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## Abstract

This paper investigates the relationship between technological change and the relative demand of skilled workers in Tunisia. For this purpose, we use a firm level database drawn from the national annual survey report on firms (NASRF) provided by the Tunisian National Institute of Statistics (TNIS). The annual data covers 635 firms from manufacturing and non-manufacturing sectors over the period 1998–2002. The estimation of the demand for skilled labor is based on the estimation of a translog cost function. We control for potential endogeneity issues and we give empirical evidence supporting the trade-induced technological change theoretical intuition. Our empirical results confirm the existence of a trade-induced technological change that contributes to increasing the relative demand for skilled workers. Yet, the relationship between trade and technology deserves deeper interest. Further empirical research on transmission channels would reinforce current studies on skill-biased technological change.



## ملخص

تدرس هذه الورقة العلاقة بين التغير التكنولوجي القائم علي المهارة و الطلب النسبي علي العمالة المدربة في دول شمال أفريقيا، و بالتحديد تونس. لذلك، نستخدم قاعدة بيانات مؤكدة مستمدة من تقرير المسح القومي السنوي علي الشركات الصادر عن المعهد الوطني للإحصاء في تونس. تغطي البيانات السنوية 635 شركة من القطاعات الصناعية و غير الصناعية خلال الفترة من 1998-2002. تقدر نسبة الطلب علي العمالة المدربة بناءا علي تقدير دالة التكاليف (الدالة اللوغاريتمية للتكلفة) .نحن نفحص معايير صناعة التكنولوجيا محليا باستخدام متغيرات فعالة. كما نقدم الدليل التجريبي الذي يدعم نظرية الحدس التي تؤكد وجود التغير التكنولوجي القائم علي المهارة. فنتائجنا التجريبية تؤكد وجود تغير تكنولوجي قائم علي المهارة يساهم في زيادة الطلب النسبي علي العمالة المدربة . توضح النتائج أيضا أن تحرير التجارة يؤثر علي الطلب النسبي علي العمالة من خلال التغير التكنولوجي القائم علي المهارة. رغم ذلك، تستحق العلاقة بين التجارة و التكنولوجيا المزيد من الدراسة . المزيد من الأبحاث التجريبية علي قنوات الإرسال سوف تدعم الدراسات التي تجري علي التغير التكنولوجي الذي يعتمد علي المهارة.

## 1. Introduction

The rise of wage differentials between skilled and unskilled workers coupled with the increase of skilled workers' relative demand constitutes an important issue for developing countries. It contributes to weakening the social cohesion by its effects on labor unemployment and poverty, especially if unskilled workers are not enjoying improvements in their situation in relative and sometimes absolute terms.

For a long time, the demand-side determinants of wage inequality have been put forward in the light of "the trade versus technology" debate isolating the contribution of each of these variables. The technological conduit under discussion is the skill-biased technological change, defined by Haskel and Slaughter (1998) as any technological progress that raises relative demand for skilled workers within sectors, at given relative factor prices. The trade contribution is defined according to the standard Heckscher-Ohlin theory that would predict a shift of labor demand towards skilled labor even in developing countries, if we relax some of the restrictions embodied in this theory[1]. Interestingly, recent literature brought about new insights into this distinction demonstrating that openness and technological bias should not be considered as independent phenomena. Indeed, technological progress could be perceived as an endogenous response to trade liberalization process (Hanson and Harrison, 1995, Lawrence, 2000, Goldberg and Pavcnik, 2004). The literature on developed countries emphasizes many channels through which trade may affect technological change. We can cite the defensive innovation process highlighted by Wood (1994), according to which firms facing intensified competition from low-wage countries react by looking for new methods of production that preserve their market share. Thoenig and Verdier (2003) develop this argument both in North-North and North-South integration contexts. They consider a dynamic model showing that northern firms respond to the increased pressure and the multiple threats of an internationally exposed environment (imitation, leapfrogging...) by adopting defensive innovations which are biased towards skilled workers. Goldberg and Pavcnik (2004) consider that this model is also appropriate for middle income developing countries dealing with low income economies. Ekholm and Midelfart (2005) also explore theoretically the trade-induced skill-biased technological change explanation by developing a model of imperfect competition and intra-industry trade with heterogeneous firms. According to these authors, trade openness leads to the expansion of the market for the individual firm, creating incentives to upgrade skill-intensive technology that becomes more profitable[2] in comparison to the technology intensive in unskilled labor. This, in turn, contributes to the rise of skilled workers' relative demand.

Focusing on developing countries, Pissarides (1997) elaborated a model through which liberalized trade allows southern firms to increase their imports of technology intensive capital goods from the North and to open up—by exporting—to competition with foreign firms, which increases the incentive to learn and imitate new technologies. This implies an increase in the relative demand of skilled workers if we assume they are complementary to new capital. In the same line, the model elaborated by Acemoglu (2003) shows that after opening to trade, firms in developing countries increase their imports of machines and developed countries technologies as a consequence of capital goods price reduction. Furthermore, Feenstra and Hanson (1997) developed a model where openness increases capital flows from North to South and hence, the relative demand for skilled workers in both regions. These foreign direct investments take the form of an outsourcing of input production

1 These restrictions are notably related to the trade protection pattern favoring the unskilled-labor intensive sectors as well as the non-inclusion of trade activities on intermediate goods.

2 This type of technology is associated with relatively high fixed costs and relatively low variable costs.

activities, which are skill-intensive, from southern technological standards and adversely, intensive in unskilled labor from northern countries standards.

We have up to now addressed the issue of trade-induced technological change, ignoring the autonomous component of technical innovation. It should be clear that the concept of innovation applied to developed countries encompasses a well-constructed and self-promoted system through which technological change occurs and expands as well as a trade-stimulated facet. However, for developing countries which are the focus of our interest in the current study, Aubert (2005) considers that "the overall context in which innovation in developing countries takes place is dominated by two global drivers: the first one is the intensification of the globalization process (…) The second is the intensive ongoing technological change stimulated by tremendous scientific advances"[3]. We may even argue that this second driver is a sub-constituent of the broader globalization phenomenon. Scientific advances emerging primarily in the context of northern developed economies are diffused in the south through trade and foreign investments flows. The autonomous innovation in developing countries is fraught by many weaknesses as the educational attainment, the business environment and the lack of infrastructure. Aubert (2005) points out the generally limited research community, the lack of connection between universities and local realities and the poorly constructed and highly fragmented innovation systems[4]. We may, hence, assume in the rest of the paper that the national and self-initiated technological change in Tunisia is comparatively negligible to the trade-induced component. For a need of rigor, an empirical assessment of the trade role is performed.

The still limited empirical literature interested in the linkages between trade-induced technological change and the relative demand of skilled workers in developing countries is mainly based on the estimation of a translog cost function. Explanatory variables representing technology transfer from abroad are introduced in the estimated equation, such as imported materials, patent use, royalty payments, expenses on foreign technical assistance and the percentage of output exported, (Fuentes and Gilchrist, 2005; Pavcnik, 2003 and Robbins, 1994 for Chile and Görg and Ströbl (2001) for Ghana). These studies mostly oriented toward Latin American countries, converge to a common outcome concerning the role of technological progress in the increase of skilled workers' relative demand. For instance, Harrison and Hanson (1999) and Mazumdar and Quispe-Agnoli (2002) confirm a positive correlation between technology variables and the relative demand for skilled workers respectively in Mexican plants and Peruvian manufacturing industries following the trade liberalization process. The same conclusion is reported by the only two existent studies on African countries relative to this issue. Görg and Ströbl (2002), using a panel of Ghanaian firms, consider that greater inflow of foreign machinery is an explanation of the increase in wage inequality. Edwards (2004) provides a similar finding for a panel of South African firms. We should note that the majority of these studies develop conclusions about the existence of a skill biased technological change, on the basis of regressions of the translog cost function. However, in our sense, such assertions need to provide empirical evidences about the link between technology, relative demand of skilled workers and relative wages. The impact of technology as a determinant of the relative demand on wage inequality is until now, insufficiently explored.

This paper, to the best of our knowledge, investigates for the first time the impact of technology on the relative demand of skilled workers, in a northern African country, namely

[3] Aubert, J.E. 2005. "Promoting Innovation in Developing Countries: A Conceptual Framework". Policy Research Working Paper N. WPS3554. April. The World Bank Institute , April, p 7.

[4] Nevertheless, the author does not exclude the existence of some success stories related to projects initiated by very motivated people that benefited from the assistance of foreign partners or political support. Other projects may have also taken advantage of the presence of a strong university or a dynamic industrial community.

Tunisia. It attempts to answer to the following questions: 1. Are descriptive statistics showing an increase in the relative demand for skilled workers at the firm level over 1998–2002? 2. If so, does the econometric analysis confirm the role of technology adoption in such a trend? 3. Is technology a channel through which trade openness raises the relative demand of skilled workers in Tunisia?

The Tunisian economy should be an instructive case of study as it has been subject to an increase, however relatively moderate, in wage inequality subsequent to trade reforms introduced in 1986[5]. Ghazali (2009) demonstrated the existence of a positive and statistically significant relationship between trade openness and wage inequality in Tunisia during the period 1998–2002.

Our empirical strategy is settled in two steps. The first step is motivated by the investigation of the relationship between technological progress and the relative demand for skilled workers. For this purpose, we regress a translog cost function including technology adoption indicators such as computer equipment purchases, research and development (R&D) expenditures and software assets value provided by the only firm level Tunisian database available for the period 1998–2002. Such indicators are relatively scarce in the context of developing countries surveys. Annual data covers 635 firms from manufacturing and non-manufacturing sectors. They were drawn from the national annual survey report on firms (NASRF) provided by the Tunisian National Institute of Statistics (TNIS). The challenge of the second step is to empirically assess the trade-induced technological change hypothesis by regressing the technology adoption proxies on trade protection measures following Bas (2008)[6]. Results suggest the existence of a technological change that contributes to increasing the relative demand for skilled workers in Tunisia. These findings are robust to many endogeneity controls. Two particular technology proxies are likely to play a role: R&D expenditures and computer equipments acquisitions. Results also corroborate the positive impact of trade liberalization on technology adoption process. Furthermore, we demonstrate that the foreign participation in firms' capital is associated with a greater share of unskilled workers which suggests a concentration of unskilled-labor biased vertical investments in Tunisia. The FDI's role as skill enhancing in developing countries, seems thus to be insignificant in Tunisia.

Our contribution to the empirical literature is to address a number of endogeneity problems related to the regression of the translog cost function. First, the relative wage rate that is a crucial determinant of the skilled workers relative demand is generally not included in the regressions due to endogeneity issues. In this paper, we attempt to take it into account and to control for the related problem. Second, a simultaneity bias may be observed given that firms which are more intensive in skilled workers are more likely to implement superior technologies[7]. Empirical studies for developing countries generally ignore this reverse causation. Third, the technology variables are likely to be endogenously determined by trade reforms (Sanders and Ter Weel, 2000). It may well be the case that some firms have a higher demand for skilled workers and for technology because of reduced trade protection. This suspicion is justified by the positive relationship between trade measures and technology

[5] The 1970s and the first half of the 1980s were characterized by a reduction in wage inequality in the Tunisian non-agricultural productive sector. A skilled worker was paid in 1975 almost four times the wage of an unskilled worker. In 1985, the relative wages ratio was about 3. This ratio increased after 1986 reaching 3.42 in 1991. During the following years, wage inequality displayed a slight decrease as the relative wage of skilled workers fell to 3.27 in 1998.

[6] We should note that it would be more relevant to use direct measures on transferred technology as imported machinery, imported materials and investments sourced abroad (Harrison and Hanson 1999; Görg and Ströbl, 2002). Indeed, such indicators make it more reliable to assess the "trade-induced" technological change impact on relative wages. Unfortunately, such data is not provided by the current database.

[7] The simultaneity bias may hold between the technology variable (explanatory variable) and the share of skilled workers in total wage bill (the dependent variable).

proxies put forward in the second empirical step. In order to alleviate the endogeneity issues, we instrument technology using a two-stage least squares estimation.

The rest of the paper is organized as follows. Section 2 describes the Tunisian trade liberalization process. Section 3 and 4 present respectively the data set used in the empirical analysis and some descriptive statistics. Section 5 provides the econometric analysis and the main estimation results. Section 6 concludes.

## 2. The Tunisian Trade Liberalization Process

The structural adjustment plan entailed a process of lowering and setting uniform tariffs such that the average import duties declined from 41% in 1986 to 33% in 1987 and to 29% in 1990[8]. The highest duty rate was reduced from 200% to 43% (Mouelhi, 2007). Table 1 reports the evolution of the effective rate of protection (ERP) in manufacturing and non-manufacturing industries. It shows that the ERP relative to all outputs excluding hydrocarbon fell from 70% in 1986 to 44% in 1990. Trade reform pattern was not uniform across manufacturing industries over the period 1986–1991. For instance, unskilled intensive sectors as the food-processing and textile industries that benefited from a relatively higher protection level prior to trade liberalization observed a decrease of their effective protection rates by about 300 and 150 percentage points respectively. However, skill intensive sectors underwent either an increase of their rate of protection or a minor decrease within the same period. For instance, the ERP shifted from 40% to 82% in construction materials, glass and ceramics industry and from 88% to 101% in the electrical and mechanical industries. Concerning the chemical industries, the ERP moved from 88% to 78% between 1986 and 1991. Overall, skill intensive industries were less protected prior to the reforms. Therefore, they were subject to smaller reductions in tariff protection. Similar patterns of protection are reported in Colombia (Attanasio et al, 2004), Mexico (Hanson and Harrison, 1999) and Morocco (Currie and Harrison, 1997).

This period also exhibits a progressive reduction in non-tariff barriers (NTBs). Table 2 reports that the share of free tariff headings[9] increased from 20% in 1987 to 52% in 1990. The Sachs and Warner (1995) Openness index classifies Tunisia as an open economy starting from 1989. In conjunction with these reforms, a real exchange rate depreciation of 30% was initiated between 1987 and 1991. In 1990, Tunisia signed the GATT agreements. The adherence to the WTO was achieved in 1995. Reflecting the government's objective to comply with the GATT/WTO negotiated rates, Tunisia witnessed over the period 1990–1998 an increase in the nominal protection rates on agricultural final goods because of non-tariff protection transformation. The nominal protection rates on industrial final goods increased for the same reason while the nominal protection rates on industrial intermediate goods decreased due to the focus of the openness process at this stage on equipments and inputs[10]. This led to an increase of the effective rate of protection for a majority of products (the ERP attained 56% in 1995 and 71% in 1998).

In 1996, Tunisia also ratified the EUROMED agreements that imply the establishment of a free trade zone including the majority of industrial products over a period of 12 years. List 1 comprises capital goods and inputs that account for 12% of the volume of imports from the European Union (EU) in 1994. Duties on this list were dismantled in 1996. List 2 is primarily related to raw materials and intermediate products that concern 28% of total Tunisian imports

8 Les Cahiers de L'Institut d'Economie quantitative (IEQ), n°9, Décembre 1991, p 51.

9 The tariff nomenclature includes the description of goods and the corresponding code is called the "heading".

10 The transformation of non-tariffs barriers into tariff equivalent implies an increase in the nominal protection rate of industry and agriculture outputs. This, coupled with a significant reduction of the nominal protection on inputs and intermediate goods lead to the rise of the effective rate of protection.

from the EU in 1994. It has been under duty-free since 2001. Lists 3 and 4 consist of locally manufactured goods. List 3 covers products considered capable of facing foreign competition. In this case protection was to be removed over a 12-year transition period (1996–2007), with duty-free status in 2008. These products represented about 30 percent of Tunisian imports from the EU in 1994. Finally, list 4 also concerns industrial products manufactured locally, but in this case tariffs were to be reduced over an eight-year period (2000–2007), following a four-year transition period (1996–1999), with duty-free status in 2008. The products covered by this list accounted for 29 percent of Tunisian imports from the EU in 1994[11]. Tunisia has also concluded other bilateral and multilateral trade agreements with members of the Arab League. The prospect of duty-free admission of European products by 2008 has paved the way for reforms seeking to increase the competitiveness of Tunisian products. Hence, private Tunisian firms have been subject over the period 1996–2006 to an "upgrading program" that provided support to almost 2000 private companies (Bougault and Filipiak, 2005). This program aimed to support modernizing investments, new technologies and know-how adoption, firm competitiveness enhancement and human resources skills improvement. Financial incentives were offered to firms to implement this program (10% to 20% of investments in physical assets and 70% of intangible investments).

As reported by Table 1, the trade liberalization process has become more active since 1997 given that the effective rate of protection decreased from 71% to 49% in 2002. However, non tariff barriers still constitute an impediment to trade openness. Lahouel and Chemmingui (2005) observe that the technical checks procedures imposed by the customs services to imported goods were augmented after 1995. Indeed, the share of total tariff headings facing such measures increased from 25% to 30% in 2001, (see Table 3 below). They also emphasize the slowness and the high cost of some of these procedures as well as the sluggishness of customs clearance process. In addition, imports of certain types of goods such as pharmaceutical, food, mining and pneumatic products are still under control of some monopolistic public firms. Therefore, one would expect the subsistence of significant industry rents specific to the most protected sectors.

According to Dennis (2006), Tunisia and Morocco are considered to have the most restrictive (MFN)[12] tariff regime in the Middle East and North African (MENA) region. The author points out that this places domestic producers in these countries at a competitive disadvantage in terms of accessing cheap inputs and in terms of imported final goods prices with its related effect on consumers' welfare. The latest World Bank's Overall Trade Restrictiveness Index (OTRI), which incorporates non-tariff measures, is at 33.90 percent which is higher than its comparators. The Trade (MFN) Tariff restrictiveness index (TTRI)[13] for Tunisia attains 20.3 percent, ranking it 123rd out of 125 countries. The World Bank demonstrates in particular that Tunisia's trade regime towards agricultural products is highly restrictive. The MFN applied tariff simple average for agriculture is 65% in 2006, which is about three times more restrictive than non-agricultural products[14]. Dennis (2006) writes that: "it would appear that there is considerable room for further liberalization of the MFN tariff regime of both

[11] For further details, see the report of the World Trade Organization (2005) on Trade and investment regimes in Tunisia available at http://www.wto.org/english/tratop_e/tpr_e/tp252_e.htm.

[12] Most favoured nation

[13] The OTRI summarizes the impact of each country's trade policies including preferential tariffs and non-tariff measures on its aggregate imports. The TTRI index summarizes the impact of each country's non-discriminatory trade policies on its aggregate imports which means that it does not incorporate preferential rates. This index is also reported disaggregated for agricultural and non-agricultural goods. The latest data correspond to 2007 and are available at: http://www.worldbank.org/wti2007.

[14]World Bank 2009. "Tunisia Trade Brief", available at:
http://siteresources.worldbank.org/INTTUNISIA/Resources/TUNISIA-ENG-2009SM.pdf

Morocco and Tunisia, especially as both countries are soon to fulfill their liberalization obligations under the free trade agreement with the EU"[15].

## 3. Data Overview

Our current firm-level database is the only firm-level data available in Tunisia. It was drawn from the National Annual Survey Report on Firms (NASRF) carried out by the Tunisian National Institute of Statistics (TNIS) over the period 1997–2002. After the elimination of extreme outliers as well as data corresponding to the year 1997[16] and confining our attention to firms that remain in the sample for at least three years[17], we obtained an unbalanced panel consisting of a sample of 635 firms from 12 sectors. As shown in Table 4, the data includes a large set of variables on value added (VA), number of workers (L), capital stock (K), sales, expenditures disaggregated by equipment type, tangible and intangible fixed assets and firm indicators such as industry classification and the structure of equity participation (public, private, semi-public, foreign). In addition, two sector industrial price indexes are provided, respectively elaborated from 20 and 50 product lists. We should also note that the database offers labor decomposition by skill. Skilled labor activities include engineering, management, administration, and general office tasks while the activities of unskilled workers include machine operation, production supervision, repair, maintenance and cleaning[18]. Besides, data on the total wage bill is available, though, without skill distinction. This is unfortunate, since this form of data is essential to the current study. In order to overcome this problem, we followed the decomposition technique of Maurin and Parent (1993) to decompose the total wage bill by skill, given the skilled and unskilled shares in total employment[19]. Besides that, we compute a capital stock proxy since the available data provided by the TNIS for this variable are based on a small balanced sample. We followed Mairesse and Hall (1996) by considering the tangible fixed assets deflated by the gross fixed capital formation deflator as a capital stock proxy.

As we want to study the relationship between relative demand of skilled workers and technology adoption, we require proxies for the latter variable. We should emphasize here a further interest of this database. Indeed, it offers relevant firm-level measures to indicate technology adoption like computer equipment purchases, R&D expenditures and software assets value which is not recurrent in developing countries' statistical surveys. We express R&D costs as a share of total acquisitions, computer equipment purchases as a share of total acquisitions and software assets value as a share of value-added[20]. Obviously, in order to assess the assumption of trade-induced technological change and its impact on the relative demand of skilled workers, we would have preferred to rely on the share of imported materials as Pavcnik (2003) or the share of royalty payments for patents, copyrights or trademarks as Harrison and Hanson (1999). These variables may better capture the transfer of advanced technology from developed countries. However, the lack of such data does not constitute an impediment to explore the role of trade liberalization as a channel of technological change. Indeed, we regress the available technology adoption proxies on trade

[15] Dennis, A., H 2006. "Trade liberalization, factor market flexibility and growth: the case of Morocco and Tunisia", *World Bank Policy Research Working Paper* 3857*,* March, p4.

[16] Data corresponding to 1997 (the start date of the survey) suffers from many shortcomings.

[17] This removal is related to the applied wage bill decomposition technique that is presented in the appendix. In a random-coefficients model, the number of observations in each panel must be greater than the number of regressors (including the constant). Thus, the first step in fitting Swamy's random coefficient model was to drop panels with less than three observations.

[18] This is nearly the white-collar/blue-collar workers classification applied by Hanson and Harrison (1995).

[19] This decomposition technique is presented in the appendix.

[20] We have also expressed these proxies as shares of total firm revenue. Regression results reported in the appendix converge with those performed using the above measures.

protection following Bas (2008) which enables us to rigorously explore the relationship linking these variables. The ratio of customs duties to total imports used to proxy trade protection is available at the sector level. It is provided, as well as the other openness measures applied in this study, by the Tunisian Institute of Quantitative Economics (IQE) and expressed in 1990 constant Tunisian Dinar.

Tables 5 and 6 provide an idea about the sample representativeness. Table 5 compares the distribution of employment across manufacturing sectors in our sample and in the industrial data as well as the contribution of each of these sectors to total manufacturing value added. Table 6 reports similar figures for non-manufacturing sectors. We have chosen to study the representativeness of the manufacturing and non-manufacturing samples separately because the survey does not include some sectors like electricity, water and mining that are taken into account in the computation of the GDP by the TNIS. We may conclude that the configuration of employment and value added is equivalent to the industrial data. This minimizes the risk of selection bias that affects a statistical sample of a population in which all participants are not equally balanced or objectively represented.

## 4. Descriptive Statistics

We conduct a preliminary descriptive analysis in order to explore trends in skilled labor employment and wages as well as technology adoption evolution at the firm level. Table 7 summarizes the evolution of the skilled workers share in total employment and total wage bill respectively, computed using unweighted firms means. We find that the share of skilled workers in the total wage bill for the average firms in our sample increased by 10% over 1998–2002. Similarly, the employment share for skilled workers for the average firms rose by about 19% over this period.

One may seek whether a similar pattern appears across skill-intensive and unskilled-labor-intensive firms. We define any firm above the median of the ratio of skilled workers to unskilled workers as skill-intensive. Table 8 presents the evolution of the share of skilled workers employment and relative wages in both types of firms. Figures suggest that skill upgrading has taken place mainly across skill-intensive firms. This raises the issue of a conditional technology adoption; the impact of the technological bias could depend on a relatively high initial level of capital intensity[21]. This converges with Pavnick (2003) that suggests that only certain Chilean plants initiated a technology adoption process consequently to the trade liberalization episode 1974–1979. These plants employed relatively more skilled workers before and after the technology adoption. In our case, we are not able, given the restricted period of observation to assess the skill intensity of these firms before the start of the Tunisian trade reforms in 1986 or at least before the strengthening of trade liberalization measures in 1998[22].

To understand the relationship between skilled labor demand and technology adoption, we report trends in sample means for the percentage of firms that use a given technology measure, and the corresponding average employment and wage bill share of such firms. These results are presented respectively in Table 9 and Table 10. Including all sectors, it appears that firms that report using any of the three measures of technology adopted in this paper (software, computer, R&D) have higher employment and wage bill shares for skilled workers relative to the overall sample. Skilled workers shares are particularly high for firms reporting use of software equipments. However, "the extent to which any of these three measures of technology can explain the rising trend in skilled labor demand at the firm level depends on the fraction of the overall sample accounted for by such plants, and the rate at

[21] To the extent that capital is complementary with skilled labor.

[22] Technological change is assumed to be driven by trade openness. This explains the choice of these dates.

which technology use expanded according to such measures"[23], as explained by Fuentes and Gilchrist (2005). Therefore, software use does not seem to be a sufficient justification for the increase in the relative demand for skilled labor noticed in the overall sample, as the share of firms using it is about 15%. Conversely the share of firms that use computer equipments increased by 29% over a period of 5 years attaining about 37% in 2002. In addition, the share of firms engaged in R&D is relatively important (41%) despite the fact that it did not visibly shift over the period. Thus, we might consider "computer usage" and "R&D activities" as two potential explanations for the skill upgrading in our overall sample. Regarding the manufacturing sample, a similar logic leads to favoring the "R&D activities" explanation.

## 5. The Empirical Strategy

Our empirical strategy involves two steps. The first step consists of exploring the impact of technology adoption on skilled workers' relative demand through the regression of a translog cost function. We also perform robustness checks related to endogeneity issues. The second step attempts to assess the role of trade liberalization on technology adoption. Before concluding, we address an appealing result relative to the impact of foreign participation in the capital of Tunisian firms on skill upgrading.

### *5.1 The relative demand for skilled workers*

#### *5.1.1 Cost function analysis*

To analyze the relationship between skill upgrading and technology adoption, we employ a standard approach based on the estimation of a translog cost function[24] introduced by Christensen et al (1973). The translog cost function has the advantage of flexibility of specification and is useful in studies of factor demand (Marcin, 1991). Indeed, it allows a derivation of input demand equations and the underlying technological structure of production without placing stringent restrictions on the elasticities of substitution (Grisley and Gitu, 1985). Furthermore, it allows for non-constant returns to scale and non neutral technological change (Sanders and Ter Weel, 2000). The estimates can be obtained from either the total or the variable cost function. In the present application of the translog function, we estimate a variable cost function set up by Brown and Christensen (1981). We assume that firms minimize the cost of skilled (*Q*) and unskilled (*NQ*) labor and that capital and technology are quasi-fixed factors (in the short run). This yields the following restricted variable cost function which has been largely used in the empirical literature (see, for example, Berman et al, 1994; Machin and Van Reenen, 1998, Pavcnik, 2003):

$$CV = f(\omega_Q, \omega_{NQ}, K, Tech, VA) \qquad (1)$$

Where C is total variable costs, $W_Q$ is the wage of skilled workers, $W_{NQ}$ is the wage of unskilled workers, K is the stock of quasi-fixed capital, Tech is a quasi-fixed technology term assumed to affect C and VA is value added.

In applications of total cost functions, the conventional assumption is that all inputs are in full static equilibrium. However, the variable cost function recognizes disequilibrium in that the quantity of physical capital and technology cannot be adjusted to achieve minimum total cost in the short run for the given set of input prices and the quantity of output (Grisley and Gitu, 1985). According to Norsworthy and Jang (1993), the conventional assumption of full equilibrium models such as the translog total cost function is not reasonable for industries characterized by rapid technological change. Furthermore, in our case the prices of capital

[23] Fuentes, O. M. and S. Gilchrist. 2005. "Skill-Biased Technology Adoption: Evidence for the Chilean Manufacturing Sector". Boston University Working Papers, WP2005-045. November, p7.

[24] The transcendental logarithmic function.

and technology inputs are not available which prevents the estimation of the total cost function.

The translog cost function for the two operating inputs and the two fixed factors is written as equation (2) below:

$$\begin{aligned}\ln CV &= \alpha_0 + \alpha_{VA}\ln VA + \alpha_Q \ln W_Q + \alpha_{NQ}\ln W_{NQ} + \alpha_k \ln K + \alpha_T Tech + \\ &\frac{1}{2}\delta_{VAVA}(\ln VA)^2 + \frac{1}{2}\delta_{QQ}(\ln W_Q)^2 + \delta_{QNQ}\ln W_Q \ln W_{NQ} + \frac{1}{2}\delta_{NQNQ}(\ln W_{NQ})^2 + \\ &\frac{1}{2}\delta_{KK}(\ln K)^2 + \rho_{VAQ}\ln VA \ln W_Q + \rho_{VANQ}\ln VA \ln W_{NQ} + \rho_{KQ}\ln K \ln W_Q + \\ &+ \rho_{KNQ}\ln K \ln W_{NQ} + \rho_{VAK}\ln VA \ln K + \lambda_{TVA} Tech \ln VA + \lambda_{TK} Tech \ln K + \\ &\frac{1}{2}\delta_{TT} Tech^2 + \lambda_{TQ} Tech \ln W_Q + \lambda_{TNQ} Tech \ln W_{NQ}\end{aligned} \quad (2)$$

The cost function must be homogeneous of degree one in input prices, implying that for a fixed level of output, variable cost must increase proportionally when all prices increase. This implies posing the following restrictions:

$$\alpha_Q + \alpha_{NQ} = 1$$
$$\delta_{QQ} + \delta_{QNQ} = 0$$
$$\delta_{NQNQ} + \delta_{QNQ} = 0$$
$$\rho_{VAQ} + \rho_{VANQ} = 0$$
$$\rho_{KQ} + \rho_{KNQ} = 0$$
$$\rho_{TQ} + \rho_{TNQ} = 0$$

Subsequently[25], we derive the variable cost function with respect to the logarithm of each labor input price. Then, we apply the Shephard's lemma which implies that $\frac{\partial \ln CV}{\partial \ln W_i} = S_i$, where $S_i$ is the share of labor type *i* in total labor costs. The wage of unskilled labor is used as numeraire and since cost shares sum to unity, only one linearly independent input share is estimated corresponding to skilled labor. This leads to the following variable cost share equation for skilled workers:

$$S_{it} = \left(\frac{WB_Q}{TWB}\right)_{it} = \alpha + \delta \ln \frac{W_{Q_i}}{W_{NQ_i}} + \rho \ln K_{it} + \beta \ln VA_{it} + \lambda Tech_{it} + \phi year + \mu_{it} \quad (3)$$

where $S_{it}$ is the share of skilled labor in the total wage bill of a firm i at time t. It is computed as the ratio of skilled workers wage bill *($WB_Q$)* to the total wage bill *(TWB)*. $W_Q$ and $W_{NQ}$ are average individual wages for skilled worker and unskilled worker respectively. The corresponding relative wage ratio is, however, time invariant in our case[26]. K is capital and VA is value added. Tech is a vector of observable technology measures that are computer equipment purchases relative to total purchases, the R&D share in total purchases and software acquisitions value relative to the value added. We also, computed a technological

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[25] In addition, symmetry restrictions are applied implying that $\delta_{NQQ} = \delta_{QNQ}; \lambda_{TK} = \lambda_{KT}$

[26] These individual wages are indeed computed using the decomposition technique of Maurin and Parent (1993) which does not allow for time variability (see page 42 for more details).

index as a simple mean of the three previous proxies. The coefficient $\rho$ measures the extent to which capital and skilled labor are complements. The log of output controls for business cycle fluctuations in the relative demand of skilled workers that may occur if firms are more likely to layoff unskilled workers than skilled workers during a temporary downturn, (Fuentes and Gilchrist, 2005). The coefficient $\delta$ will be positive or negative according to whether the elasticity of substitution between skilled and unskilled workers is below or above one. If technological change is skill upgrading, $\lambda$ should be positive. Finally, $\mu$ is an unobserved component.

*5.1.2 Regression results*

Estimation results are reported in Table 11. All standard errors are adjusted for heteroskedasticity using Huber–White correction. In the first column, the three technology adoption proxies are introduced. In columns (2) and (3), we introduce respectively the percentage of foreign and private participation in the capital. Time and individual fixed effects are introduced in all these columns. All these columns suggest that capital might be complementary to skilled labor since the coefficient on capital value added ratio is positive and significantly different from zero. The coefficient on the value added variable is negative and statistically significant. Hence, firms are more likely to layoff unskilled workers than skilled workers during a temporary economic recession.

Coefficients on computer equipment purchases and R&D expenditures are positive and significant respectively at the 10% and the 1% levels. Hence, it particularly seems that R&D and computers act to increase the relative demand for skilled labor. However the coefficient on software is not significant in these columns. This result is expected given the low rate of the firms using software in the sample. The technological index which is the simple mean of the three technology adoption proxies used here is highly significant. In columns 5-8, we regress equation (2) introducing sector dummies. Results are quasi-similar in terms of significance.

Note that up to now, we have not introduced the relative wage rate variable. The relative wage rate at the firm level is likely to be endogenous. Indeed, most of the variation in relative wages across firms is related to the different skill mixes of workers. Berman et al (1994), Görg and Ströbl (2001) and Pavcnik (2003), do not introduce the relative wage rate. Instead, they incorporate time dummies that account for these endogenous movements in wages. These time effects capture also other determinants of skilled workers relative demand that could not be introduced directly because of the data lacks such macroeconomic changes and labor supply changes. We start in this section by incorporating in column (6) the relative wage rate variable. We present corresponding results as suggestive only since we attempt to control for the endogeneity problem below. The coefficient on relative wages appears to be positive and statistically significant indicating that the elasticity of substitution between skilled and unskilled workers is below one. Furthermore, coefficients on computer equipment purchases and R&D expenditures are also positive and statistically significant.

The relative demand for skilled workers is likely to be higher in firms that account for higher private participation in capital. This result is expected, as private Tunisian firms have been subject over the period 1996–2006 to an “upgrading program” that provided support to almost 2000 private companies, (Bougault and Filipiak, 2005). This program aimed to support modernizing investments, new technologies and know-how adoption, firm competitiveness enhancement and human resources skills improvement[27].

[27] We also explore the impact of technology adoption on the relative demand of skilled workers in the manufacturing sectors. Results, which converge with those previously presented for the overall sample, are displayed in the appendix.

Overall, our empirical results show that computer acquisitions and R&D activities raise the relative demand for skilled labor. However, one question of central interest for this paper is the contribution of trade openness to the increase of skilled workers' relative demand. One might expect two effects of trade openness on skill upgrading. The first effect is designed by Thoenig and Verdier (2003) as the "price-effect" embodied in the Stolper-Samuelson theorem. Indeed, the Stolper-Samuelson logic is that trade affects relative factor rewards by changing relative prices. If trade liberalization implies an increase in relative price of skilled labor-intensive goods, this produces employment shifts towards skill-intensive industries causing an increase in the relative demand for skilled workers. The second effect is the "non-price effect" of trade that may transit through technological change. Section 5.2 is devoted to the empirical assessment of this trade-induced technological progress. However, in the current section, we attempt to examine whether trade openness may also have exerted a "direct" effect or a "price effect". Hence, we incorporate trade openness measures in equation (3) as the ratios of custom duties to imports, total exports to value added and total imports to value added. Results reported in appendix show that the "price effect" of trade is statistically insignificant but confirm the robustness of previous results[28].

#### *5.1.3 Robustness checks*

*The relative wage rate*

We tackle the problem related to the endogeneity of the relative wage rate using two approaches. First, we estimate an employment share equation in addition to the wage share equation previously regressed. From a theoretical point of view, this equation does not incorporate by definition the relative wage rate (Anderton and Brenton, 1998). Hence, we may provide interesting empirical insights if we compare corresponding results with those of Table 11 that deliberately do not include this endogenous variable. Table 12 presents regression results where the dependent variable is the share of skilled labor in total employment. Results are likely to be robust to this change in specification. Yet, the coefficient on software seems positive and statistically significant.

The second approach consists of estimating equation (3) without excluding the relative wage rate. However, we attempt to alleviate the endogeneity problem. A classic technique would be to instrument the relative wage rate variable using the two-stage least squares within estimator. Nevertheless, the variable of concern is time invariant as we noted previously. The within estimator may not estimate such variables that are eliminated by data transformation. The Hausman and Taylor (1981) estimator overcomes this problem using a method that allows to estimate time-invariant variables. Furthermore, it presents the strong advantage of not using external instruments. Indeed, they can be derived within the model (Verbeek, 2008). We divide explanatory variables into three categories: the capital stock and the value added are considered as time varying uncorrelated with individual effects included in the error term. The technology adoption proxies are time varying correlated with individual effects. Finally, the relative wage rate is the endogenous time-invariant variable. The Hausman and Taylor approach consists of using the exogenous explanatory variables as instruments for the endogenous variables. Indeed, the endogenous time invariant regressors are instrumented by the individual average of time varying exogenous regressors. The endogenous time varying regressors are however instrumented by the deviation from individual means. Results presented in Table 13 are in line with those previously determined. Whether we use the technology index or the different technology adoption variables, we find a positive and strongly significant evidence for the impact of technological changes on the

[28] This statistical insignificance is probably due to the quality of the "price effect" measures. We should rely instead on relative industry prices.

relative demand of skilled workers[29]. However, the relative wage rate is statistically insignificant.

*The measurement error*

The random coefficient regression model of Swamy used to decompose the total wage bill by skill may introduce measurement error in the firm level wage bill of skilled and unskilled labor. If this measurement error is correlated with the error of estimating equation (2), there is a risk that estimated parameters are biased. This concern might be attenuated by differencing the variables. We rely here respectively on one-year, two-year and three-year differences as Pavnick (2003). Results are reported in Table 14. They confirm that the coefficients on computer equipment purchases and R&D expenditures are positive and statistically different from zero. Moreover, as in the firm fixed effects estimations, the additional capital stock is associated with skill upgrading.

### *5.2 Trade liberalization and technology transfer*

Hoekman and Javorcik (2006) list numerous channels through which international technology diffusion may occur. We focus here on the technology transfer that takes place across developed high-income countries and developing ones. As the North is more advanced in undertaking R&D activities and innovations, it is generally considered as a supplier of new productive knowledge. The first channel is trade in goods, services and knowledge. Indeed, superior technology may be embodied in goods and transmitted through imports of new varieties of differentiated products or capital goods and equipments that become more productive than those currently employed and above all more accessible in terms of cost to developing countries[30]. Export activity also offers interesting learning opportunities. Hoekman and Javorcik (2006) mention for example the technology diffusion through exporting to knowledgeable buyers who participate in product designs and intervene in production decisions.

However, this point of view should be qualified. In fact, some conditions intervene in the ability of an open developing economy to attract foreign technology. We may cite the absorptive capacity based on human capital endowments, the technological distance of a country from the global frontier and the existence of local R&D programs.

The second trade-related channel is foreign direct investment. Saggi (2006) points out the technological spillovers that may arise from the exposure of local firms to multinationals by reducing the cost of technology adoption and increasing the incentive to imitate. However, multinationals may undertake strategies that aim to limit these effects when there is a risk of competitors' strengthening. Furthermore, as developed above, technology transfer through FDI depends largely on parent firms' motivations.

This paper assumes that trade liberalization exerts a positive "non-price effect" on the Tunisian technology adoption process. In order to assess this hypothesis, we regress the following equation where Tech is technology adoption measure; Openness is the ratio of customs duties to total imports (lagged to account for inertia effects), Foreigncap is the share of foreign participation in capital. As we noted above, more relevant technology proxies are cited by the literature as well as other trade-related technology transfer channels. It would have been interesting for instance to use royalty payments for patents, copyrights or trademarks and the share of imported equipments in total machinery purchases. Such information is not provided by our database. We also incorporate Intinvest that represents

29 The Hansen test does not reject the validity of the instruments used.

30 It may also be transferred through direct technology purchases or licensing.

total firm intangible investments. This variable is supposed to capture the firm absorptive capacity[31]. Time (Year) and sector (Ind) dummies are also introduced.

$$Tech_{it} = \lambda_1 + \lambda_2 \ln Openness_{it-1} + \lambda_3 Foreigncap_{it} + \lambda_4 \ln Intinvest_{it} + \lambda_5 Year + \lambda_6 Ind + \xi_{it}$$

Results are reported in Table 15. The coefficient on custom duties is negative as expected and statistically significant when the technological index is the dependent variable. More trade protection is likely to involve a reduced incentive to adopt new technologies, particularly through R&D expenditures and computer acquisitions (columns 1-2). Foreign participation in capital is either negative (column 1) or insignificant which suggests the absence of technological transfer via FDI.

*The endogeneity bias*

Hence, the technology variable presents a potential endogeneity risk. As we explained in the introduction, two types of bias could occur: first, the omission in the regression of variables that may drive technology adoption as well as skill upgrading. Bresnahan (1999) for the United States, emphasize for example the role of organizational change. However, regarding Tunisia, we are more inclined to favor the trade liberalization hypothesis. The second source of endogeneity may stem from the reverse causality between technology adoption and the share of skilled workers in total labor. Therefore, using a two-stage least square estimator, we instrument the technological index with trade openness indicator, the foreign equity participation and firm size dummies. We incorporate the ratio of customs duties to imports which is our favorite trade protection measure. These instruments are provided by a wide literature on innovation determinants (for a review, see for example Pamukçu and Cincera (2001)). Results are reported in Table 16. Coefficients on technological index as well as capital ratio are statistically significant. Besides, the reported Hausman test corroborates the technological index's endogeneity as the p-value rejects the exogeneity hypothesis at 5% level. To test for the relevance of our instruments, we apply the Sargan test of over-identifying restrictions which confirms the null hypothesis of instruments validity[32].

### *5.3 Is foreign participation in the capital of Tunisian firms skill-upgrading?*

The coefficient of foreign participation in capital appears to be negative and statistically significant in the majority of the specifications presented. Hence, firms that account for higher foreign participation exhibit a reduced relative demand for skilled workers. This result is at first glance unpredicted. Actually, foreign ownership may be a proxy for FDI. Regarding this concern, the literature provides mixed results. Feenstra and Hanson (1997) and Harrison and Hanson (1999) show that FDI contribute to increase wage inequality in Mexico through skill upgrading. Two channels may constitute a conduit to such a result: the implementation of advanced technologies and the technology spillover effects generated in the host country's local firms. However, Tomohara and Yokota (2007) find that Taiwanese and Japanese direct investments in Thailand increase the relative demand for unskilled workers. These studies highlight the importance of distinguishing the FDI motivations when assessing their impacts. Vertical FDI seek cost advantages while horizontal FDI are driven by market access considerations. Similarly, Dunning (1993) emphasizes four types of investments affecting differently the relative demand for skilled workers. First, natural resources-seeking investments are generally skill-intensive to operate the complex extraction methods. Second,

[31] We tried to introduce other control variables as the share of education expenditures in GDP, and the share of households with access to energy at the national level. Yet, neither is statistically significant.

[32] We have also controlled for the endogeneity of the technology variable when regressing the Hausman-Taylor estimator in section 4.2.1

market seeking investments (horizontal new multinational enterprises (MNEs)) may allocate training efforts to specific technological or marketing purposes. Third, efficiency-seeking investors (vertical MNEs) are interested in low wages, and hence provide only elementary skills training in a few weeks. Finally, strategic asset-seeking investments are perceived to be more beneficial to human capital development as they are usually based on the availability of local capabilities such as skills, technology and R&D centers.

For the Tunisian case, Meddeb (2000) points out that textiles, clothing and leather Tunisian industries, where 80% of employees are low-skilled women, account for about 68% of foreign firms investing in Tunisia. Moreover, he reports that these (mainly European) firms are seeking—through their delocalization movements—labor cost reduction. In this line, Tunisian Trade Union delegates consider that these firms do not pay higher wages than national firms. Table E (see Appendix) displays the share of firms involving foreign participation in capital, by sector, within our sample. The predominance of foreign investments in the unskilled-labor intensive textile sector (an average of 59% over the observation period) confirms Meddeb (2000) conclusions and suggests a concentration of unskilled-labor biased vertical investments in Tunisia.

These findings are not exclusive to developing host countries. In fact, Blonigen and Slaughter (2001) come across a similar effect for Japanese investments in USA: "greater Japanese affiliate presence is significantly correlated with lower, not higher, relative demand for skilled workers"[33]. According to the authors, this result points out that foreign affiliates focus in activities that are less skill-intensive than the activities of parents. Explanations in this case are suggested by MNEs models that address the influence of multi-nationalization on relative factor-returns. Markusen and Venables (1997) for instance use a two-country, two-factor model. They consider a competitive sector producing with constant returns to scale and an imperfectly-competitive sector with increasing-returns. The former is composed of three distinct activities. First, firm-level skill-intensive activities as R&D. Second, plant-level activities using a mix of skilled and unskilled labor. Third, unskilled-labor intensive final production activities. A firm affiliated to this sector may serve the other country by exports or by building a branch plant. National firms are less skilled-labor intensive than multinationals because they do not require skilled labor to support affiliate production. The model suggests that the fall in trade costs creates a home market advantage for national firms in the large skill-scarce country[34] which displaces branch plants of MNEs headquartered in the small country and depresses the relative demand for skilled labor.

## 6. Conclusion

This paper attempts to explore whether technology adoption is a channel through which openness may indirectly affect the relative demand for skilled workers in Tunisia using a firm level database covering 635 firms from manufacturing and non-manufacturing sectors over the period 1998–2002. Our empirical results confirm that technological change is skill upgrading, which may contribute to increase wage inequality between skilled and unskilled workers in Tunisia, during that period. Two particular technology proxies are likely to play a role: R&D expenditures and computer equipments acquisitions. Our findings also confirm that capital is complementary to skilled labor and corroborate the hypothesis of a trade-induced technological change. However, we should note that the relationship between trade and technology in developing countries deserves deeper interest. Further empirical researches

[33] Blonigen, B. and M. Slaughter. 2001. "Foreign-Affiliate Activity and U.S Skill Upgrading". *The Review of Economics and Statistics* Vol. 83, N. 2, pp. 362–376, May, p. 364.

[34] If one country has a very large internal market, a national firm located in that market benefits from high sales and incurs transport costs on only a small volume of sales to the small country and the multinational is disadvantaged by having to maintain a costly plant in the small market.

on the transmission channels allowing for new technologies transfer are needed. Finally, this study suggests an unexpected bias of foreign participation in capital towards unskilled labor confirming the importance of considering FDI motivations while addressing the role of foreign inflows in skill enhancing.

Many studies are inclined to conclude that, on the basis of translog cost function estimation, the existence of skill biased technological change. However, given the definition provided by Haskel and Slaughter (1998)[35], the common empirical test used allows to partially assert the skill biased technological change mechanism, because it does not include the wage inequality measure as a dependent variable. This constitutes an appealing empirical issue, given the implications of skill biased technological change (SBTC).

Indeed, in addition to rising wage disparities between skilled and unskilled workers, the skill biased technological change has another important implication regarding the country's education policy as well as parents' education decisions identified by Eggebrecht (2009)[36]. First, the increase in the skilled workers relative wage in current and subsequent periods implied by SBTC raises relative education cost for unskilled parents in current and future periods, which may negatively impact their education decisions. Yet, the increase in wage gaps boosts the incentive to invest in education, in current and future periods. The net effect depends on the country's factor endowment. According to the author, the low proportion of skilled adults in Tunisia would imply that the negative cost effect dominates the positive incentive effect. This may consequently harm the human capital accumulation in both the short and the long run. Nevertheless, the low education cost in Tunisia and the increase by about 9% per year in the next decade of the supply of highly educated workers (World Bank, 2004) cast doubt on this view. Taking into account the specificities[37] of the Tunisian case may moderate these results.

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[35] Haskel and Slaughter (1998) define it as any technological progress that raises relative demand of skilled workers within sectors, at given relative factor prices

[36] The author uses an overlapping-generations model where parents invest in the education of their children. Capital market is assumed to be imperfect. He considers two types of adults: the skilled ones who were educated in previous period, and the unskilled ones who were not.

37 However, the growing unemployment of university graduates after 2000 may eventually reduce the parent's incentive to invest in education.

## References


Acemoglu, D. 2003. "Patterns of Skill Premia". *Review of Economic Studies* Vol. 70, pp. 199–230.

Anderton, R. and P. Brenton. 1998. "Outsourcing and Low-Skilled Workers in the UK?". *CSGR Working Paper* N. 12/98. July. Available at: *http://www2.warwick.ac.uk/fac/soc/csgr/research/workingpapers/1998/wp1298.pdf*

Aubert, J.E. 2005. "Promoting Innovation in Developing Countries: A Conceptual Framework". Policy Research Working Paper N. WPS3554. April. The World Bank Institute.

Attanasio, O., Goldberg, P.K. and N. Pavcnik. 2004. "Trade Reforms and Wage Inequality in Colombia". *Journal of Development Economics* Vol. 74, pp. 331–366.

Bas, M. 2008. "Trade, Technology Adoption and Wage Inequalities: Theory and Evidence". Paris School of Economics Working Paper N. 06-2008.

Berman, E., Bound, J. and Z. Griliches. 1994. "Changes in the Demand for Skilled Labor within U.S. Manufacturing: Evidence from the Annual Survey of Manufacturers". *The Quarterly Journal of Economics* Vol. 109, N. 2, pp. 367–397.

Beyer, H., Rojas, P., R. Vergara. 1999. "Trade liberalization and Wage Inequality". *Journal of Development Economics*. Vol. 59, pp. 103–123.

Boudhiaf, M. 2001. "La Politique Tunisienne D'ouverture Commerciale" (Tunisia's Policy of Trade Openness). In *Ouverture et Développement économique,* Siroën. J-M and Boudhiaf. M. (eds.). *Economica*. Paris.

Bougault, H. and E. Filipiak. 2005. "Les programmes de mise à niveau des entreprises, Tunisie, Maroc, Sénégal" (Development programs at the enterprise level, Tunisia, Morocco, Senegal). *Notes et Documents* N. 12. Agence Française pour le développement.

Bigsten, A. and D. Durevall. 2006. "Openness and Wage Inequality in Kenya, 1964 – 2000". *World Development* Vol. 34, N. 3, pp. 465–480, March.

Blonigen, B. and M. Slaughter. 2001. "Foreign-Affiliate Activity and U.S Skill Upgrading". *The Review of Economics and Statistics* Vol. 83, N. 2, pp. 362–376, May.

Bresnahan, T.F. 1999. "Computerization and Wage Dispersion: An Analytical Reinterpretation". *The Economic Journal* Vol. 109, N. 456, pp. 390–415.

Brown, R. S. and L. R. Christensen. 1981. "Estimating Elasticities of Substitution in a Model of Partial Static Equilibrium: An Application to U.S. Agriculture, 1947 to 1974". In *Modelling and Measuring Natural Resource Substitution*. eds. E. R. Berndt and B. C. Field. Cambridge, Massachusetts: The MIT Press.

Christensen, L. R., D.W., Jorgenson and L. R. Lau. 1973. "Transcendental Logarithmic Production Frontiers". *Review of Economics and Statistics* Vol. 55, pp. 28–45.

Cragg, I. M. and M. Epelbaum. 1996. "Why Has Wage Dispersion Grown in Mexico? Is It the Incidence of Reforms or the Growing Demand for Skills?" *Journal of Development Economics* Vol. 51, pp. 99–116.

Dennis, A. H. 2006. "Trade Liberalization, Factor Market Flexibility and Growth: The Case of Morocco and Tunisia". World Bank Policy Research Working Paper 3857.

Dunning, J. 1993. "Multinational Enterprise and the Global Economy". Wokingham: Addison-Wesley Publishing Company p. 920.

Edwards, L. 2004. "A Firm Level Analysis of Trade, Technology and Employment in South Africa". *Journal of International Development* Vol. 16, pp. 45–61.

Eggebrecht, T. 2009. "How Does Skill-Biased Technological Change Affect Human Capital Accumulation Path?" Mimeo. Department of Economics, University of Konstanz, Germany. Available at: *http://cms.uni-konstanz.de/wiwi/kaas/Downloads/DynmacWorkshop/Paper/Eggebrecht.pdf*

Ekholm, K. and K. H. Midelfart. 2005. "Relative Wages and Trade-Induced Changes in Technology". *European Economic Review*, *Elsevier* Vol. 49, N. 6, pp. 1637–1663. August.

Feenstra, R. C. and G. H. Hanson. 1997. "Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras". *Journal of International Economics* Vol. 42, pp. 371–393.

Feliciano, Z. M. 2001. "Workers and Trade Liberalization: The Impact of Trade Reforms in Mexico on Wages and Employment". *Industrial and Labor Relations Review* Vol. 55, N. 1, pp. 95–115.

Fuentes, O. M. and S. Gilchrist. 2005. "Skill-Biased Technology Adoption: Evidence for the Chilean Manufacturing Sector". *Boston University Working Papers, WP2005-045*. November. Available at: *http://people.bu.edu/sgilchri/research/skillbias_1105.pdf*

Gallego, F. A. 2006. "Skill Premium in Chile: Studying the Skill Bias Technical Change Hypothesis in the South". Working Papers Central Bank of Chile 363. Central Bank of Chile. Available at: *http://www.bcentral.cl/estudios/documentos-trabajo/pdf/dtbc363.pdf*

Ghazali, M. 2009. "Trade Openness and Wage Inequality between Skilled and Unskilled Workers in Tunisia". *Economie Internationale* N. 117/1, pp. 63–97.

Goldberg, P. K. and Pavcnik, N., 2004. "Trade, Inequality and Poverty: What Do We Know?" NBER Working Papers N. 10593, June.

Görg, H., E. Ströbl. 2001. "Relative Wages, Openness and Skill-Biased Technological Change in Ghana". Credit Research Paper N. 01/18. UK: University of Nottingham. Available at: *http://ftp.iza.org/dp596.pdf*

Grisley. W. and K.W. Gitu. 1985. "A Translog Cost Analysis of Turkey Production in the Mid-Atlantic Region". *Southern Journal of Agricultural Economics* N. 64, pp. 387–409.

Hanson, G. and A. Harrison. 1995. "Trade, Technology and wage Inequality". NBER Working Paper N. 5110.

Harrison, A. and G. Hanson. 1999. "Trade Liberalization and Wage Inequality in Mexico". *Industrial and Labor Relations Review* Vol. 52, N. 2, pp. 271–288.

Harrison, Ann., (Ed). 2006. "*Globalization and Poverty*". The University of Chicago Press, p. 536.

Haskel, J. E. and M. J. Slaughter. 1998. "Does the Sector Bias of Skill-Biased Technical Change Explain Changing Wage Inequality?" NBER Working Paper N. 6565.

Hausman, J.A. and W.E. Taylor. 1981. "Panel Data and Unobservable Individual Effects". *Econometrica* Vol. 49, pp. 1377–1398.

Hoekman, B. M. and B. K. Javorcik. (Ed). 2006. "*Global Integration and Technology Transfer*". A Co-publication of Palgrave MacMillan and the World Bank, p. 346.

Lawrence, R. Z. 2000. "Does a Kick in the Pants Get You Going or Does it Just Hurt? The Impact of International Competition on Technological Change in U.S. Manufacturing". In "*The impact of international trade on wages*", ed. R.C Feenstra. The University of Chicago Press, pp. 197–224.

Machin, S. and Van Reenen, J. 1998. "Technology and Changes in Skill Structure: Evidence from Seven OECD Countries". *Quarterly Journal of Economics* Vol. 113, pp. 1215–1244.

Mairesse, J. and B. Hall. 1996. "Estimating the Productivity of R&D: An Exploration of GMM Methods Using Data on French and US Manufacturing Firms". NBER Working Papers N. 5501.

Marcin, T.C. 1991. "Cost Function Approach for Estimating Derived Demand for Composite Wood Products". Proceedings of the 1991 symposium on systems analysis in forest resources, March 3–6. Charleston, SC. Asheville, NC, pp. 225–240.

Marjit, S. and R. Acharyya. 2003. "*International Trade, Wage Inequality and the Developing Economy: A General Equilibrium Approach*". New York: Physica-Verlag. Heidelberg. p. 176.

Markusen, J. and A. Venables. 1997. "The Role of Multinational Firms in the Wage-Gap Debate". *Review of International Economics* Vol. 5, N. 4, pp. 435–451

Maurin, E. and M. C. Parent. 1993. "Productivité et coût du travail par qualifications" (Productivity and labor costs by skill). In "*Actes de la 18ème journée des centrales de bilans sur le thème : Croissance, emploi, productivité* ". Paris : Association Française des Centrales de Bilans AFCB. 23 novembre. pp. 73–78.

Mazumdar, J. and M. Quispe-Agnoli. 2002. "Trade and the Skill Premium in Developing Countries: The Role of Intermediate Goods and Some Evidence from Peru". *Federal Reserve Bank of Atlanta working paper* 2002–11. July. Available at: *http://www.frbatlanta.org/filelegacydocs/wp0211.pdf*

Meddeb, R. 2000. "Les entreprises multinationales dans l'industrie du textile- habillement en Tunisie : l'impact économique et social". (Multinational enterprises in the textile and clothing industry in Tunisia: the economic and social impact) *Programme des Entreprises Multinationales- Document de Travail* N. 82. Genève : BIT.

Norsworthy. J.R. and S.L. Jang. 1993. "Cost Function Estimation of Quality Change in Semiconductors". In "*Price Measurements and their Uses*", eds. M.Foss M.Manser & H.Tice. pp. 125–155. Studies in Income and Wealth, National Bureau of Economic Research, University of Chicago Press.

Pamukçu, T. and M. Cincera. 2001. "Analyse des déterminants de l'innovation technologique dans un nouveau pays industrialisé : une étude économétrique sur données d'entreprises dans le secteur manufacturier turc". (Analysis of the determinants of technological innovation in a newly industrialized country: an econometric study based on business data in the Turkish manufacturing sector). *Economie & Prevision* Vol. 150, N. 2001/4–5, pp. 139–158.

Pavcnik, N. 2003. "What Explains Skill Upgrading in Less Developed Countries". *Journal of Development Economics* Vol. 71, pp. 311–328.

Pissarides, C. A. 1997. "Learning by Trading and the Returns to Human Capital in Developing Countries". *World Bank Economic Review* Vol. 11, pp. 17–32.

Robertson, R. 2004. "Relative Prices and Wage Inequality: Evidence from Mexico". *Journal of International Economics*. N. 64, pp. 387–409.

Saggi, K. 2006. "Foreign Direct Investment, Linkages and Technology Spillovers". In "*Global Integration and Technology Transfer*", eds. Hoekman, B. M. and Javorcik B. K. pp. 51–66. A co-publication of Palgrave MacMillan and the World Bank.

Sanders, M. and Bas Ter Weel. 2000. "Skill Biased Technological Change: Theoretical Concepts, Empirical Problems and a Survey of the Evidence". DRUID Working Paper No 00-8. Avaialble at: *http://www.merit.unu.edu/publications/rmpdf/2000/rm2000-012.pdf*

Thoenig, M. and T. Verdier. 2003. "A Theory of Defensive Skill-Biased Innovation and Globalization". *The American Economic Review* Vol. 93, N. 3, pp. 709–728.

Tomohara, J., K. Yokota. 2007. "Foreign Direct Investment and Wage Inequality: Is Skill Upgrading the Culprit?" Working Paper Series Vol. 2007-14. The International Centre of East Asian Development, May. Available at: *http://www.icsead.or.jp/7publication/workingpp/wp2007/2007-14.pdf*

Verbeek. M. 2008. *A Guide to Modern Econometrics*. John Wiley & Sons, third edition, p. 488 England.

Wood, A. 1994. "*North-South Trade, Employment and Inequality, Changing Fortunes in a Skill-Driven World*". Oxford: Clarendon Press.

World Bank. 2004. "Tunisia-Employment Strategy". Report N. 25456 MNSHD: Washington D.C.

**Table 1: The Effective Rate of Protection (ERP) in Percentage for Tunisian Manufacturing and Non Manufacturing Industries, 1980 – 2002**

| Year | Agro-Food | Pottery, Glass and Non-Metallic Mineral | Mechanical, Electrical and Electronic | Chemical Industry | Textile, Wearing Apparel, Leather and Footwear | Other Manufacturing Industries | Total Manufacturing Industries | Mining | Agriculture | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **1980** | 258 | 198 | 96 | 111 | 272 | 224 | 242 | 10 | 27 | 70 |
| **1983** | 191 | 185 | 67 | 161 | 175 | 190 | 178 | 24 | 33 | 67 |
| **1984** | 404 | NA | 92 | 92 | 98 | NA | 153 | 23 | 46 | 74 |
| **1985** | 553 | NA | 104 | 100 | 203 | NA | 207 | 20 | 48 | 84 |
| **1986** | 421 | 40 | 88 | 88 | 194 | 101 | 124 | 9 | 46 | 70 |
| **1987** | 120 | 36 | 73 | 62 | 107 | 88 | 81 | 14 | 43 | 52 |
| **1988** | 134 | 66 | 63 | 62 | 82 | 74 | 78 | 16 | 25 | 42 |
| **1989** | 110 | 91 | 98 | 70 | 76 | 78 | 87 | 17 | 22 | 43 |
| **1990** | 100 | 82 | 101 | 78 | 73 | 80 | 84 | 18 | 24 | 44 |
| **1991** | 80 | 61 | 55 | 49 | 58 | 54 | NA | NA | NA | NA |
| **1992** | 90 | 65 | 59 | 50 | 65 | 65 | NA | NA | NA | NA |
| **1993** | 85 | 75 | 65 | 60 | 105 | 90 | NA | NA | NA | NA |
| **1994** | 71 | 85 | 64 | 65 | 126 | 102 | NA | NA | NA | NA |
| **1995** | 115 | 85 | 169 | 65 | 132 | 102 | 114 | 26 | 44 | 56 |
| **1997** | 59 | 154 | 144 | 102 | 106 | 82 | 98 | 15 | 169 | 73 |
| **1999** | 60 | 119 | 78 | 78 | 91 | 68 | 80 | 14 | 161 | 66 |
| **2000** | 65 | 85 | 88 | 60 | 79 | 56 | 72 | 13 | 164 | 64 |
| **2001** | 69 | 76 | 54 | 39 | 71 | 41 | 62 | 5 | 124 | 51 |
| **2002** | 70 | 70 | 53 | 45 | 59 | 41 | 58 | 4 | 120 | 49 |

**Sources:** Les Cahiers de L'Institut d'Economie quantitative (IEQ), n°6, Mars 1988.
Les Cahiers de L'Institut d'Economie quantitative (IEQ), n°16, Mars 2002.
Les Cahiers de L'Institut d'Economie quantitative (IEQ), n°17, Mars 2003.
NA: not available

**Table 2: The Evolution of Free Tariff Headings, 1987–1990**

| Year | Total Tariff Headings | Free Tariff Headings | Share of Free Tariff Headings (%) |
|---|---|---|---|
| 1987 | 8376 | 1678 | 20,0 |
| 1988 | 8376 | 2328 | 27,8 |
| 1989 | 8376 | 3629 | 43,3 |
| 1990 | 8376 | 4331 | 51,7 |

Note: The tariff nomenclature includes the description of goods and the corresponding code is called the "heading". Goods are classified within three categories: monopolized goods, Restricted not monopolized goods and relatively free goods. The share of this last category is reported above.
Source: Les Cahiers de L'Institut d'Economie quantitative (IEQ) n°9, Décembre 1991, p. 53.

**Table 3: Non Tariff Protection in Tunisia: the Share of Total Tariff Headings Facing Technical Checks*, 1994-2001 (in percentage)**

| Products | Total Technical Checks | | Systematic Checks | | Certification | | Schedule of Conditions | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **1994** | **2001** | **1994** | **2001** | **1994** | **2001** | **1994** | **2001** |
| **Human food** | 9,7 | 9,7 | 8,2 | 8,2 | _ | _ | 1,5 | 1,5 |
| **Energy** | 0,4 | 0,4 | _ | _ | _ | _ | 0,4 | 0,4 |
| **Mineral substances** | 2,6 | 2,6 | 2,4 | 2,4 | _ | _ | 0,2 | 0,2 |
| **Vegetal substances** | 0 | 0 | _ | _ | _ | _ | _ | _ |
| **Semi-processed goods** | 3,9 | 4 | 0,7 | 0,8 | 2,8 | 2,8 | 0,4 | 0,4 |
| **Agricultural equipments** | 0,4 | 0,4 | 0,2 | 0,2 | _ | _ | 0,2 | 0,2 |
| **Industrial equipments** | 2,1 | 2,3 | 0,7 | 0,9 | 0,9 | 0,9 | 0,5 | 0,5 |
| **Final consumption goods** | 6,8 | 11,1 | 1,7 | 1,9 | 4,5 | 8,8 | 0,4 | 0,4 |
| **Total** | **25,9** | **30,5** | **14** | **14,5** | **8,1** | **12,5** | **3,5** | **3,5** |

Notes: * This table lists three types of technical checks imposed by customs services according to imports nature: 1-Systematic checks: applied before retailing on the domestic market. They imply technical checks on product samples. 2-Certification: conformity certification to technical legislation by customs services. 3-Schedule of conditions: it implies the respect of the clauses imposed in the schedule of conditions.
Source: « Profil Pays Tunisie 2005 », Institut de la Méditerranée Report, p41.

**Table 4: Variables Description**

| Variables | Number of Observations | Mean | Standard Deviation |
|---|---|---|---|
| **Skilled wage bill** | 2783 | 339156.6 | 1404258 |
| **Skilled labor** | 2783 | 18.46 | 52.32 |
| **Unskilled labor** | 2783 | 118.60 | 289.32 |
| **Capital Stock** | 2709 | 4888686 | 2.77e+07 |
| **Value added** | 2783 | 1445127 | 4161995 |
| **Intangible investment** | 2782 | 5258.04 | 58934.48 |
| **Tangible assets acquisitions** | 2783 | 550857.7 | 4811961 |
| **Computer equipment purchases** | 2783 | 5773.45 | 35121.45 |
| **Total purchases** | 2781 | 413198.9 | 4052981 |
| **Software assets value** | 2783 | 1734.929 | 13938.63 |
| **R&D expenditures** | 2783 | 11505.82 | 107549 |

**Table 5: Representativeness of the Manufacturing Industries Sample**

| Industry | Number of Firms by Industry in the Sample | Percentage of Sample Manufacturing Employment | Percentage of Manufacturing Employment | Percentage of Sample Manufacturing Value Added | Percentage of Sectoral Manufacturing Value Added |
|---|---|---|---|---|---|
| **Agro-food** | 70 | 9.7% | 11% | 21.58% | 23.74% |
| **Textile** | 158 | 52.37% | 50% | 25.48% | 30.1% |
| **Chemical industry** | 29 | 6% | 4.2% | 11.29% | 10% |
| **Mechanical, electrical and electronic** | 61 | 16.54% | 13.3% | 16.9% | 14.1% |
| **Pottery, glass and non-metallic mineral** | 30 | 7.87% | 10.1% | 16.6% | 9.7% |
| **Other manufacturing industries** | 42 | 7.3% | 11.2% | 9% | 12.3% |

Note: the percentage of sample employment is computed using sample data as the ratio on sector employment to total non-manufacturing employment relative to 1998. The percentage of non-manufacturing employment is computed using industrial benchmark data as the ratio on sector employment to total non-manufacturing employment corresponding to 1998. Similarly, the percentage of sample non-manufacturing value added is computed using sample data as the ratio on sector value-added to total non manufacturing value-added relative to 1998. The percentage of non-manufacturing value-added is computed using industrial benchmark data as the ratio on sector value-added to total manufacturing value-added corresponding to 1998.

**Table 6: Representativeness of the Non Manufacturing Sectors Sample**

| Industry | Number of Firms by Industry | Percentage of Sample Non Manufacturing Employment | Percentage of Sectoral Manufacturin g Employment | Percentage of Sample Manufacturing Value Added | Percentage of Sectoral Manufacturing Value Added |
|---|---|---|---|---|---|
| **Energy** | 8 | 5.2% | 0.7% | 9.4% | 10.44% |
| **Transport & Communication** | 26 | 11% | 11% | 22.63% | 20,8% |
| **Trade** | 107 | 20.8% | 14% | 29.8% | 21.68% |
| **Public construction** | 30 | 25.5% | 35% | 12% | 18.67% |
| **Tourism** | 30 | 8.29% | 10% | 4.3% | 12% |
| **Other services** | 44 | 29.4% | 29.1% | 21.5% | 24% |

Note: the percentage of sample employment is computed using sample data as the ratio of sector employment to total manufacturing employment relative to 1998. The percentage of manufacturing employment is computed using industrial benchmark data as the ratio of sector employment to total manufacturing employment corresponding to 1998. Similarly, the percentage of sample manufacturing value added is computed using sample data as the ratio of sector value-added to total manufacturing value-added relative to 1998. The percentage of manufacturing value-added is computed using industrial benchmark data as the ratio of sector value-added to total manufacturing value-added corresponding to 1998.

**Table 7: Skilled Labor Share in Employment and Wage Bill for Overall Sample**

| Year | Skilled Labor Share in Total Employment | Skilled Labor Share in Total Wage Bill |
|---|---|---|
| **1998** | 0.16 | 0.39 |
| **1999** | 0.16 | 0.39 |
| **2000** | 0.17 | 0.41 |
| **2001** | 0.19 | 0.42 |
| **2002** | 0.19 | 0.43 |

Source: Author's computations from the national annual survey report on firms (NASRF) carried out by the Tunisian National Institute of statistics (TNIS)

**Table 8: Skilled Labor Share of Employment and Wage Bill by Firms' Skill Intensity**

| Year | Unskilled-Intensive Firms | | Skilled-Intensive Firms | |
|---|---|---|---|---|
| | Skilled Labor Share in Total Employment | Skilled Labor Share in Total Wage Bill | Skilled Labor Share in Total Employment | Skilled Labor Share in Total Wage Bill |
| **1998** | 0.06 | 0.27 | 0.27 | 0.53 |
| **1999** | 0.06 | 0.27 | 0.30 | 0.54 |
| **2000** | 0.06 | 0.30 | 0.30 | 0.54 |
| **2001** | 0.06 | 0.29 | 0.33 | 0.57 |
| **2002** | 0.06 | 0.28 | 0.33 | 0.59 |

Source: Author's computations from the national annual survey report on firms (NASRF) carried out by the Tunisian National Institute of Statistics (TNIS). We define any firm above the median of the ratio of skilled workers to unskilled workers as skill-intensive. This ratio is computed as an average ratio for the observation period 1998-2002. However, in the appendix, we present this table on the basis of skilled/unskilled workers ratio relative to the year 1998.

**Table 9: Firm-Level Technology Adoption Variables for Overall Sample**

| Year | Share of Firms using Software | Skilled Workers Employment Share | Skilled Workers Wage Bill Share | Share of Firms Having R&D Activities | Skilled Workers Employment Share | Skilled Workers Wage Bill Share | Share of Firms Using Computer Equipments | Skilled Workers Employment Share | Skilled Workers Wage Bill Share |
|---|---|---|---|---|---|---|---|---|---|
| **1998** | 14.93% | 0.16 | 0.37 | 40.95% | 0.16 | 0.40 | 28.47% | 0.16 | 0.37 |
| **1999** | 14.57% | 0.18 | 0.40 | 41.53% | 0.17 | 0.39 | 28.98% | 0.19 | 0.41 |
| **2000** | 17.34% | 0.21 | 0.43 | 41.44% | 0.18 | 0.41 | 30.67% | 0.20 | 0.42 |
| **2001** | 15.35% | 0.20 | 0.41 | 40.66% | 0.18 | 0.41 | 30.41% | 0.20 | 0.42 |
| **2002** | 16.50% | 0.24 | 0.49 | 41.13% | 0.18 | 0.41 | 36.70% | 0.20 | 0.42 |

Source: Author's computations from the national annual survey report on firms (NASRF) carried out by the Tunisian National Institute of Statistics (TNIS)

**Table 10: Firm-Level Technology Adoption Variables for Manufacturing Sample**

| Year | Share of Firms Using Software | Skilled Workers Employmen t Share | Skilled Workers Wage Bill Share | Share of Firms Having R&D Activities | Skilled Workers Employmen t Share | Skilled Workers Wage Bill Share | Share of Firms Using Computer Equipments | Skilled Workers Employmen t Share | Skilled Workers Wage Bill Share |
|---|---|---|---|---|---|---|---|---|---|
| **1998** | 14.32% | 0.13 | 0.36 | 39.94 % | 0.14 | 0.39 | 26.99% | 0.12 | 0.33 |
| **1999** | 13.90% | 0.13 | 0.34 | 41.68% | 0.12 | 0.35 | 27.7 % | 0.14 | 0.37 |
| **2000** | 18.00% | 0.16 | 0.39 | 40.30% | 0.14 | 0.38 | 28.4% | 0.13 | 0.36 |
| **2001** | 15.20% | 0.16 | 0.37 | 43.00% | 0.15 | 0.39 | 30.00 % | 0.15 | 0.40 |
| **2002** | 13.70% | 0.16 | 0.43 | 42.6% | 0.15 | 0.39 | 32.39% | 0.14 | 0.37 |

Source: Author's computations from the national annual survey report on firms (NASRF) carried out by the Tunisian National Institute of Statistics (TNIS)

## Table 11: Cost Share Equation Estimates

| | Dependent Variable: The Share of Skill Workers in Total Wage Bill | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** |
| **Ln capital stock** | 0.077 | 0.079 | 0.078 | 0.077 | 0.065 | 0.046 | 0.064 | 0.059 |
| | (0.045)* | (0.044)* | (0.045)* | (0.045)* | (0.022)*** | (0.019)** | (0.022)*** | (0.022)*** |
| **Ln value added** | -0.069 | -0.068 | -0.069 | -0.087 | -0.087 | -0.091 | -0.076 | -0.073 |
| | (0.030) | (0.030)** | (0.030)** | (0.022)*** | (0.022)*** | (0.021)*** | (0.022)*** | (0.022)*** |
| **Ln relative wages** | | | | | | 0.431 | | |
| | | | | | | (0.019)*** | | |
| **Computer acquisitions /Total acquisitions** | 0.163 | 0.166 | 0.162 | | | 0.156 | 0.143 | 0.137 |
| | (0.092)* | (0.092)* | (0.092)* | | | (0.083)* | (0.082)* | (0.083)* |
| **R&D expenditures/Total acquisitions** | 0.007 | 0.007 | 0.007 | | | 0.006 | 0.006 | 0.006 |
| | (0.001)*** | (0.001)*** | (0.011)*** | | | (0.001)*** | (0.001)*** | (0.001)*** |
| **Software assets value /Value added** | 0.493 | 0.491 | 0.491 | | | 0.341 | 0.319 | 0.318 |
| | (0.330) | (0.332) | (0.331) | | | (0.224) | (0.262) | (0.261) |
| **Technological index** | | | | 0.007 | 0.006 | | | |
| | | | | (0.001)*** | (0.001)*** | | | |
| **%Private capital** | | 0.001 | | | | -0.001 | 0.001 | |
| | | (0.001) | | | | (0.001) | (0.001)** | |
| **%Foreign capital** | | | -0.002 | | | -0.004 | | -0.002 |
| | | | (0.001) | | | (0.001)** | | (0.001)*** |
| **Time effects** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Sector effects** | No | No | No | No | Yes | Yes | Yes | Yes |
| **Method** | OLS/FE | OLS/FE | OLS/FE | OLS/FE | OLS/RE | OLS/RE | OLS/RE | OLS/RE |
| **Observations** | 2592 | 2592 | 2592 | 2593 | 2593 | 2592 | 2592 | 2592 |
| **Firms** | 616 | 616 | 616 | 616 | 616 | 616 | 616 | 616 |
| **R-squared** | 0.77 | 0.77 | 0.77 | 0.77 | 0.10 | 0.40 | 0.10 | 0.10 |

Note: Standard errors between parentheses: * Significant at10%; ** significant at 5%; *** significant at 1%
The dependent variable is ($WB_Q$/WBT). The regressions include a constant term. Corresponding results are not reported for space reasons. Ln (relative wages) is a time invariant variable.

## Table 12: Labor Share Equation Estimates

| | Dependent Variable: The Share of Skill Workers in Total Employment | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **Ln capital stock** | 0.079<br>(0.027)*** | 0.063<br>(0.027)** | 0.075<br>(0.027)*** | 0.080<br>(0.064) | 0.082<br>(0.064) | 0.080<br>(0.064) |
| **Ln value added** | -0.162<br>(0.029)*** | -0.066<br>(0.017)*** | -0.139<br>(0.029)*** | -0.077<br>(0.043)* | -0.075<br>(0.427)* | -0.076<br>(0.042) |
| **Computer acquisitions /Total acquisitions** | | 0.246<br>(0.113)** | 0.258<br>(0.112)** | 0.248<br>(0.126)** | 0.251<br>(0.126)** | 0.247<br>(0.126)* |
| **R&D expenditures/Total acquisitions** | | 0.008<br>(0.001)*** | 0.008<br>(0.001)*** | 0.008<br>(0.001)*** | 0.008<br>(0.001)*** | 0.008<br>(0.001)*** |
| **Software assets value /Value added** | | 0.442<br>(0.246)* | 0.445<br>(0.256)* | 0.606<br>(0.338)* | 0.602<br>(0.340)* | 0.603<br>(0.339)* |
| **Technological index** | 0.008<br>(0.001)*** | | | | | |
| **%Private capital** | | | 0.002<br>(0.001)*** | | 0.002<br>(0.001)* | |
| **%Foreign capital** | | -0.005<br>(0.001)*** | | | | -0.002<br>(0.002) |
| **Time effects** | Yes | Yes | Yes | Yes | Yes | Yes |
| **Sector effects** | Yes | Yes | Yes | No | No | No |
| **Method** | OLS/RE | OLS/RE | OLS/RE | OLS/FE | OLS/FE | OLS/FE |
| **Observations** | 2651 | 2649 | 2649 | 2649 | 2649 | 2649 |
| **Firms** | 619 | 619 | 619 | 619 | 619 | 619 |
| **R-squared** | 0.26 | 0.29 | 0.27 | 0.72 | 0.72 | 0.72 |

Note: Standard errors between parentheses: * Significant at10%; ** significant at 5%; *** significant at 1%
The dependent variable is Ln ($L_Q$/L). The regressions include a constant term. Corresponding results are not reported for space reasons.

## Table 13: Hausman-Taylor Estimations

| | Dependent Variable: The Share of Skilled Workers in Total Wage Bill | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Ln capital stock** | 0.105<br>(0.033)*** | 0.047<br>(0.025)* | 0.042<br>(0.024)* |
| **Ln value added** | -0.08<br>(0.029)*** | -0.090<br>(0.025)*** | -0.09<br>(0.025)*** |
| **Technological index** | 0.006<br>(0.002)*** | 0.007<br>(0.002)*** | |
| **R&D expenditures/Total acquisitions** | | | 0.006<br>(0.002)*** |
| **Computer acquisitions /Total acquisitions** | | | 0.165<br>(0.075)** |
| **Software assets value /Value added** | | | 0.468<br>(0.410) |
| **Ln relative wages** | -0.534<br>(0.535) | 0.438<br>(0.307) | 0.322<br>(0.296) |
| **%Private capital** | -0.000<br>(0.001) | -0.001<br>(0.001) | -0.000<br>(0.001) |
| **%Foreign capital** | -0.002<br>(0.001) | -0.003<br>(0.001)*** | -0.003<br>(0.001)*** |
| **Time effects** | No | Yes | Yes |
| **Sector effects** | Yes | Yes | Yes |
| **Hansen test of over identifying restrictions** | 3.920<br>Chi-sq(5)<br>P-value = 0.5610 | 14.793<br>Chi-sq(9)<br>P-value = 0.10 | 13.934<br>Chi-sq(9)<br>P-value = 0.1247 |
| **Observations** | 2593 | 2593 | 2592 |
| **Firms** | 616 | 616 | 616 |

Note: Standard errors between parentheses: * Significant at10%; ** significant at 5%; *** significant at 1%
The dependent variable is ($WB_Q/TWB$). The regressions include a constant term. Corresponding results are not reported for space reasons. Ln (relative wages) is a time invariant variable.

## Table 14: Cost and Labor Share Equation Estimates in Differences

| | Dependent Variable: The Share of Skilled Workers in Total Wage Bill | | | The Share of Skilled Workers in Total Employment | | |
|---|---|---|---|---|---|---|
| | **One year change** | **Two years changes** | **Three years changes** | **One year change** | **Two years changes** | **Three years changes** |
| **Ln capital stock** | 0.069<br>(0.045) | 0.120<br>(0.055)** | 0.167<br>(0.065)** | 0.087<br>(0.062) | 0.151<br>(0.073)** | 0.207<br>(0.083)** |
| **Ln value added** | -0.066<br>(0.031)** | -0.064<br>(0.039)* | -0.131<br>(0.052)** | -0.023<br>(0.042) | -0.064<br>(0.051) | -0.208<br>(0.066)*** |
| **Computer acquisitions /Total acquisition** | 0.050<br>(0.077) | 0.235<br>(0.101)** | 0.230<br>(0.147)* | 0.147<br>(0.090)* | 0.300<br>(0.126)** | 0.386<br>(0.178)** |
| **Software assets value /Value added** | 0.712<br>(0.450)* | 0.502<br>(0.550) | -2.268<br>(1.991) | 0.971<br>(0.618) | 0.607<br>(0.731) | -2.920<br>(2.483) |
| **R&D expenditures/Total acquisitions** | 0.002<br>(0.003) | 0.008<br>(0.004)*** | 0.009<br>(0.003)** | 0.002<br>(0.003) | 0.010<br>(0.004)** | 0.009<br>(0.004)** |
| **Time dummies** | Yes | Yes | Yes | Yes | Yes | Yes |
| **Sector dummies** | Yes | Yes | Yes | Yes | Yes | Yes |
| **Method** | OLS/RE | OLS/RE | OLS/RE | OLS/RE | OLS/RE | OLS/RE |
| **Observations** | 2108 | 1568 | 1042 | 2175 | 1624 | 1080 |
| **Firms** | 611 | 596 | 577 | 615 | 606 | 594 |
| **$R^2$** | 0.05 | 0.07 | 0.09 | 0.06 | 0.08 | 0.11 |

Note: Standard errors between parentheses: * Significant at10%; ** significant at 5%; *** significant at 1%. The dependent variable is ($WB_Q$/TWB) in Columns from (1) to (3). The dependent variable is Ln ($L_Q$ /L) in columns from (4) to (6).

**Table 15: Regression and Technology Adoption Proxies on Trade Protection Measure**

| | Dependent Variable | | | |
|---|---|---|---|---|
| | **Computer acquisitions /Total acquisitions** | **R&D expenditures/Total acquisitions** | **Software assets value /Value added** | **Technological index** |
| **Ln openness (custom duties/Imports (-1)** | -0.053<br>(0.029)* | -0.108<br>(0.061)* | -0.0003<br>(0.0003) | -0.112<br>(0.062)* |
| **Foreign capital** | -0.0002<br>(0.0001)* | 0.010<br>(0.009) | -0.00002<br>(0.00001) | 0.01<br>(0.009) |
| **Intangible investments** | 0.039<br>(0.035) | -0.368<br>(0.260) | 0.544<br>(0.277)** | -0.316<br>(0.243) |
| **Time effects** | Yes | Yes | Yes | Yes |
| **sector effects** | Yes | Yes | Yes | Yes |
| **Constant** | 0.219<br>(0.044)*** | 1.151<br>(1.078) | 0.001<br>(0.0009) | -0.067<br>(0.300) |
| **Method** | OLS/RE | OLS/RE | OLS/RE | OLS/RE |
| **observations** | 1451 | 1449 | 1451 | 1451 |
| **Firms** | 390 | 390 | 390 | 390 |
| **$R^2$** | 0.01 | 0.01 | 0.54 | 0.01 |

Note: Standard errors between parentheses: * Significant at10%; ** significant at 5%; *** significant at 1%
The number of observations is automatically reduced because custom duties/imports measure is only available for firms belonging to the manufacturing industry.

## Table 16: Double Least Squares Estimations

| | Dependent Variable: The Share of Skilled Workers In Total Wage Bill | | |
|---|---|---|---|
| **Ln capital stock** | 0.195<br>(0.107)* | 0.279<br>(0.111)** | 0.270<br>(0.108)** |
| **Ln value added** | -0.128<br>(0.071)* | -0.076<br>(0.072) | -0.075<br>(0.070) |
| **Technological index** | 0.108<br>(0.031)*** | 0.145<br>(0.040)*** | 0.139<br>(0.038)*** |
| **Time effects** | Yes | Yes | Yes |
| **Fixed effects** | Yes | Yes | Yes |
| **Method** | 2SLS | 2SLS | 2SLS |
| **Sargan test of over identifying restrictions** | 4.425<br>Chi-sq(3)<br>P-value = 0.22 | 4.652<br>Chi-sq(3)<br>P-value = 0.199 | 0.777<br>Chi-sq(2)<br>P-value = 0.6780 |
| **Hausman test of endogeneity** | chi2(7) = 12.24<br>Prob > chi2= 0.09 | chi2(7) = 12.43<br>Prob > chi2= 0.09 | chi2(7) = 3.167<br>Prob > chi2 = 0.36 |
| **Instruments** | ln Custom duties/Imports (-1) Size dummies %Foreign capital | Ln Imports/Value added (-1) Size dummies %Foreign Capital | Ln Exports/Value added (-1) Size dummies %Foreign capital |
| **Observations** | 1385 | 1599 | 1599 |
| **Firms** | 386 | 451 | 451 |

**Note:** Standard errors between parentheses: * Significant at10%; ** significant at 5%; *** significant at 1%. The dependent variable is ($WB_Q$/TWB). The number of observations automatically differs because trade measures are not available for all sectors. Firms belonging to manufacturing industries are however covered by all these data. The regressions include a constant term. Corresponding results are not reported for space reasons.

**Appendix**

**Firm Total Wage Bill Decomposition Technique of Maurin and Parent (1993)[38]:**

We define the following variables:

$TWB$ : Total wage bill in firm *i*

$L$ : Total employment in firm *i*

$L_Q$ : Number of firm's skilled workers.

$L_{NQ}$ : Number of firm's unskilled workers.

$l_Q$ : Skilled workers share of total employment relative to a firm i

$l_{NQ}$ : Unskilled workers share of total employment relative to a firm i

$WB$ : Average wage bill per worker in firm *i*

$WB_Q$ : Skilled worker's average wage bill in firm *i*

$WB_{NQ}$ : Unskilled worker's average wage bill in firm *i*

The (NIS) firm level database provides firm data on total wage bill, as well as skilled and unskilled workers employment. Unskilled workers are considered as our category of reference. Assuming that Q indexes the skilled workers category and NQ the unskilled workers category, we obtain the following expression of the average individual wage bill relative to a firm i:

$$\frac{TWB}{L} = WB = WB_Q l_Q + WB_{NQ} l_{NQ}$$

$$= WB_Q l_Q + WB_{NQ}\left(1 - l_Q\right)$$

$$= l_Q\left(WB_Q - WB_{NQ}\right) + WB_{NQ}$$

***The estimation method used to generate firm-level data incorporated in ETUDE III and ETUDE IV***

Our objective is to estimate skilled and unskilled wage bills, over the period 1998–2002, for each firm of the sample provided by the national annual survey report on firms.

To this purpose, we regress the following random coefficient model using the Swamy's estimator, where $\upsilon_{it}$ is an error term.

$$WB_{it} = \underbrace{WB_{NQi}}_{\beta_{0i}} + \underbrace{\left(WB_Q - WB_{NQ}\right)_i}_{\beta_{1i}} \cdot l_{Q_{it}} + \upsilon_{it}$$

The parameter $\beta_{0t}$ corresponds to the average unskilled workers wage bill $WB_{NQ}$ relative the firm *i*, for the entire period 1998–2002. Then, given estimated values of $\beta_{0t}$ and $\beta_{1t}$, we may deduce the average skilled workers wage bill $WB_Q$ associated to the firm *i*, for the entire

[38] Maurin. E and Parent. M.C (1993), « Productivité et coût du travail par qualifications » in « Actes de la 18ème journée des centrales de bilans sur le thème : Croissance, emploi, productivité » (« Productivity and labor costs by skill "in *Proceedings of the 18th day of Balance Sheet on the theme: Growth, employment, productivity*), Association Française des Centrales de bilans AFCB, Paris, 23 novembre 1993.

period 1998-2002. Note here, that this estimation provides only firm heterogeneity: we do not obtain estimates for each year of our observation period. To this aim, we multiply average firms' wage bills corresponding to each category of workers by the corresponding workers' numbers available for each year. Hence, we find skilled and unskilled total wage bills, for each company of the sample and each year of observation.

## Table A: Cost Share Equation Estimates for Firms in Manufacturing Industries

| | Dependent Variable | |
|---|---|---|
| | The share of skilled workers in total wage bill | The share of skilled workers in total employment |
| **Ln capital stock** | -0.011 | -0.050 |
| | (0.072) | (0.106) |
| **Ln value added** | -0.105 | -0.107 |
| | (0.038)*** | (0.058)* |
| **Computer acquisitions /Total acquisitions** | 0.169 | 0.316 |
| | (0.149) | (0.211)* |
| **R&D expenditures/Total acquisitions** | 0.006 | 0.008 |
| | (0.001)*** | (0.001)*** |
| **Software assets value /Value added** | 0.425 | 0.528 |
| | (0.339) | (0.350) |
| **%Private capital** | -0.000 | -0.001 |
| | (0.001) | (0.002) |
| **%Foreign capital** | -0.003 | -0.005 |
| | (0.002)* | (0.003)* |
| **Time effects** | Yes | Yes |
| **Constant** | 0.25 | -0.398 |
| | (1.036) | (1.509) |
| **Method** | OLS/FE | OLS/FE |
| **Observations** | 1622 | 1659 |
| **Firms** | 380 | 382 |
| **R-squared** | 0.79 | 0.70 |

**Note:** Standard errors between parentheses: * Significant at10%; ** significant at 5%; *** significant at 1%. The dependent variable is ($WB_Q$/TWB) in column (1). The dependent variable is Ln ($L_Q$/L) in column (2).

## Table B: Skilled Labor Share of Employment and Wage Bill by Firms' Skill Intensity

| Year | Unskilled-Intensive Firms | | Skilled-Intensive Firms | |
|---|---|---|---|---|
| | Skilled labor share in total employment | Skilled labor share in total wage bill | Skilled labor share in total employment | Skilled labor share in total wage bill |
| **1998** | 0.05 | 0.27 | 0.26 | 0.52 |
| **1999** | 0.05 | 0.27 | 0.28 | 0.53 |
| **2000** | 0.05 | 0.29 | 0.29 | 0.53 |
| **2001** | 0.05 | 0.28 | 0.32 | 0.56 |
| **2002** | 0.05 | 0.28 | 0.31 | 0.58 |

Notes: Standard errors between parentheses: * Significant at10%; ** significant at 5%; *** significant at 1%. In the two last columns, we perform Hausman-Taylor estimations. The relative wage ratio is time invariant. Results of the test of over identifying restrictions are displayed below:

Column 5: Sargan-Hansen statistic 2.452 Chi-sq(5) P-value = 0.7838

Column 6: Sargan-Hansen statistic 4.214 Chi-sq(5) P-value = 0.5191

Source: Author's computations from the national annual survey report on firms (NASRF) carried out by the Tunisian National Institute of statistics (TNIS). We define any firm above the median of the ratio of skilled workers to unskilled workers as skill-intensive. This ratio is computed as an average ratio for the year 1998.

**Table C: Cost Share Equation Estimates with Inclusion of Trade Measures**

| | The Share of Skilled Workers In Total Wage Bill | | | The Share of Skilled Workers in Total Employment | The Share of Skilled Workers in Total Wage Bill | |
|---|---|---|---|---|---|---|
| **Ln capital stock** | -0.015<br>(0.070) | 0.018<br>(0.045) | 0.068<br>(0.027)** | -0.073<br>(0.103) | 0.108<br>(0.035)*** | 0.059<br>(0.032) |
| **Ln value added** | -0.117<br>(0.037)*** | -0.063<br>(0.032)** | -0.093<br>(0.026)*** | -0.125<br>(0.058)** | -0.166<br>(0.032)*** | -0.101<br>(0.030)*** |
| **Ln relative wages** | | | | | 0.323<br>(0.293) | 0.081<br>(0.341) |
| **Computer acquisitions /Total acquisitions** | 0.253<br>(0.146)* | 0.239<br>(0.135)* | 0.211<br>(0.124)* | 0.390<br>(0.204)* | 0.575<br>(0.278)** | 0.584<br>(0.276)** |
| **R&D expenditures/Total acquisitions** | 0.006<br>(0.001)*** | 0.006<br>(0.001)*** | 0.006<br>(0.001)*** | 0.008<br>(0.001)*** | 1.001<br>(0.535)* | 0.848<br>(0.517)* |
| **Software assets value /Value added** | 0.629<br>(0.166)*** | 0.753<br>(0.146)*** | 0.526<br>(0.257)** | 0.751<br>(0.197)*** | -0.157<br>(0.189) | -0.126<br>(0.187) |
| **Ln custom duties/imports** | -0.061<br>(0.080) | | | -0.028<br>(0.124) | -0.153<br>(0.084)* | |
| **Ln imports/value added** | | -0.102<br>(0.071) | | | | |
| **Ln exports/value added** | | 0.080<br>(0.091) | | | | |
| **Ln(exports+imports)/ Value added** | | | -0.104<br>(0.036)*** | | | -0.008<br>(0.091) |
| **Time effects** | Yes | Yes | Yes | Yes | Yes | Yes |
| **Sector effects** | No | No | No | No | Yes | Yes |
| **Method** | OLS/FE | OLS/FE | OLS/FE | OLS/FE | Hausman-Taylor | Hausman-Taylor |
| **Observations** | 1642 | 1884 | 1884 | 1679 | 1641 | 1883 |
| **Firms** | 387 | 445 | 445 | 616 | 387 | 445 |
| **R-squared** | 0.78 | 0.78 | 0.78 | 0.70 | | |

Notes: Standard errors between parentheses: * Significant at10%; ** significant at 5%; *** significant at 1%. The regressions include a constant term. Corresponding results are not reported for space reasons.

**Table D: Cost Share Equation Estimates with Inclusion of Trade Measures and Technology Measures as Shares of Total Firm Revenue**

| | The Share of Skilled Workers in Total Wage Bill | | | | | The Share of Skilled Workers in Total Employment |
|---|---|---|---|---|---|---|
| **Ln capital stock** | -0.025<br>(0.068) | 0.006<br>(0.044) | 0.007<br>(0.044) | 0.053<br>(0.057) | 0.064<br>(0.086) | 0.058<br>(0.126) |
| **Ln value added** | -0.129<br>(0.038)*** | -0.071<br>(0.033)** | -0.072<br>(0.033)** | -0.072<br>(0.038)* | -0.131<br>(0.045)*** | -0.133<br>(0.068)** |
| **Computer acquisitions /revenues** | 0.634<br>(0.294)** | 0.650<br>(0.294)** | 0.640<br>(0.295)** | 0.763<br>(0.311)** | 0.615<br>(0.305)** | 0.737<br>(0.334)** |
| **R&D expenditures/revenues** | 0.955<br>(0.593)* | 0.852<br>(0.585) | 0.863<br>(0.588) | 0.732<br>(0.609) | 0.844<br>(0.593) | 1.016<br>(0.779) |
| **Software assets value /revenues** | -0.154<br>(0.143) | -0.120<br>(0.142) | -0.129<br>(0.143) | -0.035<br>(0.149) | -0.144<br>(0.146) | -0.142<br>(0.222) |
| **Ln custom duties/imports** | -0.062<br>(0.081) | | | | | |
| **% Private capital** | | | | -0.001<br>(0.001) | -0.001<br>(0.001) | |
| **Ln imports/value added** | | | -0.098<br>(0.072) | | | |
| **Ln exports/value added** | | | 0.077<br>(0.092) | | | |
| **%Foreign capital** | | | | -0.002<br>(0.002) | -0.003<br>(0.002) | |
| **Ln (exports+imports)/value added** | | -0.034<br>(0.079) | | | | |
| **Ln exports/value added (-1)** | | | | 0.173<br>(0.076)** | | |
| **Ln custom duties/imports (-1)** | | | | | 0.028<br>(0.084) | 0.055<br>(0.112) |
| **Time effects** | Yes | Yes | Yes | Yes | Yes | Yes |
| **Sector effects** | No | No | Yes | Yes | Yes | Yes |
| **Method** | OLS/FE | OLS/FE | OLS/FE | OLS/FE | OLS/FE | OLS/FE |
| **Observations** | 1641 | 2593 | 2099 | 1601 | 1385 | 1418 |
| **Firms** | 387 | 445 | 452 | 453 | 386 | 388 |
| **R-squared** | 0.77 | 0.77 | 0.71 | 0.80 | 0.80 | 0.70 |

**Table E: Number of Firms with Foreign Participation by Sector**

| Sector | Number of Firms 1998 | Number of Firms 1999 | Number of Firms 2000 | Number of Firms 2001 | Number of Firms 2002 |
|---|---|---|---|---|---|
| **Public construction** | 3 | 2 | 3 | 4 | 3 |
| **Trade** | 6 | 5 | 5 | 3 | 3 |
| **Tourism** | 3 | 4 | 5 | 3 | 2 |
| **Agro-food** | 3 | 3 | 4 | 3 | 2 |
| **Chemical industry** | 5 | 5 | 4 | 4 | 3 |
| **Pottery, glass and non-metallic mineral** | 6 | 6 | 6 | 6 | 4 |
| **Other manufacturing Industries** | 2 | 2 | 2 | 2 | 2 |
| **Mechanical, electrical and electronic** | 12 | 14 | 16 | 17 | 13 |
| **Other services** | 0 | 0 | 0 | 1 | 0 |
| **Textile** | 56 | 62 | 68 | 73 | 56 |
| **Transport and communication** | 3 | 2 | 2 | 2 | 0 |
| **Energy** | 2 | 1 | 1 | 2 | 2 |
| **Total** | 121 | 106 | 116 | 120 | 90 |
| **Share of Textile (in %)** | **46** | **58,5** | **58,6** | **60,8** | **62** |