of value and growth rate of the second economic indicator of capital intensity and productivity indicator measured by fixed capital/labour ratio measured by machinery and equipment/labour ratio showed a negative decreasing trend over the periods 2005–2006, 2006–2007 and 2005–2008 that turned into a positive increasing trend over the period 2007–2008. In particular, we find that the capital intensity and productivity indicator measured by fixed capital/labour ratio measured by machinery and equipment/labour ratio varied across firms over the period 2005–2008, for instance, either the declining trend continued for the chemical industries or the increasing trend turned into a declining trend for the medium size firms, whereas by contrast either the increasing trend continues or the declining trend turned into an increasing trend for all firms, food, metal and textile industries, small size and large size, private and mixed firms. In addition, we find that for all firms the trend of value and growth rate of raw materials/labour ratio showed a positive increasing trend over the periods 2005–2006 and 2005–2008 that turned into a negative decreasing trend over the periods 2006–2007 and 2007–2008. In particular, we find that the raw materials/labour ratio varied across firms over the period 2005–2008, for instance, either the declining trend continues or the increasing trend turned into a declining trend for all firms, food and textile industries and medium size and mixed firms, while by contrast either the increasing trend continued for the chemical industries, large size and private firms or the declining trend turned into an increasing trend for metal industries and small size firms. Moreover, we find that for all firms the trend of value and growth rate of wages/labour ratio showed a negative decreasing trend over the periods 2005–2006 and 2005–2008 that turned into a positive increasing trend over the periods 2006–2007 and 2007–2008. In particular, we find that wages/labour ratio varied across firms over the period 2005–2008, for instance, either the declining trend continued or the increasing trend turned into a declining trend for food and textile industries and medium size firms, while either the increasing trend continued for the chemical and metal industries and small size and private firms, or the declining trend turned into an increasing trend for all firms, large size and mixed firms. Moreover, we find that for all firms the trend of value and growth rate of sales value (output)/labour ratio showed a negative decreasing trend over all the periods 2005–2006, 2006–2007, 2007–2008 and 2005–2008. In particular, we find that sales value (output)/labour ratio varied across firms over the period 2005–2008, for instance, either the declining trend continued for all firms, food industries, medium size, and mixed firms or the increasing trend turned into a declining trend for private firms, while by contrast either the increasing trend continued or the declining trend turned into an increasing trend for the chemical, metal, textile industries and small size and large size firms. Moreover, we find that for all firms the trend of value and growth rate of value added/labour ratio showed a negative decreasing trend over the periods 2005–2006 and 2005–2008 that turned into a positive increasing trend over the periods 2006–2007 and 2007–2008. In particular, we find that the value added/labour ratio vary across firms over the period 2005–2008, for instance, either the declining trend continued or the increasing trend turned into a declining trend for chemical and food industries, medium and large size and mixed firms, while by contrast either the increasing trend continued for metal industries and small size firms or the declining trend turned into an increasing trend for all firms, textile and private firms (see Table 7.4 above). Moreover, we find that for all firms the trend of value and growth rate of other productivity indicators as measured by the wage productivity ratio as measured by sales/wage ratio showed a negative decreasing trend over the period 2005–2006 that turned into a positive increasing trend over all the periods 2006–2007, 2007–2008 and 2005–2008. In particular, we find that the other productivity indicators as measured by the wage productivity ratio as measured by sales/wage ratio varied across firms over the period 2005–2008, for instance, either the declining trend continued or the increasing trend turned into a declining trend for food industries and small size and mixed firms, while by contrast either the increasing trend continued for metal industries or the declining trend turned into an increasing trend for all firms, chemical and textile industries and medium size and large size and private firms. Moreover, we find that for all firms the trend of value and growth rate of other productivity indicators as measured by the raw materials productivity as measured by the sales/raw materials ratio showed a positive increasing trend over the period 2005–2006, that turned into a negative decreasing trend over the period 2006–2007 but that again turned into a positive increasing trend over the periods 2007–2008 and 2005–2008. In particular, we find that the other productivity indicators as measured by the raw materials productivity as measured by the sales/raw materials ratio varied across firms over the period

2005–2008, for instance, either the declining trend continued or the increasing trend turned into a declining trend for food, metal and textile industries and small size and large size and mixed firms, while by contrast either the increasing trend continued or the declining trend turned into an increasing trend for all firms, chemical industries and medium size and private firms. Moreover, we find that for all firms the trend of value and growth rate of the second set of indicators (the activity indicators as measured by fixed capital turnover ratio as defined by the sales/fixed capital (machinery and equipment) ratio) showed a positive increasing trend over the periods 2005–2008 and 2005–2006, that turned into a negative decreasing trend over the period 2006–2007 but that again turned into a positive increasing trend over the period 2007–2008. In particular, we find that the activity and other productivity indicators as measured by the fixed capital turnover ratio as measured by the sales/fixed capital ratio as measured by machinery and equipment varied across firms over the period 2005–2008, for instance, either the declining trend continued or the increasing trend turned into a declining trend for food industries and small size firms, while by contrast either the increasing trend continued for mixed firms or the declining trend turned into an increasing trend for all firms, chemical, metal and textile industries and medium size and large size and private firms. Moreover, we find that for all firms the trend of value and growth rate of activity and other productivity indicators, defined by capital turnover ratio, defined by sales/capital ratio showed a positive increasing trend over the period 2005–2006, that turned into a negative decreasing trend over the periods 2006–2007, 2007–2008 and 2005–2008. Particularly, we find that the activity and other productivity indicators, defined by capital turnover ratio, defined by sales/capital ratio vary across firms over the period 2005–2008; for instance, either the declining trend continued for medium size firms or the increasing trend turned into a declining trend for all firms, food industries and small size and private firms, while by contrast either the increasing trend continued for textile industries or the declining trend turned into an increasing trend for chemical and metal industries and large size and mixed firms (see Table 7.5 below).

As for the third set of profitability indicators from Table 7.5, we find that for all firms the trend of value and growth rate of profitability that we measure by the rate of return on labour or profit/labour ratio showed a positive increasing trend over the periods 2005–2006, 2006–2007 and 2005–2008 that turned into a negative declining trend over the period 2007–2008. In particular, we find that profit/labour ratio varied across firms over the period 2005–2008, for instance, either the declining trend continued for mixed firms or the increasing trend turned into a declining trend for all firms, chemical, food and textile industries, large size and private firms, while by contrast either the increasing trend continues or the declining trend turned into an increasing trend for metal industries, small and medium size firms. In addition, we find that for all firms the trend of value and growth rate of profitability as measured by the rate of return on capital as measured by profit/capital ratio showed a positive increasing trend over the periods 2005–2006 and 2006–2007 that turned into a negative decreasing trend over the periods 2007–2008 and 2005–2008. In particular, we find that profitability as measured by the rate of return on capital measured by profit/capital ratio varied across firms over the period 2005–2008, for instance, either the declining trend continued for medium size firms or the increasing trend turned into a declining trend for all firms, food and textile industries and private firms, while by contrast either the increasing trend continues or the declining trend turned into an increasing trend for chemical and metal industries and small size and large size and mixed firms. Moreover, we find that for all firms the trend of value and growth rate of profitability measured by profit margin that we measure by profit/sales ratio showed a negative decreasing trend over all the periods: 2005–2006, 2007–2008 and 2005–2008. In particular, we find that profitability as measured by profit margin as measured by profit/sales ratio varied across firms over the period 2005–2008, for instance, either the declining trend continued for chemical and food industries, large size, medium size and private firms or the increasing trend turned into a declining trend for all firms, metal and textile industries and small size, while by contrast the declining trend turned into an increasing trend only for mixed firms.

We find that in most cases the trend of these indicators seem to be more sensitive to differences in firm size, industry and sector. In particular, the industrial performance indicators that seem to be more sensitive to differences in firm size, industry and sector include the economic indicator as measured by the degree of industrialisation that we measure by the ratio of total value added as a percentage of total output measured by total sales value. Moreover, other industrial performance indicators that seem to be more sensitive to differences in firm size, industry and sector include three productivity indicators: capital productivity indicator (total output (measured by total sales value)/total capital); the fixed capital productivity indicator (total output (measured by total sales value)/fixed capital (machinery and equipment)); and the wage productivity indicator (total output (measured by total sales value)/total wage). In addition to the activity indicators or ratios measured by fixed capital turnover ratio, measured by the ratio of total sales value as a percentage of fixed capital, and capital turnover ratio measured by the ratio of total sales value as a percentage of total capital, in addition to the profitability indicator measured by the rate of return on capital measured by the ratio of profit as a percentage to capital. We find that the industrial performance indicators that seem to be to some extent sensitive to differences in firm size but less sensitive to industry and sector include the economic or capital intensity level indicator measured by both the ratio of total capital as a percentage to total labour and the ratio of fixed capital or total spending in machinery and equipment as a percentage to total labour. Moreover, we find that the industrial performance indicator that seems to be sensitive to only differences in industry is the raw materials productivity indicator measured by the ratio of total output measured by total sales value as a percentage to total spending on raw material. We find that the industrial performance indictors that seem to be insensitive to differences in firm size, industry and sector include the labour productivity indicator measured by the ratio of total value added as a percentage to the total labour and profitability indicators that we define by profit/labour ratio and profit margin indicator measured by the ratio of profit as a percentage to total sales value. These results imply that in most cases an increase in skill level – share of high skill in total employment – firm size and industry most probably leads to an improvement in most of industrial performance indicators (see Tables 7.4 and 7.5 below).

7.3.2.4 Low Skill Level and Declining Performance of Manufacturing Industrial Firms

The findings from the firm survey (2010) and Table 7.6 below support our argument that the low skill levels may contribute to declining industrial performance indicators: economic, activity, profitability and labour productivity across firms as we explained above. Table 7.6 below shows that the low skill level is indicated by firms among the important problems that are hindering industrial performance and contribution towards economic development in Sudan.[16] For instance, we find that from the perspective of all respondent firms the most important problems are: inadequate finance and inappropriate conditions for industrial development, spread of routine and bureaucracy and slow procedures related to the industrial needs, interruption and inadequate availability and high costs of electricity and water, lack of raw materials, inadequate infrastructure, weak maintenance capability and lack of spare parts, inadequate skills and lack of trained labour force, weak industrial awareness, weak and narrow marketing opportunities, weak and inadequate economic visibility studies, inadequate management and organisational facilities and inadequate transportation equipment respectively (see Table 7.6 below).[17] Moreover, from the firms' perspective other extremely important factors hindering contribution of the industrial sector in economic development in Sudan include the lack of support from Ministry of Industry and the government, and high production costs caused by the imposition of high taxes, fees, levies and customs for clearance of imported raw materials, machines, machinery and equipment imposed on the industrial firms in Sudan.[18] For chemical industries the most important problems are: interruption and inadequate availability and high costs of electricity and water, spread of routine and bureaucracy and slow procedures related to industrial needs, lack of raw materials, inadequate finance and inappropriate conditions for industrial development, inadequate infrastructure, weak industrial awareness, inadequate skill and lack of trained labour force, weak maintenance

[16] For instance, inadequate skills and lack of trained labour force is important problem that reported by 75 %, 76 %, 68 %, 100 %, 60 %, 91 %, 69 % and 60 % of all firms, chemical, food, metal, textile, large, medium and small size firms respectively.

[17] As indicated by 86 %, 85 %, 84 %, 78 %, 76 %, 75 %, 75 %, 73 %, 67 %, 61 %, 57 % and 52 % of all respondents firms respectively.

[18] According to respondent firms 95 % of industrial firms in Khartoum North industrial area are closed due to high production costs.

Table 7.6 The factors constraining improvement of industrial firms performance and economic development in Sudan (2008)

	All	Industry				Size		
	firms	Chemical	Food	Metal	Textile	Large	Medium	Small
Inadequate finance and inappropriate conditions for industrial development	86 %	84 %	82 %	100 %	100 %	88 %	88 %	85 %
Spread of routine and bureaucracy and slow procedures related to industrial needs	85 %	89 %	89 %	67 %	60 %	84 %	88 %	85 %
Interruption and inadequate availability and high costs of electricity and water	84 %	89 %	86 %	56 %	80 %	84 %	85 %	85 %
Lack of local raw materials	78 %	86 %	61 %	89 %	100 %	84 %	77 %	75 %
In adequate infrastructure	76 %	81 %	71 %	89 %	40 %	72 %	81 %	80 %
Weak maintenance capability and lack of spare parts	75 %	76 %	75 %	78 %	60 %	91 %	65 %	65 %
Inadequate skill and lack of trained labour force	75 %	76 %	68 %	100 %	60 %	91 %	69 %	60 %
Weak industrial awareness	73 %	78 %	68 %	78 %	60 %	81 %	73 %	65 %
Weak and narrow marketing opportunities	67 %	70 %	64 %	56 %	80 %	66 %	73 %	65 %
Weak and in adequate economic visibility studies	61 %	65 %	61 %	56 %	40 %	59 %	62 %	65 %
Inadequate management and organizational facilities	57 %	65 %	46 %	67 %	40 %	75 %	46 %	45 %
Inadequate transportation equipments	52 %	51 %	46 %	67 %	60 %	59 %	50 %	45 %

Source: Own calculation based on the firm survey (2010)

capability and lack of spare parts, weak and narrow marketing opportunities and inadequate management and organisational facilities respectively.[19] For food industries the most important problems are: spread of routine and bureaucracy and slow procedures related to industrial needs, interruption and inadequate availability and high costs of electricity and water, inadequate finance and inappropriate conditions for industrial development, weak maintenance capability and lack of spare parts, inadequate infrastructure, inadequate skills and lack of trained labour force, weak industrial awareness, weak and narrow marketing opportunities and lack of raw materials respectively.[20] For metal industries the most important

[19] As indicated by 89 %, 89 %, 86 %, 84 %, 81 %, 78 %, 76 %, 76 %, 70 % and 65 % of all respondent chemical firms respectively.

[20] As indicated by 89 %, 86 %, 82 %, 75 %, 71 %, 68 %, 68 % and 64 % and 61 % of all respondent food firms respectively.

problems are: inadequate skills and lack of trained labour force, inadequate finance and inappropriate conditions for industrial development, lack of raw materials, inadequate infrastructure, weak maintenance capability and lack of spare parts, weak industrial awareness, inadequate management and organisational facilities and spread of routine and bureaucracy and slow procedures related to industrial needs respectively.[21] For textile industries the most important problems are: inadequate finance and inappropriate conditions for industrial development, lack of raw materials, interruption and inadequate availability and high costs of electricity and water, weak and narrow marketing opportunities, inadequate skills and lack of trained labour force, spread of routine and bureaucracy and slow procedures related to industrial needs, weak maintenance capability and lack of spare parts and weak industrial awareness respectively.[22] For large size firms the most important problems are: inadequate skills and lack of trained labour force, weak maintenance capability and lack of spare parts, inadequate finance and inappropriate conditions for industrial development, lack of raw materials, interruption and inadequate availability and high costs of electricity and water, spread of routine and bureaucracy and slow procedures related to industrial needs, weak industrial awareness, inadequate management and organisational facilities, inadequate infrastructure and weak and narrow marketing opportunities respectively.[23] For medium size firms the most important problems are: inadequate finance and inappropriate conditions for industrial development, spread of routine and bureaucracy and slow procedures related to industrial needs, interruption and inadequate availability and high costs of electricity and water, inadequate infrastructure, lack of raw materials, narrow marketing opportunities, weak industrial awareness, inadequate skills and lack of trained labour force and weak maintenance capability and lack of spare parts respectively.[24] For small size firms the most important problems are: inadequate finance and inappropriate conditions for industrial development, spread of routine and bureaucracy and slow procedures related to industrial needs, interruption and inadequate availability and high costs of electricity and water, inadequate infrastructure, lack of raw materials, weak maintenance capability and lack of spare parts, weak industrial awareness, weak and narrow marketing opportunities, weak and inadequate economic visibility studies and inadequate skills and lack of trained labour force respectively.[25]

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[21] As indicated by 100 %, 100 %, 89 %, 89 %, 78 %, 78 %, 67 % and 67 % of all respondent metal firms respectively.

[22] As indicated by 100 %, 100 %, 80 %, 80 %, 60 %, 60 %, 60 %, 60 % and 60 % of all respondent textile firms respectively.

[23] As indicated by 91 %, 91 %, 88 %, 84 %, 84 %, 84 %, 81 %, 75 %, 72 %, and 66 % of all respondent large size firms respectively.

[24] As indicated by 88 %, 88 %, 85 %, 81 %, 77 %, 73 %, 73 %, 69 %, and 65 % of all respondent medium size firms respectively.

[25] As indicated by 85 %, 85 %, 85 %, 80 %, 75 %, 65 %, 65 %, 65 %, 65 % and 60 % of all respondent small size firms respectively.

Hence, our results from Table 7.6 and the firm survey (2010) are consistent with the findings in developing countries and the Sudanese literature that indicate several problems of industrialisation in Sudan (El-Sayed 1998; Abdel-Salam 2006) similar to those in the typically developing countries (Ismail 1994). Different from the studies in the Sudanese literature (El-Sayed 1998; Abdel-Salam 2006) which provide a somewhat general overview concerning the problems of industrialisation in Sudan, an interesting and novel element in our analysis is that our findings are based on recent micro primary data based on the firm survey (2010) and the follow-up interviews with firm managers, and we present a new and more elaborate interpretation of the main problems of industrialisation in Sudan from the perspective of the different industrial firms considering the opinions of a more diversified sample of industrial firms, defined by industry and size as we explained in Table 7.6 below.[26]

Therefore, our findings in this section verify the first hypothesis that high skill requirements and low skill levels – due to high share of unskilled workers – lead to skills mismatch and probably contribute to industrial performance and productivity decline across firms. In the next sections we examine the second and third hypotheses.

7.4 Upskilling, Improving Industrial Performance and Relationships Between Required Education (Occupation), Attained/Actual Education, Experience and Average Wages

Before examining the second and third hypotheses, it is useful to briefly show the importance of upskilling, because explaining this can be used to prevent the decline in labour productivity and industrial performance indicators and to enhance the complementary relationships between skill, technology and upskilling across firms.

7.4.1 Upskilling and Improving Performance of Manufacturing Industrial Firms

The findings from the firm survey (2010) presented in Tables 7.3, 7.4, 7.5, and 7.6 above, support our argument that low skill levels may contribute to the declining of labour productivity and other industrial performance indicators including economic, productivity, activity and profitability indicators across firms as we explained above. These findings imply that improving skill level is an important factor for facilitating improvement of labour productivity and other industrial performance indicators. Table 7.7 below indicates upskilling or improving skill

[26] See for instance, El-Sayed (1998), (pp. 184–188), Abd-Salam (2006), pp. 28–32 and Ismail (1994), pp. 206–209.

Table 7.7 The factors facilitating improvement of industrial firms performance and economic development in Sudan (2008)

	All firms	Industry				Size		
		Chemical	Food	Metal	Textile	Large	Medium	Small
Improving and enhancing adequate availability of finance and appropriate conditions for industrial development	91 %	92 %	89 %	89 %	100 %	97 %	85 %	95 %
Improving and enhancing adequate availability of local raw materials	90 %	92 %	82 %	100 %	100 %	100 %	85 %	85 %
Improving and enhancing adequate availability of industrial awareness	90 %	92 %	86 %	100 %	80 %	97 %	88 %	85 %
Improving and enhancing adequate availability of maintenance capability and spares parts	89 %	92 %	82 %	100 %	80 %	97 %	81 %	90 %
Avoiding of routine and bureaucracy and speed up the procedures related to industrial needs	87 %	86 %	89 %	89 %	80 %	91 %	88 %	85 %
Improving and enhancing adequate availability of infrastructure	86 %	92 %	82 %	89 %	60 %	94 %	81 %	85 %
Improving and enhancing adequate availability of electricity and water with cheap and subsidised price	86 %	84 %	86 %	89 %	100 %	88 %	81 %	95 %
Improving and enhancing adequate availability of skill and trained labour force	85 %	86 %	79 %	100 %	80 %	100 %	81 %	70 %
Improving and enhancing adequate availability of marketing opportunities	85 %	89 %	82 %	78 %	80 %	88 %	81 %	90 %
Improving and enhancing adequate availability of management and organizational facilities	81 %	89 %	68 %	89 %	80 %	100 %	65 %	75 %
Improving and enhancing adequate availability of transportation equipments	75 %	73 %	75 %	89 %	60 %	88 %	62 %	75 %
Improving and enhancing adequate availability of economic visibility studies	72 %	76 %	71 %	67 %	60 %	84 %	58 %	75 %

Source: Own calculation based on the firm survey (2010)

level and adequate availability of skill and trained labour force to be amongst the important factors facilitating improvement of industrial firms performance and contributing towards economic development in Sudan.[27] For instance, we find that from the perspective of all respondent firms the most important factors facilitating improvement are: improving and enhancing adequate availability of finance and appropriate conditions for industrial development, improving and enhancing adequate availability of raw materials, improving and enhancing adequate availability of industrial awareness, improving and enhancing adequate availability of maintenance capability and spare parts and avoidance of routine and bureaucracy and speeding up of the procedures related to industrial needs. In addition to improving and enhancing adequate availability of infrastructure, improving and enhancing adequate availability of electricity and water with cheap and subsidised price, improving and enhancing adequate availability of skill and trained labour force, improving and enhancing adequate availability of management and organisational facilities, improving and enhancing adequate availability of transportation equipment and improving and enhancing adequate availability of economic visibility studies (see Table 7.7 below).[28] Furthermore, from the firms' perspective other extremely important enhancing factors for the development of the performance of the industrial firms include lowering or cancellation of fees, taxes and levies imposed by the government, establishment of databases, reduction of government intervention in the industrial activities and improving and accelerating the procedures for customs clearance of imported raw materials and speeding up of the process of final export of industrial products. From the perspective of chemical firms the most important factors are: improving and enhancing adequate availability of finance and appropriate conditions for industrial development, improving and enhancing adequate availability of raw materials, improving and enhancing adequate availability of industrial awareness, improving and enhancing adequate availability of infrastructure, improving and enhancing adequate availability of maintenance capability and spare parts and improving and enhancing adequate availability of marketing opportunities. In addition to improving and enhancing adequate availability of management and organisational facilities, improving and enhancing adequate availability of skills and trained labour force, avoidance of routine and bureaucracy and speeding up of the procedures related to industrial needs, improving and enhancing adequate availability of electricity and water with

[27] For instance, improving skill level and adequate availability of skill and trained labour force is one important factor facilitating improvement of industrial firms performance and contribution towards economic development that is reported by 85 %, 86 %, 79 %, 100 %, 80 %, 100 %, 81 %, and 70 % of all firms, chemical, food, metal, textile, large, medium and small size firms respectively.

[28] As indicated by 91 %, 90 %, 90 %, 89 %, 87 %, 86 %, 86 %, 85 %, 85 %, 81 %, 75 % and 72 % of all respondent firms respectively.

cheap and subsidised prices.[29] From the perspective of food firms the most important factors are: improving and enhancing adequate availability of finance and appropriate conditions for industrial development, avoidance of routine and bureaucracy and speeding up of the procedures related to industrial needs and improving and enhancing adequate availability of industrial awareness. In addition: improving and enhancing adequate availability of electricity and water with cheap and subsidised prices, improving and enhancing adequate availability of maintenance capability and spare parts, improving and enhancing adequate availability of raw materials, improving and enhancing adequate availability of infrastructure, improving and enhancing adequate availability of marketing opportunities and improving and enhancing adequate availability of skill and trained labour force respectively.[30] From the perspective of metal firms the most important factors are: improving and enhancing adequate availability of skills and trained labour force, improving and enhancing adequate availability of raw materials, improving and enhancing adequate availability of maintenance capability and spare parts, improving and enhancing adequate availability of industrial awareness, improving and enhancing adequate availability of finance and appropriate conditions for industrial development, improving and enhancing adequate availability of infrastructure and avoidance of routine and bureaucracy and speeding up of the procedures related to industrial needs. In addition: improving and enhancing adequate availability of electricity and water with cheap and subsidised prices, improving and enhancing adequate availability of management and organisational facilities and improving and enhancing adequate availability of transportation equipment's respectively.[31] From the perspective of textile firms the most important factors are: improving and enhancing adequate availability of finance and appropriate conditions for industrial development, improving and enhancing adequate availability of raw materials, improving and enhancing adequate availability of electricity and water with cheap and subsidised prices and improving and enhancing adequate availability of skills and trained labour force. In addition to improving and enhancing adequate availability of industrial awareness, improving and enhancing adequate availability of maintenance capability and spares part, improving and enhancing adequate availability of marketing opportunities, improving and enhancing adequate availability of management and organisational facilities, avoidance of routine and bureaucracy and speeding up of the procedures related to industrial needs and improving and enhancing adequate availability of infrastructure respectively.[32] From the perspective of large size firms the most important factors are: improving

[29] As indicated by 92 %, 92 %, 92 %, 92 %, 92 %, 89 %, 89 %, 86 %, 86 % and 84 % of all respondent chemical firms respectively.

[30] As indicated by 89 %, 89 %, 86 %, 86 %, 82 %, 82 %, 82 %, 82 and 79 % of all respondent food firms respectively.

[31] As indicated by 100 %, 100 %, 100 %, 100 %, 89 %, 89 %, 89 %, 89 %, 89 % and 89 % of all respondent metal firms respectively.

[32] As indicated by 100 %, 100 %, 100 %, 80 %, 80 %, 80 %, 80 %, 80 %, 80 % and 60 % of all respondent textile firms respectively.

and enhancing adequate availability of skills and trained labour force, improving and enhancing adequate availability of management and organisational facilities, improving and enhancing adequate availability of raw materials, improving and enhancing adequate availability of finance and appropriate conditions for industrial development, improving and enhancing adequate availability of maintenance capability and spare parts, improving and enhancing adequate availability of industrial awareness and improving and enhancing adequate availability of infrastructure. In addition: avoidance of routine and bureaucracy and speeding up of the procedures related to industrial needs, improving and enhancing adequate availability of electricity and water with cheap and subsidised prices, improving and enhancing adequate availability of marketing opportunities, improving and enhancing adequate availability of transportation equipment and improving and enhancing adequate availability of economic visibility studies respectively.[33] From the perspective of medium size firms the most important factors are: improving and enhancing adequate availability of industrial awareness, avoidance of routine and bureaucracy and speeding up of the procedures related to industrial needs, improving and enhancing adequate availability of finance and appropriate conditions for industrial development, improving and enhancing adequate availability of raw materials and improving and enhancing adequate availability of skills and trained labour force. In addition to improving and enhancing adequate availability of infrastructure, improving and enhancing adequate availability of maintenance capability and spare parts, improving and enhancing adequate availability of electricity and water with cheap and subsidised prices, improving and enhancing adequate availability of marketing opportunities and improving and enhancing adequate availability of management and organisational facilities and availability of transportation equipment.[34] From the perspective of small size firms the most important factors are: improving and enhancing adequate availability of finance and appropriate conditions for industrial development, improving and enhancing adequate availability of electricity and water with cheap and subsidised prices, improving and enhancing adequate availability of maintenance capability and spare parts, improving and enhancing adequate availability of marketing opportunities, improving and enhancing adequate availability of raw materials and improving and enhancing adequate availability of infrastructure. In addition: avoidance of routine and bureaucracy and speeding up of the procedures related to industrial needs, improving and enhancing adequate availability of industrial awareness, improving and enhancing adequate availability of management and organisational facilities, improving and enhancing adequate availability of economic visibility studies, improving and enhancing adequate availability of transportation equipment and

[33] As indicated by 100 %, 100 %, 100 %, 97 %, 97 %, 97 %, 94 %, 91 %, 88 %, 88 %, 88 % and 84 % of large size firms respectively.

[34] As indicated by 88 %, 88 %, 85 %, 85 %, 81 %, 81 %, 81 %, 81 %, 81 %, 65 % and 62 % of medium firms respectively.

improving and enhancing adequate availability of skills and trained labour force respectively.[35]

7.4.2 Relationships Between the Required Education (Occupation), Attained/Actual Education, Experience and Average Wages

Based on the above findings, in this section we examine a part of the second hypothesis that an increase in skill levels and firm size leads to improved relationships between actual and required education, and between actual education, required education, experience and wages across firms.

We begin with the relationship between occupation and education. Using the above definitions of occupation and education/actual and required education respectively, we translate the required qualifications for each of the occupation groups into average years of schooling and use the OLS regression, assuming that the required schooling in each occupation class is dependent on the actual/attained education. Our findings in Table 7.8 and Fig. 7.7 below illustrate that improvement in occupational status (measured by the required education) is positively and significantly correlated with education (measured by actual/attained education) across all firms. In addition, Table 7.8 illustrates that an increase in firm size and industry level leads to improved relationships between required and actual education. For instance, the required education appears to be more sensitive to and increasing in attained/actual education within both large size and chemical and food firms, and more sensitive within all firms. This result is plausible since the skill level – share of high skilled measured by educational attainment – is higher within large size and chemical and food firms compared to metal and textile, medium and small size firms (see Fig. 7.1 above). This is also probably because large size firms are more prevalent in the chemical and food industries (see Table 7.2 above) and may have more consistent recruitment strategies. These results confirm our earlier observations that skill levels and requirements (actual and required education) are non-homogenous across firms and are determined by size and industry.

Concerning the relationship between education, occupation and experience, Table 7.8 above shows that average years of experience are positively correlated and increasing in education (i.e. attained/actual education) and occupation (i.e. required education) respectively. This result is consistent with Fig. 7.5 above, and probably implies that skill indicators – education and experience – are complementing rather than substituting each other.

Table 7.9 below illustrates a considerable variation in the distribution of average wages amongst high, medium and low skill – educational and occupational – levels

[35] As indicated by 95 %, 95 %, 90 %, 90 %, 85 %, 85 %, 85 %, 85 %, 75 %, 75 %, 75 % and 70 % of small firms respectively.

Table 7.8 Required and actual/attained education and experience across firms (2008)

Independent variable		Coefficient (t-value)			R^2	N[a]
Dependent variable	Group of firms and skill	Actual education	Required education	Constant		
Required education. All groups (high, medium and low)	All firms	0.873**		2.101	0.759	74
		(25.172)		(4.691)		
	Large	0. 905**		1.849	0.772	26
		(16.672)		(2.627)		
	Medium	0.864**		2.291	0.766	18
		(14.592)		(2.999)		
	Small	0.825**		2.297	0.742	15
		(11.761)		(2.554)		
	Chemical	0.883**		1.895	0.731	27
		(15.390)		(2.540)		
	Food	0.879**		2.037	0.777	21
		(15.816)		(2.850)		
	Metal	0.814**		3.262	0.793	7
		(9.387)		(2.913)		
	Textile	0.875**		1.749	0.842	4
		(8.338)		(1.316)		
Average years experience	All firms	0.412**		0.767	0.056	73
		(3.469)		(0.505)		
All firms	Large	0.539**		−0.521	0.102	26
		(3.059)		(−0.231)		
	Medium	0.388*		0.777	0.390	18
		(1.576)		(0.245)		
	Small	0.295*		2.232	0.306	15
		(1.429)		(0.852)		
	Chemical	0.274*		3.424	0.023	27
		(1.452)		(1.404)		
	Food	0.617**		−3.065	0.185	21
		(4.010)		(−1.568)		
	Metal	0.371		2.131	0.032	7
		(0.940)		(0.423)		
	Textile	0.068		3.810	0.003	4
		(0.164)		(0.724)		
	All firms		0.641**	−1.810	0.089	71
			(4.260)	(−0.892)		
	Large		0.439**	0.880	0.070	26
			(2.407)	(0.354)		
	Medium		0.566*	−0.697	0.043	18
			(1.606)	(−0.145)		
	Small		1.156**	−8.273	0.288	15
			(4.311)	(−2.369)		
	Chemical		0.465*	1. 528	0.039	27

(continued)

Table 7.8 (continued)

Independent variable / Dependent variable	Group of firms and skill	Coefficient (t-value) Actual education	Required education	Constant	R^2	N[a]
			(1.875)	(0.458)		
	Food		0.658**	−3. 490	0.148	21
			(3.305)	(−1.304)		
	Metal		1.402**	−12.262	0.373	7
			(3.621)	(−2.290)		
	Textile		0628	−1.047	0.106	4
			(1.034)	(−0.129)		

Correlation is significant * at the 0.05 level (one-tailed); ** at the 0.01 level (one-tailed)
[a]For this regression we use relatively few observations, because some of the respondent firms were particularly reluctant to provide adequate quantitative data on skill indicators. Sometimes we exclude some observations due to inconsistency or unreliability. As we explained in Chap. 4 above, the main problem is the varying response rate for different questions (e.g. to measure education, occupation and wages) across firms. Moreover, the classification of firms into chemical, food, metal and textile industries, small, medium and large size also divided the few observations between them and so allow for only few observations for regression for each group independently.

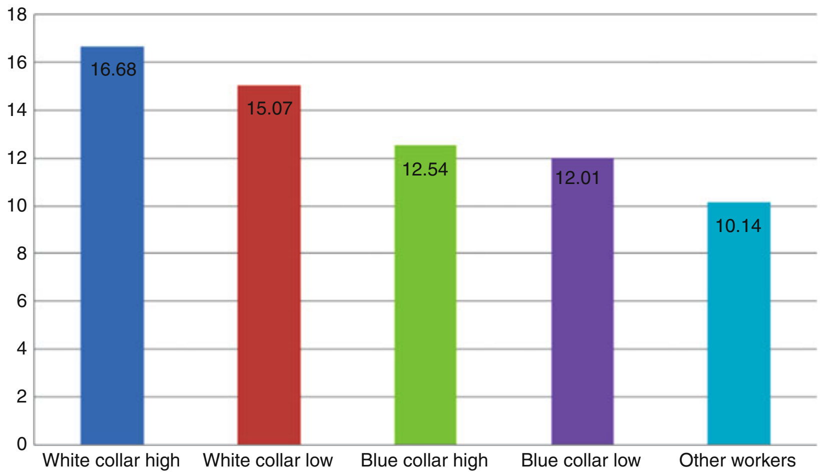

Fig. 7.7 The distribution of occupation classes according to the translated average years of schooling across firms (2008) (Source: Firm Survey (2010))

across firms. When using the occupational rather than the educational definition the distribution of wages shows less fluctuation across firms. Therefore, the effect of occupation/required education on the distribution of average wages across firms

Table 7.9 Differences in the distribution of average wages defined by firm size and industry level and sector (2008)

Characteristics		Industry/activity				Size			Sector		
Wages defined by skill level	All firms	Chemical	Food	Metal	Textile	Large	Medium	Small	Public	Private	Mixed
(a) Skill variables: Education											
High educated/white collar high											
4,001–5,000	1 %	0 %	0 %	13 %	0 %	3 %	0 %	0 %	0 %	2 %	0 %
3,001–4,000	4 %	6 %	0 %	13 %	0 %	7 %	0 %	5 %	0 %	5 %	0 %
2,001–3,000	13 %	19 %	11 %	0 %	0 %	10 %	13 %	16 %	0 %	11 %	40 %
1,001–2,000	46 %	41 %	44 %	50 %	80 %	50 %	48 %	37 %	0 %	45 %	60 %
0,200–1,000	36 %	34 %	44 %	25 %	20 %	30 %	39 %	42 %	100 %	38 %	0 %
Medium educated/white collar low											
1,001–2,000	4 %	6 %	0 %	12 %	0 %	3 %	0 %	11 %	0 %	3 %	20 %
0,200–1,000	96 %	94 %	100 %	88 %	100 %	97 %	100 %	89 %	100 %	97 %	80 %
Low educated/blue collar high											
0,200–1,000	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
(b) Skill variables: occupation											
High educated/white collar high											
4,001–5,000	8 %	6 %	11 %	11 %	0 %	13 %	9 %	0 %	0 %	7 %	20 %
3,001–4,000	11 %	12 %	11 %	11 %	0 %	13 %	9 %	11 %	0 %	10 %	20 %
2,001–3,000	28	21 %	30 %	33 %	60 %	29 %	30 %	26 %	0 %	29 %	20 %
1,001–2,000	34 %	39 %	26 %	33 %	40 %	35 %	26 %	42 %	100 %	32 %	40 %
0,200–1,000	19 %	21 %	22 %	11 %	0 %	10 %	26 %	21 %	0 %	21 %	0 %
Medium educated/white collar low											
2,001–3,000	1 %	3 %	0 %	0 %	0 %	3 %	0 %	0 %	0 %	2 %	0 %
1,001–2,000	24 %	23 %	25 %	33 %	0 %	27 %	26 %	14 %	0 %	22 %	50 %
0,200–1,000	75 %	73 %	75 %	67 %	100 %	70 %	74 %	86 %	100 %	76 %	50 %
Low educated/blue collar high											
1,001–2,000	6 %	4 %	9 %	13 %	0 %	3 %	10 %	7 %	0 %	7 %	0 %
0,200–1,000	94 %	96 %	91 %	88 %	100 %	97 %	90 %	93 %	100 %	93 %	100 %
Blue collar low											
1,001–2,000	3 %	0 %	5 %	13 %	0 %	0 %	9 %	0 %	0 %	3 %	0 %
0,200–1,000	97 %	100 %	95 %	88 %	100 %	100 %	91 %	100 %	100 %	97 %	100 %
Others											
4,001–5,000	2 %	0 %	4 %	0 %	0 %	0 %	5 %	0 %	0 %	2 %	0 %
0,200–1,000	98 %	100 %	96 %	100 %	100 %	100 %	95 %	100 %	100 %	98 %	100 %

Source: Firm Survey (2010)

seems to be less sensitive to differences in firm size and industry. In contrast, when using the educational definition, we observe that the effect of the actual/attained education on the distribution of average wages across firms seems to be more sensitive to differences in firm size and industry. Our interpretation of the observed differences across firms implies the presence of a significant wage differential, the lack of a coherent, homogeneous, unified and sound wage policy and the lack of systematic and consistent recruitment strategies across firms that most probably related to the lack of systematic regulations to organise the labour market in Sudan

The above results are consistent with the OLS regression reported in Table 7.10 below, which indicates that the average wages are positively and significantly correlated with and more sensitive to attained/actual education. For instance, Table 7.10 below illustrates that the average wages are increasing in actual/attained education, experience and its square (cf. Mincer 1974) and therefore, is biased against less educated and experienced workers. These findings support our results from the firm survey, which indicate that wages are increasing in education and biased against low educated workers because the ratio of high skilled to low skilled wages, which can be interpreted as wages/skills premium, exceeds one (see Fig. 7.8 below).[36] These results are consistent with the findings in the new growth literature, particularly skilled biased technical change theorems (cf. Aghion and Howitt 1992, 1998; Acemoglu 1998; Autor et al. 1998). Our results from Table 7.11, which indicate that required education also has significant impact on wages, are plausible and consistent with our expectation in view of the results of the overeducation literature (Hartog 2000; Muysken and ter Weel 1998; Muysken and Ruholl 2001; Muysken et al. 2002a, b; Muysken et al. 2003). We find that the positive correlations between actual education, experience, its square and wages seem more sensitive to firm size and industry level and are particularly significant for large and medium size firms and chemical and food industries, which may not be surprising since these firms have sufficient scope for a coherent wage policy (Nour 2005; Muysken and Nour 2006). This is also probably because large size and medium size firms and chemical and food industries may have more consistent recruitment strategies and high skill levels – share of high skilled workers in total employment (see Fig. 7.1 above and Fig. 7.9 below). These results imply that an increase in skill level/actual education and firm size and industry leads to an improved relationship between actual education, experience and wages.

[36] From the firm survey (2010) we find that the proportion of high skilled wages/low skilled wages accounts for 3.5, 3.7, 3.45, 2.96, 3.6, 4.2, 3.1 and 2.98 for all firms, chemical, food, metal, textile, large, medium and small size firms respectively. We find that the wage premium for Sudan in 2010 is less than the wage premium which we estimated for the large and medium size firms active in the chemical and metal industries in the UAE in 2002 (Nour 2005). This result at the micro level is not surprising and it is expected in view of the observed wage differential between Sudan and UAE at the macro level; in particular, this result is consistent with the observed differences in per capita income levels in Sudan and the UAE at the macro level, notably, when using UNDP-HDR (2010) most recent data on per capita income for the year 2008, we realise the low per capita income level in Sudan (US$ 1,353) as compared to high per capita income in the UAE (US$ 56,485) at the macro level.

Table 7.10 Correlation between wages (log) actual and required education and experience (2008) (education definition)

Independent variable		Coefficient						
		(t-value)					R^2	N[a]
Dependent variable: Average wages (log)	Group of firms	Actual education	Experience	Experience^2	Required education[b]	Constant		
Average wages (log) high, medium and low skilled	All firms	0.196**				3.948	0.595	73
		(17.478)				(27.570)		
	Large	0.223**				3.663	0.646	26
		(12.532)				(16.114)		
	Medium	0.178**				4.045	0.564	18
		(9.099)				(16.121)		
	Small	0.178**				4.248	0.596	15
		(8.972)				(16.838)		
	Chemical	0.206**				3.860	0.605	27
		(11.742)				(17.156)		
	Food	0.192**				3.896	0.657	21
		(12.131)				(19.349)		
	Metal	0.172**				4.591	0.523	7
		(4.906)				(10.337)		
	Textile	0.197**				3.715	0.724	4
		(5.834)				(8.668)		
	All firms	0.187**	0.021**			3.951	0.625	70
		(16.398)	(3.188)			(27.877)		
	Large	0. 221**	0.010			3.652	0.653	26
		(11.383)	(0.866)			(15.407)		
	Medium	0. 161**	0.033**			4.101	0.675	18
		(9.054)	(3.674)			(18.465)		
	Small	0.175**	0.010			4.225	0.601	15
		(8.582)	(0.780)			(16.575)		
	Chemical	0. 198**	0.023**			3.817	0.634	27
		(11.519)	(2.418)			(17.268)		
	Food	0. 175**	0.027**			3.976	0.689	21
		(10.097)	(2.240)			(19.533)		
	Textile	0.219**	0.040**			3.378	0.912	4
		(9.289)	(2.228)			(11.057)		

All firms	0.187**	0.024	−0.0001		3.951	0.625	70
	(15.360)	(1.249)	(−0.156)		(27.806)		
Large	0.221**	0.009	0.00003		3.652	0.653	26
	(10.626)	(0.263)	(0.18)		(15.302)		
Medium	0.156**	0. 055*	−0.001		4.113	0.678	18
	(8.192)	(1.924)	(−0.792)		(18.192)		
Chemical	0.195**	0.043*	−0.001		3.789	0.636	27
	(10.919)	(1.397)	(−0.687)		(16.818)		
Food	0.176**	0.022	0.000		3.977	0.689	21
	(9.783)	(0.822)	(0.197)		(19.396)		
Textile	0.205**	0.093	−0.004		3.433	0.917	4
	(6.546)	(1.148)	(−0.673)		(10.536)		
All firms	0.153**	0.028*	−0.0004	0.038*	3.868	0.621	69
	(6.019)	(1.360)	(−0.356)	(1.532)	(23.996)		
Large	0.172**	0.030	−0.001	0.047	3.579	0.654	26
	(4.125)	(0.808)	(−0.482)	(1.221)	(13.676)		
Medium	0.126**	0.045*	−0.001	0.037	4.018	0.668	18
	(2.866)	(1.420)	(−0.384)	(0.852)	(15.438)		
Small	0.175**	−0.059	0.004	0.016	4.228	0.614	15
	(3.587)	(−0.989)	(1.076)	(0.314)	(12.664)		
Chemical	0.162**	0.047*	−0.001	0.031	3.791	0.609	27
	(4.064)	(1.360)	(−0.725)	(0.850)	(14.547)		
Food	0.136**	0.024	0.000	0.054*	3.751	0.718	21
	(3.939)	(0.861)	(0.100)	(1.545)	(16.511)		
Textile	0.119*	0.104*	−0.004	0.092	3.291	0.931	4
	(1.486)	(1.305)	(−0.756)	(1.172)	(9.657)		

Correlation is significant * at the 0.05 level (one-tailed); ** at the 0.01 level (one-tailed)

[a]For this regression we use relatively few observations, because some of the respondent firms were particularly reluctant to provide adequate quantitative data on skill indicators. Sometimes we exclude some observations due to inconsistency or unreliability. As we explained in Chap. 4 above, the main problem is the varying response rate for different questions (e.g. to measure education, occupation and wages) across firms. Moreover, the classification of firms into chemical, food, metal and textile industries, small, medium and large size also divided the few observations between them and so allow for only few observations for regression for each group independently.

[b]The required education is not used as a variable in the upper half of this table, because, we want to check the relation with respect to actual/attained education and experience independently and then compare the result when the required education is also included in the regression.

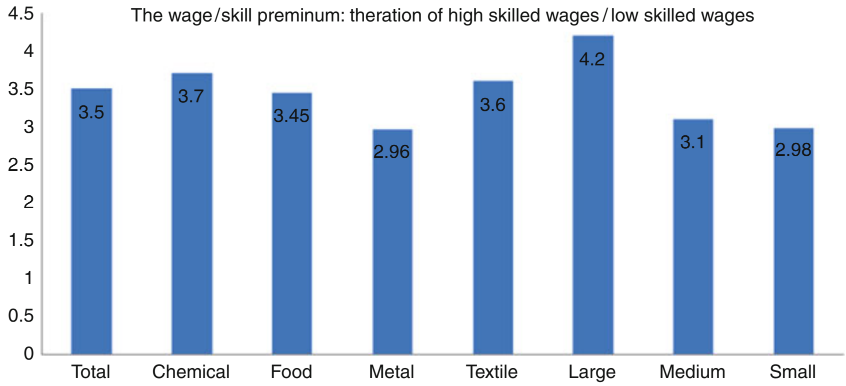

Fig. 7.8 Differences in wage/skill premium (the ratio of high skilled wages/low skilled wages) defined by education levels across firms (2008) (Source: Firm Survey (2010))

One interesting observation from the firm survey data (2010) and the follow-up interviews with firms managers and the results presented in Tables 7.9, 7.10, and 7.11 is that in most cases, the OLS regression results seem to be more significant when using the education definition as compared to occupation definition. This finding seems to be consistent with the observations from Table 7.9 above but seem to be opposite to the observations from the follow-up interviews and the wide belief among firm managers, which probably implies that across the majority of the respondent firms, the structure of wage policy is most likely structured to be more consistent based on occupation definition compared to education definition. This also implies that from the firms' perspective the decision of determining wages levels for workers is most probably determined by the nature of jobs that the workers will do in the firms rather than the years of schooling the workers have already obtained. This also most probably implies the positive but weak return and incentives for additional years of schooling to compensate the costs of additional years of schooling. Another interesting observation is that for all groups of firms when using both education and occupation definitions the OLS regression reported in Tables 7.10 and 7.11 below indicate that the correlations between wages levels and years of education variable are more significant as compared to the correlations between wages levels and average years of experience variable. This result implies that the rate of return to the worker's average years of education is higher and more significant than the average years of experience. This finding is also opposite to the observations from the follow-up interviews and the wide belief among some firm managers which probably implies that across some firms and from some firms' perspective, the decisions of hiring and offering wages are largely determined by experience in the practice of work which is measured by a worker's average years

Table 7.11 Correlation between wages (log) actual and required education and experience (2008) (occupation definition)

Independent variable		Coefficient (t-value)				R^2	N^a
Dependent variable: average wages (log)	Group of firms	Actual education[b]	Experience	Experience^2	Required education	Constant	
Average wages (log) high, medium and low skilled	All firms			0.212**	3.713	0.429	73
				(12.176)	(15.884)		
	Large			0.245**	3.318	0.678	26
				(13.152)	(13.061)		
	Medium			0.210**	3.749	0.503	18
				(7.977)	(10.636)		
	Small			0. 204**	3.871	0.568	15
				(7.855)	(11.500)		
	Chemical			0.219**	3.639	0.637	27
				(12.130)	(15.041)		
	Food			0.225**	3.551	0.531	21
				(9.034)	(10.662)		
	Metal			0. 102	5.142	0.036	7
				(0.904)	(3.306)		
	Textile			0.274**	2.972	0.929	4
				(13.055)	(11.047)		
	All firms	0.034**		0.189**	3.792	0.472	70
		(4.056)		(10.315)	(16.074)		
	Large	0.023*		0.236**	3.289	0.688	26
		(1.930)		(11.832)	(12.518)		
	Medium	0.029**		0.190**	3.800	0.627	18
		(3.349)		(7.998)	(12.120)		
	Small	0.040**		0.154**	4.252	0.625	15
		(2.991)		(5.231)	(12.288)		

(continued)

Table 7.11 (continued)

Independent variable		Coefficient (t-value)					R^2	N[a]
Dependent variable: average wages (log)		Group of firms	Actual education[b]	Experience	Experience[2]	Required education	Constant	
	Chemical		0.025**		0.206**	3.629	0.691	27
			(3.527)		(12.160)	(16.255)		
	Food		0.055**		0.194**	3.641	0.638	21
			(3.683)		(7.620)	(11.365)		
	Textile		0.018*		0.236**	3.376	0.950	4
			(1.611)		(10.982)	(12.444)		
	All firms		0.086**	−0.002*	0.172**	3.840	0.483	70
			(3.148)	(−1.985)	(8.592)	(16.322)		
	Large		0.088**	−0.003*	0.223**	3.255	0.699	26
			(2.202)	(−1.697)	(10.538)	(12.505)		
	Medium		0.066*	−0.001*	0.173**	3.902	0.633	18
			(1.647)	(−0.956)	(5.866)	(11.772)		
	Small		0.069*	−0.001	0.147**	4.259	0.628	15
			(1.464)	(−0.632)	(4.649)	(12.217)		
	Chemical		0.079**	−0.002**	0.188**	3.663	0.710	27
			(3.237)	(−2.307)	(10.297)	(16.795)		
	Food		0.044	−0.000	0.197**	3.631	0.639	21
			(1.025)	(−0.269)	(6.994)	(11.181)		
	Metal		0.271*	−0.009	−0.065**	6.230	0.176	7
			(1.314)	(−0.879)	(−0.439)	(3.585)		
	Textile		0.037	−0.001*	0.233**	3.344	0.951	4
			(0.850)	(−0.455)	(10.042)	(11.360)		
	All firms	0.132**	0.062**	−0.001*	0.068*	3.637	0.519	70

	(3.658)	(2.281)	(−1.344)	(1.964)	(15.526)		
Large	0.193**	0.031	−0.001	0.076**	3.013	0.775	26
	(4.969)	(0.838)	(−0.720)	(2.183)	(12.983)		
Medium	0.111**	0.063*	−0.001	0.076*	3.794	0.663	18
	(2.169)	(1.612)	(−0.979)	(1.449)	(11.698)		
Chemical	0.120**	0.056**	−0.001*	0.097**	3.434	0.753	27
	(3.710)	(2.364)	(−1.559)	(3.243)	(16.206)		
Textile	0.080	0.019	−0.0003	0.163**	3.337	0.960	4
	(1.161)	(0.417)	(−0.145)	(2.519)	(11.611)		

Correlation is significant *at the 0.05 level (one-tailed); **at the 0.01 level (one-tailed)

[a]For this regression we use relatively few observations, because some of the respondent firms were particularly reluctant to provide adequate quantitative data on skill indicators. Sometimes we exclude some observations due to inconsistency or unreliability. As we explained in Chap. 4 above, the main problem is the varying response rate for different questions (e.g. to measure education, occupation and wages) across firms. Moreover, the classification of firms into chemical, food, metal and textile industries, small, medium and large size also divided the few observations between them and so allow for only few observations for regression for each group independently.

[b]The actual/attained education is not used as a variable in the upper half of this table, because, we want to check the relation with respect to required education and experience independently and then compare the result when the actual/attained education is also included in the regression.

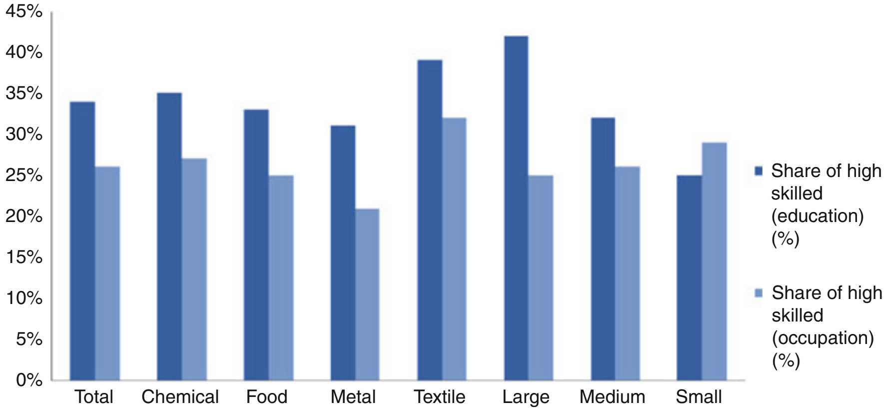

Fig. 7.9 Differences in skill level (share of high skilled) defined by education and occupation classes across firms (2008) (Sources: Firm Survey (2010))

of experience, which is more important than average years of education for some firms that prefer to hire more experienced than educated workers for specific fields.

Therefore, our findings in this section corroborate the first part of the second hypothesis that an increase in skill levels and firm size leads to an improved relationship between actual and required education and experience and between actual education, required education, experience, its square and wages. In the next section we proceed to examine the second part of the second hypothesis that an increase in skill levels and firm size lead to improved relationships between skill, upskilling and technology (ICT). Finally, we test our third hypothesis on the relationship between technology (ICT) and input–output indicators at the micro/firm level.

7.5 Skill, Upskilling (ICT Training), Technology (ICT) and Input–Output Indicators

Based on the above results, in this section we examine the other part of the second hypothesis that an increase in skill levels and firm size leads to improved relationships between skill, upskilling and new technology (ICT) across firms. Before examining this hypothesis, it is useful to briefly show the variations in the use of new technology (spending on ICT) and upskilling (spending on ICT training) across firms, because the observed differences in skill and spending on ICT and ICT training can be used to interpret the complementary relationships between skill, technology and upskilling across firms.

7.5.1 Skill and the Share of Spending on Technology (ICT) and Upskilling (ICT Training)

Table 7.12 shows considerable variations in the share and trend of total spending on ICT including computers, telecommunications, training, Internet, maintenance and other items, defined by firm size and industry. The share of telecommunications exhibits a continuous increasing trend for all firms, while that of training shows an opposite declining trend. Table 7.2 above shows that, on average, the share of large size and food and chemical firms represents about 48 %, 53 % and 23 % of total spending on ICT respectively and about 75 %, 73 % and 2 % of total spending on ICT training respectively. However, despite the big share of spending on ICT and ICT training, large size and food firms experienced declining trends of ICT and ICT training (cf. Figs. 7.10 and 7.11). The decline in total ICT spending can be interpreted as being due to a lack of plan for critical expansion in ICT sector or probably due to a general cutback in total spending across food and large size firms. The declining expenses on both ICT training and computers follow the general decline in total ICT spending, which can also be attributed to a lack of plan for critical expansion and a possible change in the strategy of firms that, having already established a sound basis for these components, probably need to shift priority to increase spending on both telecommunications and maintenance.

We now proceed to examine the second part of our second hypothesis that an increase in skill levels and firm size leads to improved complementary relationships between skill, technology (ICT) and upskilling (ICT training) (see Table 7.13 below). For instance, we observe the complementary relationship between the share of high education and the share of expenditure on ICT, which can be seen and understood as complementarity between skill and technology (cf. Goldin and Katz 1998; Acemoglu 1998). We find a complementary relationship between the share of high education and the share of expenditure on ICT training, which can be interpreted as complementarity between skill and upskilling. Tables 7.13 and 7.14 show complementary relationships between the share of expenditure on ICT and ICT training, and between spending on computers, telecommunications, Internet and training, which can be read as complementarity between technology and upskilling (cf. Colecchia and Papaconstantinou 1996; Bresnahan et al. 1999). Our findings, that these complementarities are particularly significant for large size firms, are plausible since these firms have more spending on ICT and ICT training (see Table 7.2 above) and have high skill levels – share of high skilled workers in total employment (see Fig. 7.1 above). These results are consistent with the second part of our second hypothesis that an increase in skill levels and firm size lead to improved complementary relationships between skill, upskilling and technology (ICT) (cf. Acemoglu 1998). The results also imply the importance of a good education/high skill level for the enhancement of skill, technology and upskilling complementarity at the micro level. That also seems consistent with the

Table 7.12 Spending on ICT defined by firm size and industry (2005–2008) (% share in total spending)

Share in total spending in ICT (%) (2005–2008)	Group of Firms/ Years	Industry/activity				Size		
		Chemical	Food	Metal	Textile	Large	Medium	Small
Share in total spending in computer (%)	2005	16 %	48 %	13 %	23 %	28 %	29 %	43 %
	2006	15 %	55 %	14 %	16 %	35 %	22 %	43 %
	2007	32 %	45 %	9 %	14 %	50 %	6 %	45 %
	2008	46 %	42 %	2 %	9 %	53 %	27 %	20 %
Share in total spending in telecommunication (%)	2005	17 %	55 %	24 %	3 %	51 %	5 %	44 %
	2006	13 %	64 %	21 %	2 %	24 %	31 %	44 %
	2007	26 %	52 %	9 %	12 %	50 %	9 %	41 %
	2008	29 %	62 %	3 %	7 %	32 %	42 %	26 %
Share in total spending in training and software development (%)	2005	0 %	100 %	0 %	0 %	97 %	0 %	3 %
	2006	0 %	84 %	16 %	0 %	79 %	16 %	5 %
	2007	3 %	83 %	0 %	15 %	93 %	0 %	7 %
	2008	3 %	82 %	0 %	15 %	82 %	6 %	12 %
	2005–2008	2 %	73 %	12 %	13 %	75 %	18 %	7 %
Share in total spending in internet (%)	2005	25 %	26 %	50 %	0 %	25 %	0 %	75 %
	2006	19 %	24 %	53 %	4 %	19 %	4 %	76 %
	2007	15 %	37 %	26 %	21 %	57 %	0 %	43 %
	2008	10 %	41 %	11 %	38 %	57 %	23 %	21 %
Share in total spending in maintenance services (%)	2005	3 %	3 %	94 %	0 %	3 %	0 %	97 %
	2006	17 %	1 %	81 %	0 %	15 %	21 %	64 %
	2007	6 %	1 %	33 %	61 %	61 %	0 %	39 %
	2008	5 %	13 %	24 %	59 %	59 %	14 %	27 %
Share in total spending in hosting and other relevant ICT services (%)	2005	1 %	99 %	0 %	0 %	100 %	0 %	0 %
	2006	0 %	99 %	0 %	0 %	95 %	0 %	5 %
	2007	0 %	41 %	0 %	59 %	98 %	0 %	2 %
	2008	4 %	28 %	0 %	67 %	94 %	4 %	1 %
Share in total spending in ICT (%)	2005	13 %	57 %	19 %	11 %	47 %	14 %	39 %
	2006	12 %	59 %	22 %	7 %	37 %	22 %	40 %
	2007	22 %	49 %	11 %	18 %	59 %	5 %	36 %
	2008	31 %	52 %	4 %	14	49 %	30 %	21 %
	2005–2008	24 %	53 %	11 %	13 %	49 %	22 %	30 %
Share in average total spending in ICT (%)	2005–2008	23 %	53 %	11 %	13 %	48 %	21 %	30 %
Numbers of respondents	54	27	16	6	5	20	18	16

Source: Firm Survey (2010)

endogenous growth framework and stylised facts concerning the relationships between human capital, technical progress and upskilling (see our theoretical framework in Chap. 3 above).

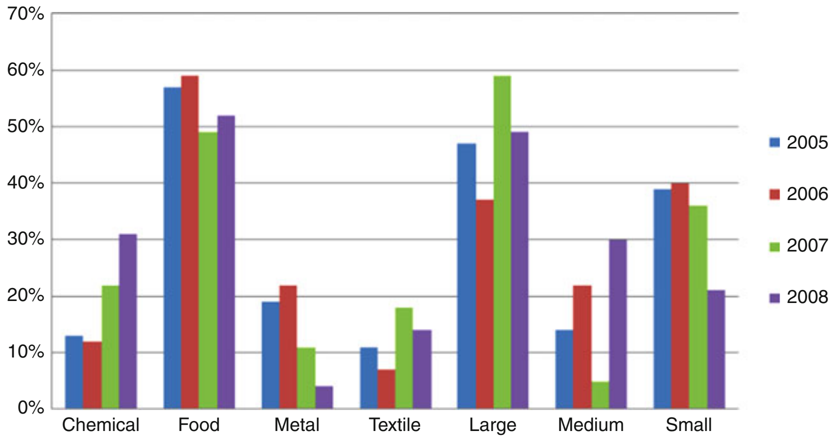

Fig. 7.10 The share and trend of total spending on ICT across firms (2005–2008) (Source: Firm Survey (2010))

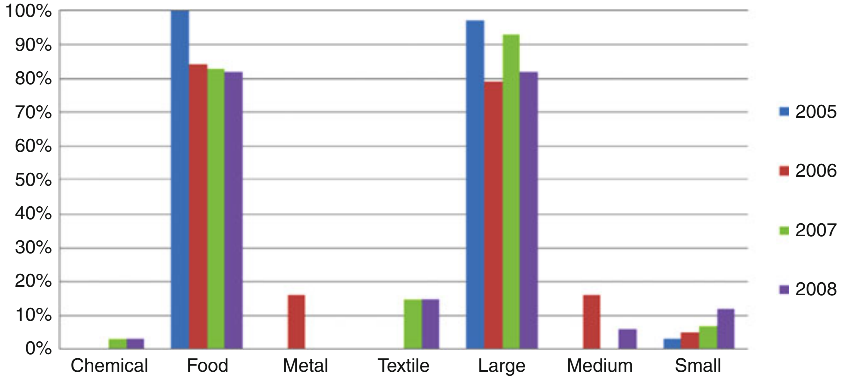

Fig. 7.11 The share and trend of spending on ICT training across firms (2005–2008) (Source: Firm Survey (2010))

7.5.2 *The Use of Technology, ICT, Skill and the Demand for Skilled Workers Across Firms*

One implication of the above complementary relationship between skill and technology is that the demand for skilled workers has changed in response to the increasing uses of ICT and other technologies. For instance, during the period 2006–2008 the uses of ICT (85 %) increased faster than that of other technologies (70 %); similarly, the corresponding rise in the demand for skilled workers needed for ICT (65 %) was more than that for other technologies (61 %) across all respondents firms (see Fig. 7.12 below). This trend may reflect the fact that the

Table 7.13 The relationship between ICT, skill and upskilling across firms (2008) (2005–2008)

Independent variables		Coefficient (t-value)				
Dependent variables	Group of firms	ICT expenditures	Training expenditures	Constant	R^2	N
High education (linear)	All firms (linear)[a]	0.002* (1.385)		0.344 (14.420)	0.014	34
	All firms (linear)[b]			30.963 (6.770)	0.023	44
	All firms (linear)[b]	0.003** (2.115)		31.724 (10.198)	0.052	82
	Chemical (linear)[b]	0.003* (1.241)		33.111 (7.354)	0.042	36
	Food (linear)[b]	0.002* (1.200)		29.619 (5.387)	0.051	28
	Metal (linear)[b]	0.001 (0.764)		31.684 (3.186)	0.055	11
	Textile (linear)[b]	0. 001** (4.773)		19.140 (3.175)	0.884	4
	Large (linear)[b]	0.006** (2.440)		23.384 (2.740)	0.351	13
	Large (linear)[b]	0.005** (2.349)		26.992 (3.796)	0.283	16
	Medium (linear)[b]	0.004* (1.953)		27.875 (6.103)	0.128	27
	All firms (linear)[a]		0.001** (2.309)	0.3123 (4.765)	0.262	15
ICT(linear: 2005–2008)	All firms (linear)[a]		1.746** (4.827)	15135109 (2.830)	0.608	6
Training expenditures	All firms (linear)[a]	0.349** (4.827)		−1905361 (−0.653)	0.608	6
	All firms (linear)[b]	0.054 (0.485)		4407619.75 (0.680)	0.045	6
	Large (linear)[b]	0.473** (2.301)		−3989610.8 (−0.536)	0.726	3
	Food (linear)[b]	0.036 (0.229)		5907673.03 (0.565)	0.017	4
	All firm (log)[b]	1.018** (5.218)		−1.077 (−0.762)	0.845	6
	Large (log)[b]	1.258** (9.317)		−2.597 (−2.750)	0.977	3
	Food (log)[b]	1.046** (4.627)		−1.399 (−0.851)	0.877	4

Correlation is significant * at the 0.05 level (one-tailed); ** at the 0.01 level (one-tailed)
[a](2005–2008).
[b]2008.

Table 7.14 The relationship between computers, training, internet and telecommunications expenditures across firms (2005–2008)

Independent variables		Coefficient(t-value)						
Dependent variables (All firms)		Computer expenditure	Training expenditure	Telecommunication expenditure	Internet expenditure	Constant	R^2	N
Computer expenditure: All firms	2005			1.587** (6.836)		748133.60 (0.980)	0.745	17
	2005		0.571** (2.687)			3059520.92 (0.958)	0.783	3
	2006			0.367** (4.410)		241933.61 (0.333)	0.506	20
	2006		0.865** (2.229)			3153599.66 (0.530)	0.713	3
	2007		0.147 (0.540)	0.981** (2.008)		−969394.91 (−0.241)	0.674	5
	2008		−0.001 (−0.002)	1.129** (4.445)		−2508705.42 (−0.391)	0.832	6
	2008			1.136** (7.319)		376032.41 (0.218)	0.579	40
	2008		−0.104 (−0.114)			15637070.23 (1.450)	0.003	6
	2005–2008			0.763678** (8.536810)		1435747. (2.370763)	0.450	36
	2005–2008		0.247* (1.523)	1.023** (6.353)		165382.95 (0.063)	0.741	6
	2005–2008				1.128** (3.160)	2952505.00 (2.484)	0.169	23
	2005–2008			0.780** (6.971)	0.458* (1.684)	1312687.00 (1.493967)	0.587	23

(continued)

Table 7.14 (continued)

Independent variables		Coefficient(t-value)						
Dependent variables (All firms)		Computer expenditure	Training expenditure	Telecommunication expenditure	Internet expenditure	Constant	R^2	N
Training expenditure: All firms	2005	1.370** (2.687)				−2505285.03 (−0. 439)	0.783	3
	2005			3.054** (22.081)		−676083.74 (−0.973)	0.996	3
	2006	0.824** (2.229)	0.067 (0.044)			138622.51 (0.022)	0.713	3
	2007	0.601 (0.540)				2443767.60 (0.303)	0.236	5
	2005–2008	0.512* (1.523)		−0.416 (−0.986)		5907509.77 (1.708)	0.140	6
	2005–2008	0.001* (1.252)				12.94005 (14.723)	0.125	5
Telecommunication expenditure: All firms	2005	1.379** (4.410)				1752340.80 (1.294)	0.506	20
	2005		0.326** (22.081)			231759.71 (1.046)	0.996	3
	2007	0.584** (2.008)	0.010 (0.044)			2754897.90 (1.023)	0.642	5
	2008	0.510** (7.319)				2032297.91 (1.828)	0.579	40
	2008		−0.092 (−0.125)			16072454.82 (1.845)	0.003	6
	2008	0.737** (4.445)	−0.015 (−0.044)			4553581.73 (0.956)	0.832	6
	2005–2008	0.589516** (8.536810)				758843.9 (1.398)	0.450	36

	2005–2008				0.896**	1864490.00	0.138	23
					(2.936)	(1.921)		
	2005–2008	0.700**	−0.138			2203956.51	0.721	6
		(6.353)	(−0.986)			(1.054)		
	2005–2008	0.645**			0.132	197942.2	0.565	23
		(6.971)			(0.520)	(0.242)		
Internet expenditure: All firms	2005–2008	0.150**				1058449.00	0.169	23
		(3.160)				(2.436)		
	2005–2008	0.122*		0.043		1044110.00	0.174	23
		(1.684)		(0.520)		(2.380526)		
	2005–2008			0.154**		1142708.00	0.138	23
				(2.936)		(2.968)		

Correlation is significant * at the 0.05 level (one-tailed); ** at the 0.01 level (one-tailed)

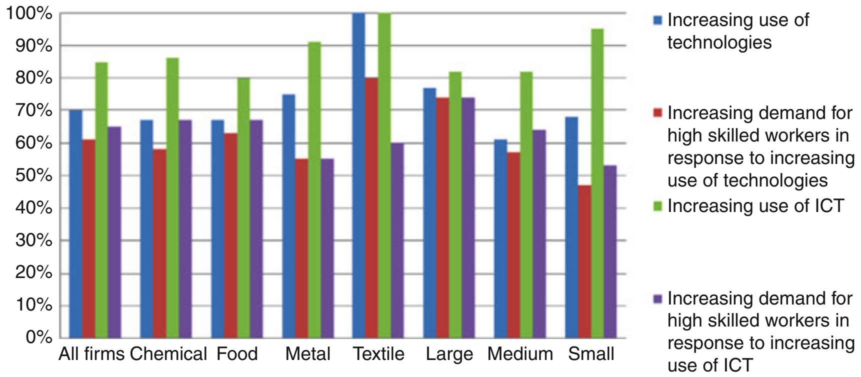

Fig. 7.12 The increasing use of technology, ICT and the demand for high skilled workers across firms, 2006–2008 (Source: Firm survey (2010))

real demand for skilled workers needed for ICT is more than that of other technologies across firms, which may not be surprising given the recent rapid increasing trend of IT diffusion despite the recent history of IT diffusion in Sudan. For instance, according to the World Development WDI database (2005), before 2000 the number of users of both mobile phone and Internet per 1,000 population were zero and up until the year 2000 both were only one; in recent years, Sudan has shown a growing telecommunication network and Internet services but still the highest price/most expensive Internet services as compared to other African and Arab and developing countries.

According to the respondent firms, the increasing use of new technologies caused an increase in both the demand for more skilled workers and the required skill levels of the respective workers involved with them. Table 7.15 indicates that the increasing use of new technologies has important effects on increasing the general skill levels and the demand for skilled workers amongst 88 % and 83 % of the respondent firms respectively.[37] However, it has relatively less important effects on increasing skill levels mainly for unskilled workers, and decreasing and substituting the demand for unskilled workers due to reduction and elimination/ substitution of some unskilled jobs. This implies change in the structure of employment/demand for workers in response to the increasing uses of new technologies and is also evidence of skilled-biased technical change theorem.[38]

[37] Firms reported the use of different types of new technologies such as mass chemicals plants, advanced process controls, food processing machines and plants installation, CNC machines, new advanced machines and ICT and computer. In addition to the use of modern new packing and covering machines, modern (cut and wrap) machines and modern tagged machines.

[38] This result is consistent with Skilled Biased Technical Change (SBTC) theorem and our earlier findings indicating that wages are increasing in education and biased against unskilled workers.

Table 7.15 The effects of new technologies on skill level and the demand for workers in the Sudan, 2008

The effects of new technologies in:	All firms	Chemical	Food	Metal	Textile	Large	Medium	Small
Increasing the general skill level	88 %	94 %	92 %	64 %	80 %	91 %	88 %	89 %
Increasing the demand for skilled workers (more educated, trained and experienced workers)	83 %	82 %	81 %	82 %	100 %	84 %	88 %	72 %
Increasing skill level mainly for unskilled workers	79 %	85 %	65 %	82 %	100 %	84 %	76 %	72 %
Reduction in some unskilled jobs	79 %	85 %	80 %	60 %	80 %	88 %	76 %	76 %
Increasing the demand for more professional workers	76 %	76 %	77 %	82 %	60 %	72 %	80 %	78 %
Decreasing the demand for less skilled workers (less educated, trained and experienced workers)	74 %	79 %	65 %	73 %	80 %	81 %	72 %	67 %
Decreasing the demand for production workers	68 %	68 %	69 %	64 %	80 %	84 %	56 %	56 %
Elimination/substitution of some unskilled jobs	65 %	68 %	69 %	50 %	60 %	75 %	52 %	71 %
Substituting the demand for less skilled workers	57 %	53 %	58 %	55 %	80 %	69 %	44 %	50 %
Total response	76 %	34 %	26 %	11 %	5 %	32 %	25 %	18 %

Source: Own calculation based on the firm survey (2010)

Moreover, from the firm survey we find that the increasing use of new technologies has not only raised the demand for high skilled workers in the past years, but also encouraged firms to predict a future/long run increase in the demand for high skilled workers. For instance, for 68 % of the respondent firms the interpretations of the predicted long run increase in the demand for skilled workers are related to planned/expected expansion of production, product diversification, implementation of new process, output technologies, purchases of new machines and equipment and increasing R&D activities.[39] This result seems consistent with the assumption made by Aghion and Howitt (1992) that an expectation of more research in the next period must correspond to an expectation of higher demand for skilled labour in research in the next period.

[39] Moreover, other factors are: the expected increases in market share, turnover, sales, adoption of international standards and enhancement of production, advanced control systems, shortage of manpower, competition, increasing motivation to reduce costs, achieving high standard precision work, improving productivity, quality of work and demand for more specialised skills in IT.

7.5.3 The Share of Spending on ICT and Input–Output Indicators

Finally, in this section we investigate the third hypothesis on the positive relationships between new technology (total expenditures on ICT) and input–output indicators across firms and over time. For instance, when investigating the relationship between ICT and input variables, we find from Table 7.16 that the total spending on ICT is positively correlated and more sensitive to labour (firm size), and industry level throughout the period 2005–2008 and also became sensitive to capital (net worth), notably, throughout the period 2007–2008. Both the total spending on ICT and ICT training (upskilling) are positively and significantly correlated and more sensitive to labour (firm size), and capital (net worth) throughout the period 2005–2008. The relationship between ICT and labour (firm size) is particularly more significant for the large size, chemical and textile firms. The different results across chemical and textile or large size firms is plausible and can be attributed to differences in the skill levels – share of high skilled workers in total employment (see Fig. 7.1 above). This is also because large size firms are more prevalent in the textile and chemical industries, they have high share in total ICT spending, employment, fixed capital, value added and profit (see Table 7.2 above) and probably have more consistent entrepreneurial/organisational strategies.

We examine the relationship between the use of new technology as measured by total spending on ICT, profit and output. Table 7.17 illustrates plausible positive though not significant correlations between the use of new technology (as measured by total spending on ICT) and capital, labour, total output (as measured by total sales value), output diversification (as measured by sales diversification), and productivity (as measured by total sales value/labour ratio) over the period 2007–2008. Moreover, Table 7.17 shows positive significant correlations between the use of new technology as measured by total spending on ICT and total profit and value added over the period 2007–2008.[40] In addition to positive significant correlations between old technology measured by total spending on machinery and equipment and total output measured by total sales value, profit and value added, between value added and old technology measured by total spending on machinery and equipment, spending on raw materials and capital. For old technology measured by total spending on machinery and equipment, the correlation coefficients are more significant than traditional inputs (labour-capital) over the period 2005–2008. These results prove our third hypothesis regarding the positive correlation between ICT and input–output indicators at the micro/firm level. However, our results should be interpreted carefully as they probably have two-ways causality and may leave open the possibility for reversed causality. Mainly because more profit and output would imply more financial capacity that permits more spending on ICT, on the other hand, more spending on ICT implies higher costs and lower profit (see Table 7.17 below).

[40] Except in 2008, where the correlations between labour and profit, labour, capital, productivity and diversification are negative.

Table 7.16 Total spending on ICT, labour and capital across firms (2005–2008)

Independent variables		Coefficient (t-value)				
Dependent variable (ICT expenditures)		Labour	Capital	Constant	R^2	N
ICT expenditures	All firms (2008)	31189.873** (2.068)		4017773.618 (1.286)	0.090	44
	Large	39678.002* (1.801)		659819.035 (0.091)	0.178	16
	Small	851008.625* (1.350)		−17122964.336 (−0.871)	0.132	13
	Chemical	16570.802* (1.261)		1352016.355 (0.482)	0.077	20
	Food	114796.261 (1.194)		2209388.184 (0.205)	0.106	13
	Textile	41167.945* (1.749)		6311339.471 (0.678)	0.505	4
ICT expenditures (All firms) (log)[a]	2005	50597.659** (2.047)	0.00003 (0.624)	200891.316 (0.051)	0.173	23
	2006	48260.393* (1.636)	0.00001 (1.113)	1868612.501 (0.425)	0.132	26
	2007	30134.482* (1.906)	0.00001** (2.779)	1535671.553 (0.525)	0.266	31
	2008	34994.538** (2.707)	0.00002** (5.597)	2453825.412 (0.941)	0.525	35
ICT expenditures (All firms) (log) (2005–2008)	Total ICT (log)	0.007** (3.196)	0.002** (3.514)	10.770 (24.801)	0.166	36
	Training (log)	0.03** (4.714)	0.002** (3.791)	6.648 (4.155)	0.655	5
	Computer (log)	−0.011* (−1.649)	0.002** (3.227)	11.516 (17.591)	0.167	30
	Telecommunication (log)	−0.004* (−1.434)	0.002** (3.02)	10.949 (24.147)	0.127	34
	Internet (log)	−0.001 (−0.145)	0.001 (1.134)	11.170 (12.641)	0.0394	17
	Maintenance (log)	0.006 (0.631)	0.0004 (0.577)	9.596 (7.641)	0.0271	11
	Other, web host (log)	−0.008 (−0.745)	0.0002 (0.222)	11.417 (9.707)	0.0426	6

Correlation is significant * at the 0.05 level (one-tailed); ** at the 0.01 level (one-tailed)
[a]Log value for all estimated variables: ICT, labour and capital.

Our findings concerning the significant positive correlations between ICT and profit and value added and the insignificant correlation between ICT and output imply an inconclusive effect at the micro level. These results agree with our

Table 7.17 The correlation between, firm performance, output and profit and labour, capital, total spending on ICT, machinery and equipment and raw materials across firms across firms, (2005–2008)

Independent variables		Coefficient (t-value)							
Dependent variables all firms		Labour	Capital	Total spending on ICT	Total spending on machinery and equipment	Total spending on raw materials	Constant	R^2	N
Total output (total sales value)[a]	2005[a]	0.624	0.196				9.935	0.077	22
		(0.729)	(1.112)				(2.024)		
	2005[a]			0.097			14.828	0.006	23
				(0.356)			(4.497)		
	2006[a]	0.748	0.253*				8.728	0.110	25
		(0.812)	(1.526)				(1.755)		
	2006[a]			0.103			14.864	0.008	27
				(0.464)			(5.346)		
	2007[a]	0.126	0.222*				11.509	0.075	30
		(0.167)	(1.502)				(2.638)		
	2007[a]			0.185			13.847	0.025	34
				(0.915)			(5.583)		
	2008[a]	0.095	0.193*				12.508	0.059	34
		(0.142)	(1.403)				(3.091)		
	2008[a]			0.154			14.566	0.021	40
				(0.913)			(6.965)		
	(2005–2008)[a]	0.349	0.337**	0.075			8.220	0.244	35
		(1.047)	(5.046)	(0.845)			(4.387)		
	(2005–2008)[a]	0.003	−0.0005		0.006**		16.195	0.154	35
		(1.328)	(−0.869)		(4.210)		(36.991)		
Profit[a]	2005[a]	0.553	0.416**	0.119			4.111	0.419	15
		(0.576)	(2.448)	(0.488)			(0.806)		

	2006[a]	0.890	0.441	0.040		3.350	0.480	19
		(1.076)	(3.384)	(0.214)		(0.769)		
	2007[a]	0.450	0.433**			5.095	0.392	26
		(0.660)	(3.910)			(1.408)		
	2007[a]			0.273*		11.891	0.055	29
				(1.281)		(4.498)		
	2008[a]	−0.190	0.291**	0.117		9.277	0.312	28
		(−0.359)	(2.270)	(0.818)		(2.905)		
	2008[a]			0.300*		11.740	0.097	33
				(1.854)		(5.820)		
	(2005–2008)[a]	0.001	0.0001	0.0001		14.615	0.013	34
		(0.280)	(0.715)	(0.352)		(29.834)		
	(2005–2008)[a]	0.003	0.0007		0.001**	14.213	0.203	33
		(1.124)	(1.278)		(4.558)	(34.225)		
Value added[a, b]	2005[a]	0.700	0.335**			7.482	0.256	21
		(1.026)	(2.430)			(1.884)		
	2005[a]			0.205		13.820	0.039	20
				(0.883)		(4.806)		
	2006[a]	0.568	0.328**			8.278	0.267	23
		(0.839)	(2.694)			(2.225)		
	2006[a]			0.076		15.249	0.008	24
				(0.426)		(6.948)		
	2007[a]	0.307	0.427**			7.164	0.306	28
		(0.467)	(3.384)			(1.887)		
	2007			0.439**		10.936	0.143	28
				(2.122)		(4.347)		
	2008[a]	0.363	0.399**			7.482	0.286	31
		(0.620)	(3.399)			(2.085)		
	2008[a]			0.275*		12.922	0.071	33
				(1.561)		(5.994)		

(continued)

Table 7.17 (continued)

Independent variables		Coefficient (t-value)							
Dependent variables all firms		Labour	Capital	Total spending on ICT	Total spending on machinery and equipment	Total spending on raw materials	Constant	R^2	N
	(2005–2008)[b]	246591.7	0.02**		0.0154**	0.159**	−82886294	0.981	18
		(0.609)	(2.529)		(4.064)	(13.050)	(−1.441)		
Diversification (sale diversification)	2008[a]	−0.073	−0.013	0.014			0.677	0.056	34
		(−1.137)	(−0.937)	(0.832)			(1.798)		
Productivity (sale/labour)	2005–2008[a]	−0.004	−0.0001	0.0002			12.36	0.027	35
		(−1.450)	(−1.068)	(0.947)			(26.760)		
Total spending on machinery and equipment	(2005–2008)[a]		0.514**				7.631	0.465	32
			(5.195)				(4.437)		
Wage[a]	(2005–2008)[a]	0.395*	0.445**				6.080	0.431	35
		(1.534)	(9.171)				(4.167)		

Correlation is significant * at the 0.05 level (one-tailed); ** at the 0.01 level (one-tailed)
Log value for all estimated variables: ICT, labour and capital
[a]log.
[b]linear.

observations at the aggregate level, which imply that the growing expenditures on ICT in Sudan raises the shares of the population using the Internet, enhances e-business, e-education and e-government. However, despite the growing ICT expenditures, their effects are inconclusive at the aggregate level, probably due to low spending on ICT, high poverty and illiteracy rates, low skill levels and inadequate investment in education.[41] The macro observations are consistent with the recent literature indicating the growing but limited effects of ICT diffusion in the developing countries due to a lack of sufficient investment in the complementary infrastructure such as education, skills and technical skills (cf. Pohjola 2002; Kenny 2002). Therefore, these results prove the third hypothesis in Chap. 1 above about the inconclusive effect of ICT at the micro level.

7.6 Conclusions

In this chapter we use the data from the firm survey (2010) to examine skill indicators, their implications and relationships with average wages, and with upskilling (ICT training) and technology (ICT), ICT and input–output indicators at the micro/firm level.

Our findings in Sect. 7.3 illustrate the low skill levels – due to the excessive share of unskilled workers (Figs. 7.1 and 7.2) – and the implications on skills mismatch (Fig. 7.6), industrial performance indicators and productivity decline across firms (Tables 7.3, 7.4, 7.5, and 7.6). These results are consistent with the micro–macro findings in Chap. 5 above, which indicate the low share of high skilled in total population and employment – measured by both educational and occupational levels – and the serious implications on skills mismatch and the macro–micro duality with respect to upskilling efforts. These findings together with those in Chap. 5 above verify hypotheses 3.b and 4.a in Chap. 1 above regarding the implications of the interaction between the deficient educational system and high use of unskilled workers. These findings then confirm our first hypothesis, which we proved in Chap 2 above, concerning the pressing need for upskilling, particularly within the private sector.

Our results in Sect. 7.4 show positive correlations between actual and required education, experience and average wages (Tables 7.8, 7.9, 7.10, and 7.11). We verify hypothesis 4.b. in Chap. 1 above that an increase in skill level and firm size lead to improved relationships between actual and required education (Table 7.8), between actual education, experience and wages (Table 7.10) and between required education, experience and wages (Table 7.11).

[41] Our attempt to examine the effect of ICT at the macro level in Sudan is constrained by the lack of adequate and reliable data on ICT spending, as the most recent data on the share of spending on ICT relative to GDP (2010) is available only for two years over the period 2007–2008.

In Sect. 7.5 our findings with respect to the positive complementary relationships between skill, technology (ICT) and upskilling (ICT training) and between computers, telecommunications and ICT training (Tables 7.13 and 7.14) are consistent with the findings in the new growth literature. We illustrate and corroborate hypothesis 4.c. in Chap. 1 above that an increase in skill level and firm size lead to an improvement in the complementary relationships between skill, upskilling and technology (ICT).

Taken together, all these results imply the importance of a good education for bridging differences between firms and also for enhancing skill, technology and upskilling complementarity at the micro level. These findings seem consistent with the endogenous growth framework and stylised facts concerning the relationships between human capital, technical progress and upskilling and our theoretical framework in Chap. 3 above.

Finally, our results in Sect. 7.5 indicate positive significant correlations between total spending on ICT and profit and value added, but insignificant correlations between total spending on ICT and output at the micro/firm level (Table 7.17). This result confirms the fifth hypothesis in Chap. 1 above, which implies an inconclusive effect of ICT at the micro level and supports the observations at the macro level in Sudan and the recent literature in the developing countries.

Moreover, our results in Sects 7.4 and 7.5 show the relationships between actual and required education, experience and wages and between skill, technology (ICT) and upskilling (ICT training), defined by firm size and industry level. These results are consistent with our findings in Chap. 5 above, which imply that both skill and technology indicators vary across firms and increase with firm size and industry level.

Therefore, our findings in this chapter are consistent with hypotheses 3.b. and 4. a. in Chap. 1 above with respect to the implications of the excessive use of unskilled workers at the micro level. In addition, our results verify hypotheses 4.b. and 4.c. in Chap. 1 above concerning the relationships between actual and required education and experience and between actual education, required education, experience and wages and the relationships between technology (ICT), skill and upskilling (ICT training). Finally, we corroborate the fifth hypothesis in Chap. 1 above regarding the inconclusive effect of ICT at the micro level.

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