ARE MEN TAKING OVER?

The relation between capital intensive technology and the female-male labour ratio in garment factories in Bangladesh

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Abstract

In the labour-intensive garment industry female labour is important. Therefore a change in labour demand can have a large impact on the employment opportunities for women. This research looks at the relation between (the increased) capital intensive technology and the female-male labour ratio in garment factories in Bangladesh. The data used is collected by BIDS among 261 garment factories in 2018. With the data two proxies are created for capital intensive technology: the amount of machines and the productivity per worker. Export percentage is used as a proxy for quality and price. Three models are econometrically estimated using Ordinary Least Square. The models have similar outcomes. The two proxies for capital have a negative coefficient. However, the proxy productivity per worker is not significant in the estimated models. The proxy total amount of machines is in both models significant at a 1% level. Based on these outcomes I conclude that a more capital intensive technology is related to a lower percentage of female workers.

Preface

This thesis addresses the relation between capital intensive technology and the female-male labour ratio of the garment industry in Bangladesh.
As a teenager I was already interested in the clothing industry, I wondered about the prices of the clothes and what working in the garment industry would feel like. When it was time to write my thesis I knew I wanted it to be about the garment industry.

Thanks to my thesis supervisor Jack Peerlings and Nazneen Ahmed, this topic was made known to me. Already from the start I was very interested and curious about the outcome of this research.

I cannot say the process of writing this research was easy, but it was certainly worth it. During the research I learned a lot about the garment industry and came to new insights, which I hope to share with you on the following pages.

I would like to thank my supervisor Jack Peerlings for guiding me through the process of writing a thesis and providing me with useful feedback. In addition I would like to thank Nazneen Ahmed and Iqbal Hossain for providing me with this interesting topic and the data used for this research. And finally I would like to thank my family and friends for their support.

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Content

1. Introduction

The production of garment is labour-intensive and has been the first step to industrialisation for many countries (Kabeer & Mahmud, 2004a). According to Mottaleb & Sonobe (2011) Bangladesh is one of the main exporting countries for garment. 75% of the export of this country is earned through this industry.

The production of garment starts with fibres, by spinning these fibres they create yarn. By weaving or knitting yarn fabrics are created. The textile is then cut and sewed into apparel or garment. If items need to be dyed and printed this happens before the cutting and sewing phase (Ahmed, 2006).
The two main production categories are knitted and woven[1]. When the yarn is made into fabric this can either be woven or knitted. The two production types use different yarn, fabric, machines and production technology. The type of workers differs as well. Knitted garment production requires more skilled workers and because there are relatively few female skilled workers in Bangladesh, the workforce in this sector mainly consists of males (Ahmed, 2006; Siddiqi, 2000 in Hossain, 2012). The woven garment sector has mainly female labour.

In total 90% of the workers in the ready-made garment industry are women (USITC, 2004 in Yang & Mlachila, 2007). These labour opportunities changed the lives of women in Bangladesh. For women in Bangladesh this is an opportunity because there are limited options available for working outside the household. However working in the garment industry has two sides. The factory jobs are often not stable and it is not always safe. There are for example regular fires in factories. The work is also physically hard and can cause illness. Working overtime and inadequate transport have a negative impact and make women vulnerable towards sexual harassment (Hossain, 2012).

However there all also benefits. A job and salary of their own can empower women. Many workers are from poor areas and are rural migrants, for whom working in the garment industry is their first job. Even though wages are not always paid on time, the job provides women with a secure income (Kabeer and Mahmud, 2004a). According to Kabeer and Mahmud (2004a) women work on average five years in the garment industry. Mainly young and unmarried women or women who just married work in this industry. They often do not regard working in the garment industry as a life-long job. Working in the garment industry brings women possibilities. Work increases the ability to negotiate with dominant family members as well as bringing the possibility of delaying their marriage and providing more freedom in their choice with whom they will marry. Because many workers send a part of their income back to their family in the countryside it gives them the possibility to support their family. To conclude a wage makes women more independent and gives them a greater say in regard to aspects of their lives (Kabeer and Mahmud, 2004a).

Because the RMG industry impacts the employment possibilities for women in Bangladesh, a change in these possibilities can have a big influence. In the article “Number of female workers declining in RMG sector” of Textile Today (2018) it was reported that the ratio female-male workers in the RMG industry in Bangladesh is declining according to a survey by the Centre for Policy Dialogue (CPD). They found that the participation ratio of female workers declined from 64 percent in 2015 to 60.8 percent in 2016. The survey was held among 2270 workers of 193 factories. The director of the CPD states in the article that he assumes that the ratio is declining because the owners of RMG factories think that

[1] In the collected data, there is a third category: sweater. This is separated because sweater has some unique features in terms of pricing, but it is a knitted product.

the female workers are not capable of handling the modern machinery correctly. If this is true this will have an impact on the RMG industry in Bangladesh and the position of women in Bangladesh.

Economic theory

The garment industry is labour-intensive, and therefore labour is crucial, but what happens with the supply and demand of labour with more capital intensive technology in factories? According to Manning (2004) the effect of capital intensive technology on labour differs per sector and between people. On average Manning (2004) concludes that more capital intensive technology creates more jobs instead of reducing it. However as with most economic changes, each situation has winners and losers.

There are differences between the sectors with regard to the introduction of capital intensive technology. Not necessarily the jobs with the lowest payment are replaced by capital but often jobs where a lot of tasks are repetitive and tasks need precision. It also has to be possible to replace the human labour with capital. Mainly in manufacturing jobs can the introduction of a more capital intensive technology increase productivity. This new capital intensive technology will bring winners and losers. However it is often harder to recognise the winners, a reduction in garment costs will increase the demand for something else, but it is not possible to show where the demand goes. The losers are often easier to identify (Manning, 2004). According to Autor, Levy & Murnane (2003) a decline in the price of capital will cause a substitution and complementarity effect. With an increase in capital labourers with a routine job will be replaced by capital. On the other hand the new capital intensive technology increases the demand for workers with non-routine tasks because they complement the capital. According to this theory, an increase in capital will cause an increase in relative demand for labourers who have a comparative advantage with regard to their non-routine tasks, which are often high skilled labourers (Autor, Levy & Murnane, 2003; Autor et al., 2003).

As mentioned before there are relatively few high skilled women in Bangladesh (Ahmed, 2006). According to the theory I expect that an increase in capital will decrease the demand for low-skilled labour and in the case of Bangladesh female labour. The reason why firms start to implement more capital intensive technologies will not be in the scope of this research.

Research objective

The objective of this research is to analyse if there is a relation between the amount of capital and the female-male labour ratio in garment factories in Bangladesh. The hypothesis I test is if there is a negative relation between a more capital intensive technology and the female-male labour ratio. This research has scientific as well as social relevance because it adds new knowledge to the existing literature and the outcome of this research will give new insights on the position of female garment workers.

Research questions

This main research question will be divided in the following sub-questions:

1. What is the context of the RMG sector in Bangladesh?
2. What is the relation between capital intensive technology and the female-male labour ratio according to the theory?
3. What data is gathered on the relation between capital intensive technology and female-male labour ratio?
4. How can the relation between capital intensive technology and the female-male ratio statistically be established?
5. What is the relation between capital intensive technology and the female-male labour ratio?

Methodological design

The first two research questions will be answered with a literature study. A description of the garment sector in Bangladesh provides the necessary background information for this study. Besides this description also literature on the relation between female and male labour participation and capital intensive technology will be investigated.

For the third research question a descriptive analysis of the data collected by BIDS via a survey will be used. The data set I will use is obtained via a questionnaire among a representative sample of 261 garment factories in Bangladesh in 2018. This data set contains data on the amount of workers, divided in female and male and the number of machines. The factories are from the following regions: Dhaka, Gazipur, Narayangonj and Chattagram. This data set will be regarded as a cross-section data set. The data is collected at one moment in time but they asked the data from the administrative record of previous years as well. However because of data reliability only the data of the most recent year will be used in this research.

I will answer the fourth research question by means of an econometric analysis. The total amount of machines and the productivity per worker will be used as proxies for the amount of capital intensive technology. With these variables I will perform a regression analysis to explain the change. The model will be estimated using Ordinary Least Square (OLS). To test whether variables have a significant explanation for the difference in FM-ratio, a t-test will be used. With a quantitative research as in this thesis it is easier to make predictions based on the research and to generalize the outcome of the research.

Chapter 2 provides insights on the context of the RMG sector in Bangladesh. In Chapter 3 is discussed what the relation between the amount of capital intensive technology and the female-male labour ratio is according to the theory. Chapter 4 describes the data gathered on the relation between the amount of capital intensive technology and the female-male labour ratio. In Chapter 5 is discussed how the relation between capital intensive technology and the female-male ratio statistically can be established.

2. Background garment industry

This chapter provides background knowledge on the RMG industry in Bangladesh. The knowledge puts the theory and data to be used in perspective. Information on the historic, technological, economic and social aspects of the garment industry is provided in sections 2.1 – 2.4 respectively.

2.1 History

Garment production has been the first step towards industrialisation for many developed countries (Kabeer and Mahmud, 2004a). Due to competition on the price of clothing and the increasing price of labour in industrialised countries the production of garments moved to low-wage countries like Taiwan, South Korea and Hong Kong. In these countries the production costs of garments was much lower while the quality remained the same. The import of clothes from developing countries to developed countries worried the developed countries, who reacted in 1974 with the Multi-Fibre Arrangement (MFA). This arrangement regulated the trade in textiles and garments. The MFA allowed an increase of 6% each year for the export from developing countries to developed countries. If the export of a developing country increased with more than 6% per year the importing country was allowed to impose a quota which put a limit on the volume of the export. Instead of stopping the incoming flow of garment the MFA caused a reaction of 'quota hopping'; the search of producers and buyers for a new low wage location which was still without a quota. This is the moment when Bangladesh became involved in the garment production (Kabeer and Mahmud, 2004a).

Bangladesh became independent from Pakistan in the year 1971. At that moment the total amount of exported goods and services had a worth of $540 million dollars. This was 6.3% of the country's GDP. At that moment the export of ready-made garments did not exist (Ahmed, Greenleaf & Sacks, 2014). In 1978 this changed. The South-Korean company Daewoo came to Bangladesh and partnered up with the Bangladeshi firm Desh garments to start the production and export of garment (Kabeer and Mahmud, 2004; Mottle and Sonobe, 2011).

This shift of producing in Bangladesh was partly due to the favourable position of Bangladesh with regard to quotas (Hossain, 2011). Due to the Multi-Fibre Arrangement (MFA) of 1974, South-Korea was one of the countries who faced a quota with regard to the export of garment. South-Korea had a restriction on the quantity of garments that could be exported to and imported by developed countries. Bangladesh was a quota-free location and therefore a favourable location for the production of garment. This encouraged companies to move to Bangladesh (Hossain, 2011).

On January 1st 2005 the last and most important step was taken to end the Multi-Fibre Arrangement and to remove all quotas of member nations of the World Trade Organisation (Abernathy, Volpe & Weil, 2006). As a consequence Bangladesh lost its favourable position with regard to quotas. Although quotas were removed, tariffs remained. Due to this Bangladesh still faced some advantages. Because Bangladesh received the status 'Least Developed Nation' all apparel that goes through two stages of production receives free entry into the European Union (Abernathy et al., 2006).

The rapid growth of the Ready Made Garment (RMG) industry in Bangladesh that started around 1985 was influenced by more than just the MFA. Another factor contributing to this process is the population density of Bangladesh. The population density of Bangladesh is one of the highest in the world and there is not enough employment available for the entire labour force. This led to a comparative advantage for labour-intensive goods (Kabeer & Mahmud, 2004b).

During the growth of the garment sector the government of Bangladesh had a policy to assist the growth by 'a *non-interference* and *a decentralized industrial policy*' (Ahmed et al., 2014 page 260). The policy of the government focused on privatization and export oriented growth. The government set up

private organisations that took over tasks of the government, like garment associations BGMEA and BKMEA. The government also created Export-Processing Zones (EPZ). These were regions in which producers had several advantages. With policies like the Duty Drawback System or Centrally Bonded Warehouse these exporters for example did not have to pay taxes on the products they imported for the production of export goods (Ahmed et al., 2014). These factors all influenced the fast growth of the production and export of the garment industry in Bangladesh.

2.2 Technology

The production process of garment consists out of 4 phases. First material is needed to create the fabric, these fibres can be natural or man-made. Cotton is often used but also materials like silk, nylon and polyamides. The second step is to create yarn by spinning these fibres. The third step determines the type of garment. There are two types of garment: woven and knitted. The yarn can be turned into fabric by either weaving or knitting the yarn. At this point while the product is still a fabric it can be dyed or printed. Once the fabric is woven or knitted it goes into the fourth phase where the fabric can be made into apparel by cutting and sewing the fabric (Ahmed, 2006). These are the first steps of the commodity chain of garments. The commodity chain of apparel contains all the steps needed to transform raw material into clothing and to sell these clothes (Appelbaum & Gereffi, 1994). When a garment is finished it will be exported via trade channels. After the shipping process the garments will be sold via retailers (Appelbaum & Gereffi, 1994).

The two types of garment products; knitted and woven vary in the use of yarn, fabric, machines and production technology. The type of workers differs as well. There is a high level of female labourers in the woven garment production and a large amount of male workers in the knitted sector. This difference exists due to a difference in skill that is needed for the production. More skilled workers are needed for the production of knitted garment and because there are not many skilled female workers in Bangladesh this is mostly done by men (Ahmed, 2006; Hossain, 2011).

During the first years of the garment industry in Bangladesh the main production consisted of woven garment. Starting in the year 2004 the share of knitwear products started to increase. Besides this the product range of RMG in Bangladesh expanded as well (Hasan et al., 2016). The export of garments mainly existed of woven and knitted shirts and blouses together with trousers, skirts and shorts (Ali & Habib, 2012). This was later diversified by also producing garments with a higher value like suits, branded jeans, jackets and embroidered apparel (Hasan et al., 2016).

2.3 Economic

To reduce costs producers can outsource a step of the production chain and in such a way focus on a smaller part of the production process (Ali & Habib, 2012). According to Habib (2016) garment producers in Bangladesh often import fabric from other countries. This is because local produced fabric is often more expensive and of less quality.

The production itself can also be outsourced to another factory when there are a lot of orders coming in. Or the production can be called off when there are no orders. During the lean season, when not a lot of orders are coming in factories sometimes accept cheaper orders to be able to keep paying their labourers (Kabeer & Mahmud, 2004a).

The garment industry has a '*buyer-driven commodity chain'* (Appelbaum & Gereffi, 1994 page 44). This means that retailers and brands have the central role in planning the production network. The production is outsourced to a developing country and the clothing brands do not own factories. They design and market the production they sell, but do not produce the product. Due to this buyer-driven demand the chain reacts to changes in the market demand as well as changes in the costs of the

production. Production of clothing is outsourced to a location with low wages and low production costs, often combined with flexibility. Pressure from the market leads to retailers reducing the price of garment and decreasing the price they pay to the 'middle men'. These middle men will reduce their payments to their contractors. The contractors are then forced to reduce the production costs, which leads to lower wages and lower quality of the product, or further subcontracting to factories with even lower costs (Appelbaum & Gereffi, 1994).

Due to this structure the owners of garment factories deal with a large part of the risk. Before they get paid for an order they need to pay for the fabric needed. If the buyer is not satisfied with the purchase or the shipment arrives too late, the price of the order might become lower. At the same time it is not certain for the factory owner when and if the orders will come in (Kabeer & Mahmud, 2004a).

With regard to garment factories in Bangladesh a division can be made based on where the factory is located. In Bangladesh garment factories can be in an export-processing zone (EPZ). This is a region in which there are certain advantages for export manufacturers (Hossain, 2011). There are several export-processing zones. Factories in these zones provide for 12% of the employment in Bangladesh. These factories are very large and employ many workers. They have modern and more complex machinery and deal with international buyers directly. Working conditions in these factories are often better than in factories outside the EPZ. This is because of pressure from abroad through buyers and indirectly consumers on the factory owners. Outside the EPZ is more variation between factories. There is a lot of variation with regard to the size, profitability and their relation to the informal economy. Many factories provide similar wages and working conditions as can be found in the informal economy (Kabeer & Mahmud, 2004b).

As a whole the clothing industry went through some changes. Before there were two main seasons (summer and winter) and the fashion trends were known in advance. This changed to multiple seasons and with that a more frequent change of clothing items. This changed the response time towards trends; clothing brands adapted faster to trends. For retailers it became important to be flexible and to respond fast to the market. Because of this supply chains had to be more flexible and efficient (Bhardwaj & Fairhurst, 2010).

The objective behind the production process is to make the price of the product as low as possible and to reduce the lead time. The lead time is the time it takes to produce a product and depends on the backward and forward linkages of the garment industry. Lead time can be reduced by things like efficient planning, good management of logistics, the availability of a reliable infrastructure, access to proper warehouses and inventory planning (Ali & Habib, 2012).

2.4 Social

The clothing production in Bangladesh has several actors involved. There are the international buyers of the garment, when there is no direct contact with the factory owners they often have contact with the 'middle managers'. They form the bridge between the international buyers and the factory owners. Due to this middle manager a lot of transparency is lost on where garment is produced. Next to the factory owners another important actor are the factory workers. The government also play a role in the garment industry (Saxena, 2010). In addition there are also the actors that have a backward linkage with the RMG industry and who provide the raw materials for the production process, the suppliers (Hossain & Roy, 2016).

Bangladesh is a country with a labour surplus. This means that there is more labour than there are jobs available (Kabeer and Mahmud, 2004a). A labour-intensive industry as the garment industry who aims for minimum costs will try to find cheap labour. Women in Bangladesh do not have a lot of

options with regard to jobs and can be paid less than men with the same skills. Because of this a lot of women are hired in the garment industry so that factories can produce garment at low costs (Kabeer and Mahmud, 2004b).

As mentioned before males do work in the garment industry. There is a division between male and female workers, whereas most male workers work in the knitted garment sector and most females in the woven sector (Ahmed, 2006). According to Paul-Majumder & Begum (2000) 35% of the people working in knitwear are female and in the woven sector around 68% of the workforce is women.

Most of the workers in the garment industry come from the poorer regions of Bangladesh. They often are from poor families who are often landless with little education and that do not have enough food for the entire year (Kabeer and Mahmud, 2004a).

According to Aziz (1989 in Naved, Newby & Amin, 2001) the status of women in Bangladesh is traditionally tied with their relationships with their fathers, husbands and sons. Their marriage is therefore very important for the status and economic position of women. The traditional custom is that marriage is arranged by the families and not by the bride itself. Naved et al. (2001) state that the majority of the garment workers is expecting an arranged marriage. Support through social networks is considered very important and women do not want to put this in jeopardy. Nevertheless working in the garment industry does have an effect on the timing of the marriage, the arrangements and the characteristics of the husband (Naved et al., 2001). Females working in the garment industry can earn a higher wage than they can elsewhere. A lot of workers sent a part of their salary back to their family to support them. This positive influence on the living circumstances of their family helps women to switch from being dependent to being an economic actor. This is increasing their influence on different aspects of their life (Kabeer and Mahmud, 2004a). Due to the financial support the marriage of women is often delayed, for women who migrated without their parents it is also more common to choose their own partner (Naved et al., 2001). However in Bangladesh there is still a dowry system in which a dowry is given to the groom's family from the bride's family. Many rural girls work to earn their own dowry. Even if a woman is earning her own income a dowry can still be expected. Or when men marry women who are working in the garments industry they accept their income instead of a dowry with as consequence that the women's income is controlled by her husband (Chowdhury, 2010).

Around the year 1970 the amount of women with a paid job started to increase. Because most of these jobs were in the informal economy hardly any attention was given to their working conditions and wage. This informal approach complies with the strategy of garment employers to have maximal profits with minimal costs. To achieve this they employ labourers with no or only a little education and give them a small training on the job. They do not provide them with a contract nor all the benefits to which they have a right. In addition they give themselves the freedom to fire workers without letting them know in advance (Kabeer and Mahmud, 2004a).

Workers in the garment industry have to work more hours than other workers within the manufacturing sector. Besides this from time to time workers have to work all night to make the deadline of an order. Their monthly wage is not the lowest of the formal manufacturing sector but due to all their extra hours their wage per hour might be the lowest (Kabeer & Mahmud, 2004a).

Working in the garment industry is physically hard work (Hossain, 2011), due to the long working hours and highly repetitive work women often stop working in the factories after a couple of years. Especially when women have children it is hard to combine the work with taking care of their children due to the many working hours (Kabeer and Mahmud, 2004a).

In addition working in the garment industry comes with risks due to the bad working conditions. For example most factories have not taken sufficient measures in case of a fire. Or factories can be overcrowded and have bad ventilation (Paul-Majumder & Begum, 2000). In addition the combination of working overtime and inadequate transport can make women vulnerable to sexual harassment (Hossain, 2012).

3. Theory

This chapter discusses theories that can explain the relation between the use of machines and the female-male labour ratio. Section 3.1 discusses micro-economic theory. Section 3.2 shortly addresses possible other factors outside basic micro-economic theory that explain the relation between the use of machines and the female-male labour ratio.

3.1 Micro-economic theory

Short term profit

I assume firms maximize short term profit given market and institutional constraints (Perloff, 2018). The profit function is the outcome of this profit maximization:

$$\pi(p, w, Lf, Lm, K) = \max_{Lf, Lm, X} \left(p.y - w.X - P_{Lf}.Lf - P_{Lm}.Lm : T(y, X, Lf, Lm, K)\right)$$

Where:
π*: short term profit,* p*: vector of output prices,* y*: vector of outputs,* w*: vector of non-factor input prices,* X*: vector of non-factor inputs,* P_{Lf}*: price of female labour,* Lf*: female labour,* P_{Lm}*: price of male labour,* Lm*: male labour,* K*: capital,* $T(..)$*: technology set.*

Short term profit is revenue minus variable costs. It is short term because capital is assumed fixed. Profit is short term profit minus fixed costs (i.e. including capital costs). The price of sold goods (output price) times the sold amount (output) is revenue. I assume that prices of outputs and variable inputs, i.e. inputs that can be adjusted in the short term, are exogenous. Costs consist of three parts. First, variable material and service costs (i.e. non-factor inputs) needed to produce output (price times quantity: $w.X$). Second, labour costs. I divide labour into female and male labour (Lf, Lm respectively). I assume that firms can adjust the quantities of labour in the short term so labour costs are variable. Thirdly cost of capital (K). I assume capital (i.e. buildings and machinery) cannot be adjusted in the short term. So capital costs are fixed in the short term. Therefore they are not part of the optimization.

So, output is produced by means of non-factor inputs, female labour, male labour and capital. The way this is done is represented by the technology set (*T*). To create maximum profit firms will keep producing until the cost of producing one extra good is equal to the price that they get for that extra produced product (marginal cost equals price).

On the short term only the amount of X and labour can be changed. It is important to note that part of the labour might be fixed in the short term, for example management or labour under long term contracts. However, in Bangladesh labour is expected to be largely variable (Yunus & Yamagata, 2012). Capital is fixed in the short term but on the long term a firm can adapt the amount of capital.

Applying Hotelling's lemma gives the short term supply function of output and demand functions of the variable inputs:

$$y(p, w, P_{Lf}, P_{Lm}, K) = \frac{\partial \pi}{\partial p}$$

The supply function shows that if the price of output goes up the supply of output goes up. A decrease in the prices of non-factor inputs or labour also have a positive effect on supply of the output. An increase in the capital amount also has a positive effect on the supply of the output. An increase in supply is given the exogenous prices associated with an increase in profit.

$$X(p, w, P_{Lf}, P_{Lm}, K) = -\frac{\partial \pi}{\partial w}$$

$$Lf(p, w, P_{Lf}, P_{Lm}, K) = -\frac{\partial \pi}{\partial P_{Lf}}$$

$$Lm(p, w, P_{Lf}, P_{Lm}, K) = -\frac{\partial \pi}{\partial P_{Lm}}$$

The demand functions show that if the price of the output goes up the demand for variable inputs goes up as the supply of the output goes up. A decrease in the price of a non-factor input or labour (ceteris paribus) increases the demand for this variable input. An increase in the capital amount can have a positive or negative effect on the demand of a variable input depending on whether they are substitutes or complements.

Long term profit

In the long term a firm can adjust the capital amount. An adjustment of the amount of capital is called an investment. If the shadow price of capital is higher than the market price the firm will buy capital till the point where both are equal (see figure 3.1).

The shadow price of capital (P_K) is the extra profit a firm would earn if it could use one additional unit of capital. It is therefore the maximum price a firm is willing to pay for an additional unit of capital. The shadow price of capital is given by:

$$P_K(p, w, P_{Lf}, P_{Lm}, K) = \frac{\partial \pi}{\partial K}$$

A higher price of the output increases the shadow price of capital. The sign of the effect of a change in the price of the variable inputs on the shadow price depends whether they are substitutes or complements with capital.

Female and male labour and capital are substitutes in case:

$$\frac{\partial Lf}{\partial P_K} < 0 \qquad \frac{\partial Lm}{\partial P_K} < 0$$

So, in case capital use becomes more profitable (the shadow price of capital increases and more capital is used) less labour is used.

Female and male labour and capital are complements in case:

$$\frac{\partial Lf}{\partial P_K} > 0 \qquad \frac{\partial Lm}{\partial P_K} > 0$$

So, in case capital use becomes more profitable (the shadow price of capital increases and more capital is used) more labour is used.

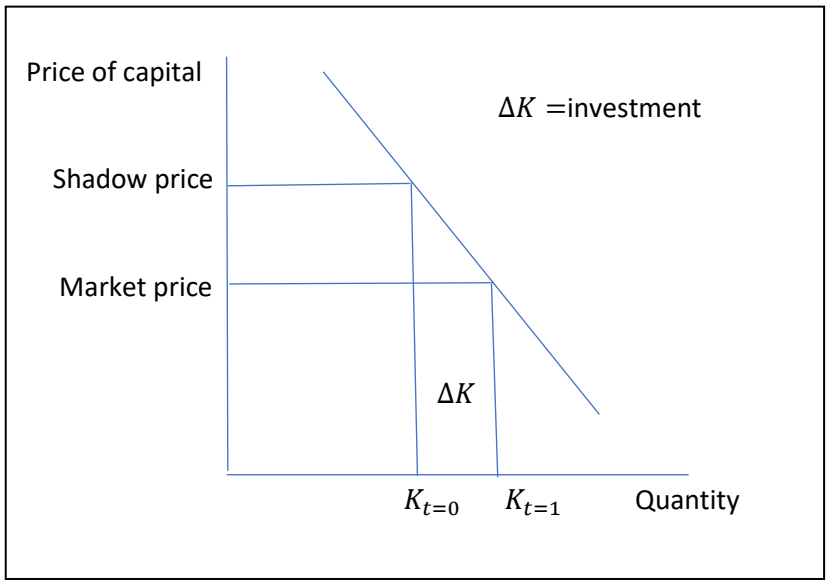

Figure 3.1: Investment, a firm invests when the shadow price of capital is higher than the market price of capital

Suppose the amount of capital can be adjusted (long term) and the firm invests. In the case female labour and capital are substitutes this implies that more capital leads to less use of female labour. In case female labour and capital are complements the use of female labour goes up in case of an investment.

Whether capital and labour are complements or substitutes depends on the type of labour. When capital increases the routine jobs are replaced by capital. So for this type of labour there is a substitution effect. However an increase in capital leads to a demand for labourers with non-routine tasks since they complement capital. These are generally the high skilled labourers (Autor, Levy & Murnane, 2003; Autor et al., 2003).

With regard to the garment industry in Bangladesh, Ahmed (2006) and Hossain (2011) state that there are not many skilled female workers. Based on the previous theory I expect a substitution effect for low skilled labour and a complementary effect for skilled workers. Regarding the RMG industry in Bangladesh this would mean that with an increase in capital female labour will be replaced with male labour. Therefore I expect a negative relation between an increase in capital intensive technology and the female-male labour ratio.

3.2 Other explanatory factors

In line with profit maximalisation women's lower wages are the main explanation why employers prefer female labour in labour-intensive industries. However according to Caraway (2006) wages alone are not sufficient to explain why labour-intensive industries have a preference for female labour; as countries with the largest wage gap between male and female labour are not the countries with the highest female-male labour ratio. Some other factors playing a role are briefly discussed next.

It is important to keep in mind that the shadow price of labour depends on the quality of the production factors, and therefore productivity. Employers in labour-intensive industries often consider women's productivity to be higher than that of men (Caraway, 2006). This is due to certain characteristics associated with female workers. They are for example considered to be more obedient,

disciplined and careful. Therefore employers believe women's productivity to be higher and are willing to pay a higher wage.

In the profit maximalisation problem discussed in section 3.1 labour is considered as a variable input. In labour-intensive industries that demand unskilled labour, firms can handle absences of low skilled female employees due to maternity relatively easy. However in a capital intensive industry demanding more high skilled labour firms prefer more permanent staff and are more likely to create job ladders and reward workers that work there for a longer time. This makes it harder to deal with absences due to for example maternity and therefore female labour is less attractive (Caraway, 2006).

In addition social constraints play a role in the hiring of labour. According to Jayasinghe (2001) cultural norms label hard labour or work with advanced technology as masculine. With the result that manufacturing jobs requiring these masculine skills are seen as not suited for women. In addition in a more capital intensive industry there is an increased demand for technological skills. Because men have better access to training this is a reason behind a preference for male labour.

4. Data

This chapter describes the data and variables that are used in the empirical model. Section 4.1 explains how the data is collected. Section 4.2 describes the variables I use.

4.1 Data collection

This article uses data collected by BIDS via a survey. The data set is obtained via a questionnaire among a representative sample of 261 garment factories in Bangladesh in 2018. After sorting and cleaning the data set there are 231 factories included. The factories are from the following regions: Dhaka, Gazipur, Narayangonj and Chattagram. The data is collected at one moment in time, so technically the survey data is a cross-section data set. However, in the survey previous years are also included, nevertheless this data is not complete and therefore I only use the year 2017 in this research.

4.2 Variables

The dependent variable is the female-male labour ratio. This variable is created by dividing the number of female workers over the number of male workers per factory. So the higher the ratio, the higher the relative amount of female workers.

Unfortunately the data set does not contain all the variables of interest making that I have to choose some proxies.

This thesis studies the relation between capital intensive technology and the female-male labour ratio. As a proxy for capital I use the total amount of machines. This variable is created by adding up all the machines a factory uses except for plain machines. Plain machines are not included because they are the basic machines needed for production and therefore do not represent capital intensive technology. I do not look at the specific machinery used given the lack of quality of the data.

As a proxy for technology I use productivity per worker. This variable is created by dividing the production of a factory by the amount of workers. Because a higher amount of capital should increase the productivity per worker, a factory with a higher productivity per worker probably has a higher amount of capital per worker as well.

As context variables I use two dummy variables and the export percentage. The first dummy variable is the sub sector. This is the type of production in the factory. There are two main types of production: knitted and woven. The two production types differ in the use of yarn, fabric, machines and production technology. There is also a third category: sweater. This is separated because sweater has some unique features in terms of pricing, but it is a knitted product. The other dummy variable is the region. Data is collected from the following 4 regions: Dhaka, Gazipur, Narayangonj and Chattagram.

I also use the export percentage as a context variable. This is calculated by dividing the amount of export by the amount of production. The export percentage is a proxy for price, quality and export-processing zones. The higher the export percentage the higher the expected price and quality.

Table 4.1 Summary statistics

Variable	Observations	Mean	Standard dev.	Min	Max
Female-male ratio	231	1.983	1.129	0.150	6.571
Sub sector					
Knit	231	0.372	0.484	0	1
Sweater	231	0.010	0.300	0	1
Area					
Gazipur	231	0.273	0.446	0	1
Narayangonj	231	0.095	0.294	0	1
Chattagram	231	0.152	0.359	0	1
Export percentage	231	0.946	0.172	0.067	1.442
Productivity per worker in million dollar per year	231	1.135	1.125	0.007	5.648
Total amount of machines divided by 100	231	4.491	3.265	0.220	17.950

Table 4.1 summarizes some simple descriptive statistics of the variables used. The mean of the FM-ratio is 1.98, this shows that in proportion to every male worker there are 1.98 females working in the factories.

5. Empirical model and analysis

This chapter discusses how the relation between capital intensive technology and the female-male labour ratio statistically can be established. Section 5.1 explains the empirical model. Section 5.2 presents and discusses the results.

5.1 Empirical model

The model econometrically estimated is:

$$FM_i = a_0 + a_1 * PW_i + a_2 * TM_i + a_3 * AC_i + a_4 * EP_i + a_5 * SuS_i + E_i$$

Where:

FM: ratio female and male labour, PW: production per worker, TM: total amount of machines, AC: dummy variable for region, EP: export percentage, SuS: dummy variable for production sub sector and E represents the error term.

i is 1,2,… 231 factories.

PW and TM are proxies for capital intensive technology, AC and SuS are context variables as well as EP which is a proxy for quality and price.

The model is estimated using Ordinary Least Square (OLS) (Dougherty, 2016). OLS assumes the error terms are uncorrelated with mean zero. I ignore possible endogeneity making that the outcomes should be interpreted as a correlation and less as a causal relationship. Endogeneity emerges if the ratio of female and male labour is one of the explanatory variables for the production per worker or the total amount of machines.

I estimate three models. With the first regression I estimate the complete model. In the second regression the production per worker (PW) is included and the total amount of machines is omitted. In the third regression I include the amount of machines (TM) but omit the production per worker.

5.2 Results

This section shows and discusses the results of the OLS regression of the model specified in section 5.1.

Table 5.1 OLS regressions results of FM-ratio on complete model (CM), FM-ratio on production per worker model (PWM) and FM-ratio on total amount of machines (TMM).

FM-ratio	Coefficient CM	Coefficient PWM	Coefficient TMM
Sub sector			
Knit	-0.243	-0.239	-0.241
Sweater	-0.844*	-0.807*	-0.860*
Survey area			
Gazipur	0.130	0.045	0.135
Narayangonj	0.482*	0.515*	0.504*
Chattagram	1.263*	1.373*	1.293*
Export percentage	-0.343	-0.493	-.356
Production per worker	-0.051	-0.036	-
Total machines	-0.075*	-	-0.073*
Constant	2.602*	2.390*	2.544*
F	11.18*	10.30*	12.68*
Adjusted R^2	0.261	0.220	0.262

*Note: * for P values smaller than 0.05*

Figures A4-A6 in the appendix show that the residuals are indeed normally distributed around mean 0. Table A7 further shows that multicollinearity is not present. Table A3 gives the summary statistics of the OLS regression. All three models have a significant outcome on the F-test. This test shows if the model as a whole has explanatory value for the differences in the FM-ratio. The adjusted R square shows that the first and third model explain 26 percent of the variation in the FM-ratio and the second model 22 percent. This is as expected because not all the desired data is available and it is only logical to expect that these other missing variables also have explanatory value with regard to the FM-ratio.

Table 5.1 gives the outcomes of the three OLS regressions. It is interesting to notice that the values of these three models match. The R-square adjusted is a little bit higher in the models with the total amount of machines variable, which indicates that including this variable improves the model.

As expected the dummy variables sweater and knitted garment have a negative impact on the FM-ratio compared to the third dummy variable: woven garment. This is as expected because these two production types require higher skilled labour. Therefore I expect a higher percentage of male labour which results in a lower FM-ratio. The production sub sector sweater is significant, the knit variable is not significant at a 5% significance level but is significant at a 10% significance level.

All three regions have a positive coefficient in comparison to the fourth region: Dhaka. This means that the Dhaka region has the lowest FM-ratio. Differences between regions are expected due to social and geographical differences. Factories can for instance be located in- or outside an export-processing zone (EPZ). There are EPZs in the regions of Dhaka, Chattagram and Narayangonj (National Board of Revenue, 2016). However due to time restrictions it is beyond the scope of this research to go into

depth to why the FM-ratio in Dhaka is lower than the other three regions. The Gazipur area variable is not significant. The other two area variables: Narayangonj and Chattagram are significant.

The export variable has a negative coefficient. This variable is a proxy for the price and quality. With a higher export percentage I expect a higher output price. A higher output price leads to an increase in the supply of the output. This can be achieved via an increase in labour or in capital. Export producing factories can be located in an export-processing zone (EPZ). These zones have modern and more complex machinery. Therefore I can expect a decrease in FM-ratio. However in this data set it is not clear if the factory is located in an EPZ. The export variable is not significant in all tests.

The two proxies for capital intensive technology have a negative coefficient. This is in line with the expectation that an increase in capital intensive technology leads to a decrease in the FM-ratio. However, the first proxy 'production per worker' is not significant in both estimated models. However the second proxy is significant in both models even at a 1% level.

A higher total amount of machines is significantly related to a lower FM-ratio. Indicating that capital intensive technology is related to a lower percentage of female workers. In addition the production type and production area can also be related to a difference in FM-ratio.

6. Conclusion & Discussion

This chapter concludes and provides a general discussion. Section 6.1 provides the conclusions. Section 6.2 discusses this research by assessing the limitations of this research and will give a recommendation for further research.

6.1 Conclusion

The first chapter introduced the aim of this research: to establish a relation between a more capital intensive technology and the female-male labour ratio in garment factories. The second chapter gave information on the context of the RMG sector. Knitted and woven garment are the main production types. They differ, among other things, in the division of female and male labour (Ahmed, 2006; Siddiqi, 2000 in Hossain, 2012). The knitted garment production makes mainly use of male labour because it requires more skilled workers and there are relatively few skilled female workers in Bangladesh (Ahmed, 2006; Siddiqi, 2000 in Hossain, 2012).

The third chapter looked at the relation between capital intensive technology and the FM-ratio according to theory. It concluded that if the amount of capital increases this can have a positive or negative effect on the demand of other inputs depending on whether they are substitutes or complements. With regard to high skilled labour a complementary effect is expected and regarding low skilled labour a substitution effect.

The fourth chapter elaborated on the data used to establish a relation. The data used to establish a relation between the amount of capital and the FM-ratio is collected by BIDS via a survey among a representative sample of 261 garment factories in Bangladesh in 2018. The data set contains information on the amount of machines and the productivity per worker. These variables are used as proxies for the amount of capital. Data on prices of output were not available and therefore the export percentage is used as a proxy for quality, price and export-processing zones.

The fifth chapter discussed how the relation between capital intensive technology and the female-male labour ratio statistically is established. With the variables three models are econometrically estimated. The models are estimated using Ordinary Least Square (OLS). The outcomes of the three models are similar.

As expected the two proxies for the amount of capital have a negative coefficient, which indicates that an increase in capital is related to a lower FM-ratio. The proxy production per worker is however not significant in the models estimated. Nevertheless the second proxy is in both models significant, even at a 1% level.

Therefore I can conclude that a higher amount of capital intensive technology is significantly related to a lower FM-ratio. This leads to the conclusion that a lower percentage of female workers can be related to a higher amount of capital. This corresponds with the research of Caraway (2006) who states that with an increase in capital intensity the female share of employment decreases, as well as with Kucera and Tejani (2014) who discuss the defeminization of manufactory employment related to technological upgrading.

This conclusion gives new insights on the position of female garment workers. Due to the large impact of the RMG industry on the employment possibilities of women in Bangladesh a change can have a

huge impact on the lives of these women. However this research has only established a correlation, further research is necessary to establish if there is a causal relation as well.

6.2 Discussion

Data limitations

Due to data limitations not all relevant variables are included in the model. Chapter 3 states the importance of output and input prices on the ratio of capital and labour, however due to limitations it was not possible to obtain this data. A proxy for output quality and price was included (export percentage) but in this way the effect is measured indirectly, and therefore, less precise. Especially female and male labour costs and the price of capital are important to include.

Another data limitation is that it was beyond the scope of this research to specify different categories of machines. Each machine had the same value regardless of the type of machine. An exception are sewing machines, which were excluded from the proxy. However not every machine has the same (shadow) price, and therefore, by including this specific data insights on the relation between an increase in capital and the FM-ratio can be improved.

Validity & methodology

The data in this quantitative research is collected from a representative sample of factories in Bangladesh. Therefore it can be generalizable beyond the sample and can be seen as representative for factories in Bangladesh. However the sample size is relatively small: <5% of the total amount of garment factories in Bangladesh (Sarkar et al., 2017) and therefore, the external validity could have been higher by increasing the number of factories in the data set. However that data is not available.

The internal validity is based on the methodology and the conclusions that are based on this research. I estimated the model using Ordinary Least Square (OLS). Due to endogeneity, outcomes can only be interpreted as a correlation and not as a causality. In total three models were estimated, with similar outcomes. Of the proxies total amount of machines and productivity per worker the negative coefficients with regard to capital were as expected. However it is striking that the proxy total amount of machines is significant in both models at a 1% level, while the proxy productivity per worker is not significant in both models. This is an interesting difference for further research to explore.

For women in Bangladesh a decrease in labour demand in the garment industry strongly affects their job opportunities. Therefore when capital intensive technology in the garment industry increases it is important to create short and long term policy to protect women's job opportunities. On the short term policy can focus on providing women with training on the job and better education to improve their skills. This will increase their chances to keep or get a job in garment factories with more capital intensive technology. Besides this, it is also important to focus on stereotypes and gender norms. Females with high skills and high education can still miss out on job opportunities due to stereotypes.

Despite the caveats this study contributes to the knowledge of the position of women in Bangladesh. It shows that an increase in capital intensive technology is significantly related to relatively fewer women working in the garment industry.

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Appendix A

Table A1: OLS regressions results of FM-ratio on complete model (CM), FM-ratio on production per worker model (PWM) and FM-ratio on total amount of machines (TMM).

FM-ratio	Coefficient CM	Coefficient PWM	Coefficient TMM	Standard error CM	Standard error PWM	Standard error TMM	T CM	T PWM	T TMM	P>|t| CM	P>|t| PWM	P>|t| TMM
Sub sector												
Knit	-0.243	-0.239	-0.241	0.137	0.140	0.137	-1.78	-1.70	-1.76	0.077	0.091	0.080
Sweater	-0.844*	-0.807*	-0.860*	0.222	0.228	0.221	-3.81	-3.55	-3.89	0.000*	0.000*	0.000*
Survey area												
Gazipur	0.130	0.045	0.135	0.157	0.160	0.157	0.82	0.28	0.86	0.411	0.780	0.391
Narayangonj	0.482*	0.515*	0.504*	0.228	0.234	0.227	2.12	2.20	2.22	0.035*	0.029*	0.027*
Chattagram	1.263*	1.373*	1.293*	0.196	0.199	0.193	6.45	6.91	6.71	0.000*	0.000*	0.000*
Export percentage	-0.343	-0.493	-.356	0.384	0.392	0.383	0.89	-1.26	-0.93	0.373	0.210	0.353
Production per worker	-0.051	-0.036	-	0.058	0.060	-	-0.87	-0.60	-	0.384	0.547	-
Total machines	-0.075*	-	-0.073*	0.020	-	0.020	-3.65	-	-3.60	0.000*	-	0.000*
Constant	2.602*	2.390*	2.544*	0.377	0.383	0.371	6.90	6.24	6.85	0.000*	0.000*	0.000*
F	11.18*	10.30*	12.68*									
Adjusted R^2	0.261	0.220	0.262									

*Note: * for P values smaller than 0.05.*

Table A2: OLS regressions 95% confidence intervals results of FM-ratio on complete model (CM), FM-ratio on production per worker model (PWM) and FM-ratio on total amount of machines (TMM).

FM-ratio	95% Confidence interval CM		95% Confidence interval PWM		95% Confidence interval TMM	
Sub sector						
Knit	-0.513	0.027	-0.516	-0.038	-0.510	0.028
Sweater	-1.281	-0.407	-1.256	-0.359	-1.295	-0.423
Survey area						
Gazipur	-0.180	0.439	-0.270	0.340	-0.174	0.444
Narayangonj	0.033	0.932	0.054	0.976	0.057	0.950
Chattagram	0.877	1.649	0.981	1.765	0.914	1.673
Export percentage	-1.098	0.413	-1.265	0.280	-1.111	0.399
Production per worker	-0.166	0.064	-0.154	0.082	-	-
Total machines	-0.115	-0.034	-	-	-0.114	-0.033
Constant	1.858	3.344	1.634	3.144	1.812	3.275

Table A3: OLS regressions summary statistics results of FM-ratio on complete model (CM), FM-ratio on production per worker model (PWM) and FM-ratio on total amount of machines (TMM).

	Number of observations	F (8, 233)	F (7, 233)	Prob > F	R-squared	Adjusted R-squared
Complete Model	231	11.18	-	0.000*	0.287	0.261
PW Model	231	-	10.30	0.000*	0.244	0.220
TM Model	231	-	12.68	0.000*	0.285	0.262

Figure A4: Histogram of the residuals (CM)

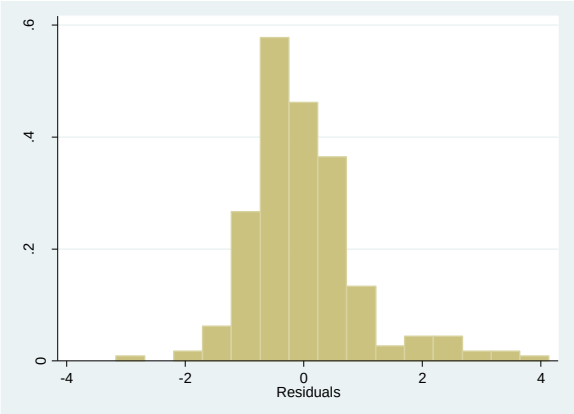

Figure A5: Histogram of the residuals (PWM)

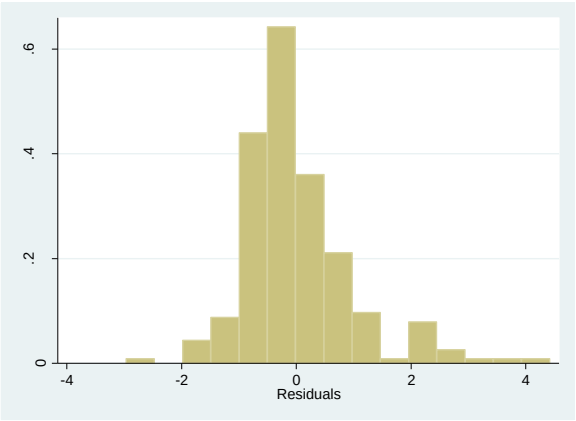

Figure A6: Histogram of the residuals (TMM)

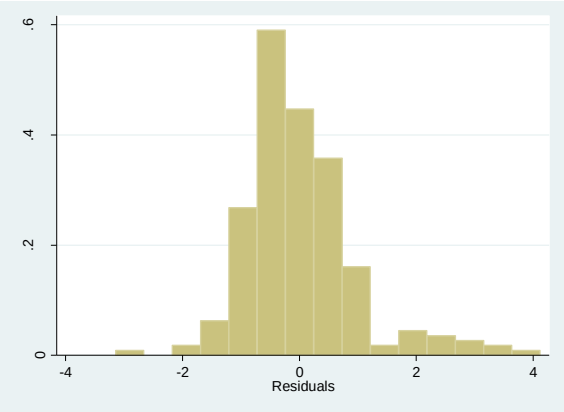

Table A7: Correlation matrix

	FM-ratio	Sub sector	Survey area	Export percentage	Production per worker	Total machines
FM-ratio	1.000					
Sub sector	-0.215	1.000				
Survey area	0.402	-0.037	1.000			
Export percentage	-0.028	-0.008	0.146	1.000		
Production per worker	-0.128	0.054	-0.181	0.013	1.000	
Total machines	-0.273	-0.042	-0.108	0.106	-0.041	1.000