

# How does productivity affect manufacturing employment in Sub-Saharan Africa?

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## **Abstract**

This thesis studies how productivity and productivity growth affect employment in the Sub-Saharan African manufacturing sector, focusing on the short run effects. Answers are sought by analyzing macroeconomic theory, existing literature and research and by conducting a data-analysis.

For developing countries, manufacturing sector is generally a very important sector for GDP and productivity growth, as well as for the creation of so called “good jobs.” However, in Sub-Saharan Africa the sector is lagging behind other countries and industries on all measures. It seems that in long term, productivity growth holds a key role in the development of the sector, but unfortunately it might have negative short run effects on employment. Uncovering the effect is thus essential for conducting optimal industrial and macroeconomic policy.

According to the examined theory, the short run impacts of productivity shocks should be positive. However, some of the underlying assumptions, like price being elastic in relation to demand, are found to be problematic in the specific context of Sub-Saharan Africa. The existing research, conducted mostly in developed countries, finds both positive and negative relationships, depending on host of factors (e.g. productivity measure). The few studies conducted in Sub-Saharan Africa have found a negative short run effect.

Because not much research on the productivity-employment relationship in the context of Sub-Saharan African manufacturing sector exists, a data-analysis with fixed effects OLS methodology is also conducted. It finds a negative relationship of labor productivity and employment that is robust to all tested specifications, but on the other hand subject to some credibility issues.

No definite answers are found, but in conclusion the evidence seems to support a view, that the short run relation of productivity and employment is typically negative in Sub-Saharan African manufacturing sector. Further research is needed to verify the results and for specific policy recommendations. For example, more evidence on country specific results is necessary. According to results, policy design should account for the short run effects of productivity growth to employment and mitigate them.

### **KEYWORDS:**

Sub-Saharan Africa, productivity, employment, manufacturing, labor productivity, total factor productivity.

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# **1. Introduction**

## **Manufacturing sector is important but in a poor state**

Manufacturing sector is very important for developing countries. Historically its success has been possibly the most important pre-requisite for long lasting, sustained growth (Rodrik, 2012). According to Rodrik (2014), industrialization is very essential also for the Sub-Saharan African countries, but lagging behind, compared to countries at similar levels of GDP per capita. When compared to other sectors, the data of De Vries et al (2013a) reveals that not only in terms of GDP, but also in terms of value added, employment, productivity and exports, manufacturing sector is lagging behind.

## **Improvements in both manufacturing productivity and employment are needed**

It seems to be quite clear that what Sub-Saharan African manufacturing sector needs on long term is productivity growth. For example ILO (2005) makes strong arguments for productivity growth in the developing countries; “The magnitude of underemployment and poverty in the developing world is a reflection, not of the absence of economic activity of the poor, but of the unproductive nature of that activity.” Also Rodrik (2014), Filmer and Fox (2014), Yusof (2007) and many others strongly argue that productivity growth is crucial for the growth and development of manufacturing sector in Sub-Saharan Africa. However, the importance of manufacturing employment is also emphasized (ILO, 2005; Filmer and Fox, 2014, among others), because it is such a potential solution to unemployment, lack of good quality jobs and economic informality.

## **A short run and a medium run trade-off**

While the productivity growth is an important goal for manufacturing (and other sectors too), it might have unwanted side effects. Importantly, productivity shocks might have negative short run effects on the employment. As Cavelaars (2005) puts it, whether a tradeoff between productivity development and employment development

exists in manufacturing sector has relevancy to industrial as well as macroeconomic policies.

### **Reasons why productivity is the priority**

However, there is a strong understanding, that whether or not productivity growth causes negative short run effects on employment in a developing country, it should not be compromised. ILO (2005) states, that “no country can afford to neglect improving the productivity of its workforce.” Rather, if a tradeoff exists, it implies that the government should consider extra efforts to support employment while boosting productivity. Yusof (2007), among others, argues that if productivity growth has negative effects on employment, the challenge is in maintaining good employment possibilities despite of the productivity growth. Also according to ILO (2005) it is essential to “develop pro-growth progressive policies at the micro- and macro-levels – to ensure growth in the long term – while at the same time providing adjustment strategies (in the form of financial assistance and retraining) for displaced workers.”

### **The research gap**

A lot of research has been done to find out how productivity and employment affect each other in the short run on manufacturing sector and more generally. However, a large majority of that work is conducted in U.S., Europe and other industrialized countries. On the other hand, not much research has been conducted in Sub-Saharan Africa. Applying results from the developed world to developing world (and especially Sub-Saharan Africa) is problematic, because the context and circumstances for manufacturing are totally different. This is discussed in detail in the Chapter 2. Assumptions that are held given in the developed world might be very unrealistic in the Sub-Saharan Africa. Consequently, it is important to bring the research into Sub-Saharan African context. That is also what this thesis attempts to do.

### **How does this thesis contribute to the research?**

A few important questions that need to be addressed are: How does productivity and its growth affect manufacturing employment in Sub-Saharan Africa? Does a short run trade-off exist? And if so, how significant is it? How could it be mitigated? These are

very wide questions. Because of the length limitations of this thesis, the first question is chosen as the focal point and research question of this thesis. Furthermore, the analysis focuses mostly in the short run and medium run (understood as a maximum of a few years) relationships. Nevertheless, also the other stated questions are occasionally addressed to give some background and context.

Even though this thesis serves the final goal of finding whether a short run trade-off between productivity and employment exists in Sub-Saharan Africa, it does not assume to find the final answers. The goal of the analysis is more modest; it is to give one perspective, something that further research could hopefully build on.

### **How are the research questions answered?**

The research questions are addressed with a multifaceted approach. Firstly, the situation of manufacturing in Sub-Saharan Africa is evaluated in Chapter 2. This gives some background on the topic of the thesis.

Secondly, in Chapter 3, the macroeconomic theory of Sørensen and Whitta-Jacobsen (2010) is analyzed to find out what is the short run productivity-employment relationship in macroeconomic theory and what are the assumptions behind it. The models and assumptions are then evaluated in Sub-Saharan African context.

Thirdly, the existing research and their results are assessed in Chapter 4. The chapter consists of an introduction to some research approaches, and more importantly, an overview of the existing research. Some of the most important sources are ILO (2005), Wakeford (2004), Mollick and Cabral (2009), Chang and Hong (2006) and Gali (1999). The focus is kept on the results and findings that could be most relevant for Sub-Saharan Africa.

Fourth, in Chapter 5 an empirical study is conducted to evaluate the short run relation of labor productivity and employment in Sub-Saharan Africa. Finally, Chapter 6 concludes the key findings.



It is clear that this thesis alone does not give final answers – more research is obviously needed. Nevertheless, this thesis gives some initial perspectives, which the further research can possibly utilize.

### **Key findings**

A host of findings emerge, most important of which are the following. The current state of manufacturing, including employment and productivity, is found to be poor. Productivity growth seems to be the most important policy target, but its possible short run effects on employment should be taken into account and mitigated, if negative. According to theory, the short run impacts are positive, but the assumptions might not be credible in the Sub-Saharan African context. The existing research, on the other hand, finds both positive and negative relationships, depending on host of factors (productivity measure, for example). Data-analysis finds a negative relationship of productivity and employment, but the result is also subject to some credibility issues.

Finally, no definite answers are found, but in conclusion, the evidence seems to support a view, that the short run relation of productivity and employment might be negative in Sub-Saharan Africa.

## **2. Manufacturing in Sub-Saharan Africa**

### **Importance of manufacturing sector as a whole**

Regarding the development of poor countries, like those in Sub-Saharan Africa, manufacturing is a hugely important sector. Almost all of the countries that have grown rapidly (say at 4.5% per annum) over a period of three decades or more have done so by industrializing (Rodrik 2012). Furthermore, export oriented manufacturing has historically been a huge success in development of countries (Rodrik, 2014 and Palley, 2011).

### **Manufacturing and structural change**

However, it seems that industrialization is not progressing in Sub-Saharan Africa. For example the United Nations Economic Commission for Africa (UNECA, 2014) has raised concerns about inadequate structural change in Africa, referring to the slow industrialization.

According to the Lewis' (1954) dual model of economy, a nation's economy grows when the labor force moves from non-productive traditional sectors (agriculture) to more productive modern sectors of the economy (manufacturing). This is not happening currently in Sub-Saharan Africa. Instead, labor is mostly moving from agriculture to the unproductive and informal service sector (Filmer and Fox, 2014). According to Rodrik (2014), "Industrialization has lost ground since the mid-1970s, and not much of a recovery seems to have taken place in recent decades." In fact, the sector's average share of GDP is no more than about 10 percent, down from almost 15 percent in 1975. This seems to be a consistent trend across all data sources from De Vries et al (2013a) to World Bank's World Development Indicators (World Bank, 2014). According to researchers and literature, this is quite worrying. The potential of industrialization is underutilized compared to other places (Rodrik, 2014).

### **Manufacturing is in a poor state**

In Sub-Saharan Africa, manufacturing is not only diminishing as a share of GDP, but also otherwise lagging behind other sectors. According to the data of De Vries et al (2013a), the value added, employment and relative productivity levels of manufacturing have declined relative to other sectors. Africa Economic Outlook (2013) reveals that also the export share of manufacturing is diminishing. The processed goods' (including manufactures) share of exports has diminished from approximately 40% to 30%, since the beginning of 2000's (Africa Economic Outlook, 2013). This is partly due to the fast growth of natural resource exports, but also due to slow manufacturing growth. Manufacturing sector is simply not exporting enough, and the local markets are too small (Rodrik, 2014; Filmer and Fox, 2014).

Unfortunately, compared to manufacturing, natural resource economy can be often much less beneficial in terms of development, because it tends to be more capital intensive, create enclaves within the economy (Rodrik, 2014), often worsens corruption problems and can undermine development incentives in policy making (Collier, 2007). For these and some other reason, it is often not seen as a preferential development strategy for developing countries.

### **Why is manufacturing in so poor state?**

It is important to keep in mind, that there are no panaceas to cure the Sub-Saharan African manufacturing sectors. In fact, a host of problems exists. Because the problems are very intertwined, solving just one of them (low productivity, for example) might not help much if the other problems remain (bad governance and high corruption, for example). Consequently, a multi facet strategy is needed to address the problems. This thesis concentrates on productivity growth as a solution, but next some of the other key solutions and problems related to the manufacturing sector will be shortly discussed, too.

### **Lack of global competitiveness**

“Competitiveness” is an ambiguous and somewhat disputed term, but all the same quite intuitive and useful in explaining problems of Sub-Saharan African manufacturing. The definition of the term is not discussed in detail here, suffice it to say that the competitiveness of Sub-Saharan African manufacturing sector is very low. For example, in the Global Competitiveness Index by World Economic Forum and Doing Business Index by World Bank, Sub-Saharan African countries are mostly among the worst. An important matter regarding the competitiveness is typically its level in relation to foreign manufacturers, because that largely defines the export demand for manufactures. Good competitiveness on global scale gives the opportunity for exporting, which has the benefit of practically unlimited market size (Palley, 2011). Moreover, Nordhaus (2005) defines that productivity compared to foreign competitors is the key factor contributing to the growth of the manufacturing sector and employment.

### **Lack of competition**

Competition is an important factor that is often necessary to drive and motivate productivity growth, which in turn leads also to better competitiveness. However, as Filmer and Fox (2014) remark, the size of the domestic markets in Sub-Saharan Africa are typically really small and able to support just a few companies in each manufacturing industry. This is rarely enough to ensure competitive pressure. Filmer and Fox (2014) also continue, that the competitive pressure from abroad is very low.

According to Filmer and Fox (2014), a good example of a manifestation of the low competition is that in many Sub-Saharan African countries very unproductive manufacturing companies hold a lot of market power. Monopolies exist and competition is low due to relatively common corruption, political favoritism, entry barriers and harmful regulations. A good example is that in South Africa the manufacturing firms are on average actually more productive than in China, but in China the efficient firms dominate markets whereas in South Africa they don't (Filmer and Fox, 2014).

### **Lack of agglomeration**

Furthermore, Sub-Saharan African manufacturing sector has never really gained agglomeration economies. (Filmer and Fox, 2014; Collier, 2007). An agglomeration economy means the state of development of some sector, in which enough economic activity is accumulated in some area so that positive spill over effects are created and the agglomerate gains competitive advantage (Collier, 2007).

### **Poor "business climate"**

According to Rodrik (2014), there is almost a universal consensus that a lot of the problems of Sub-Saharan Africa and its manufacturing sector are due to so called "poor business climate", which is another somewhat ambiguous but well suited term. It simply describes the multitude of difficulties related to manufacturing in Sub-Saharan Africa, but also to development in general. Rodrik (2014) lists the following problems; the factor endowments (like capital, human capital, utilities, etc.) are mostly scarce and relatively expensive or accrue relatively large additional costs, and the costs of

transportation, trade barriers and some other aspects of conducting business are relatively high in Sub-Saharan Africa. Filmer and Fox (2014) state that also things like unstable macroeconomic environment, bad infrastructure, costs of starting a business, bad public services and trade barriers account to the “poor business climate.” Collier (2007) brings up also the effects of bad governance, political instability, geographic landlock combined with “bad” neighboring countries, Dutch disease arising from natural resource exports, and their negative effects on business and trade.

### **Productivity**

Finally, an important constraint for the manufacturing development and production in Sub-Saharan Africa is its low productivity. The productivity situation will be discussed in more detail shortly in Chapter 2.2. The next chapter will review the state, role and importance of the manufacturing employment.

## **2.1. Manufacturing employment**

Manufacturing employment can potentially have a large role in development of Sub-Saharan Africa, just like it had in East-Asia. Increasing the amount of manufacturing employment would potentially be very beneficial for several reasons, some of which will be presented next.

### **Unemployment situation and the dire need for jobs**

Firstly, the need for wage jobs in Sub-Saharan Africa is huge. The population is growing faster than anywhere else in the world and in addition it's very young. The labor force in Sub-Saharan Africa is expected to increase with a staggering 11 million people every year for the next ten years, most of which will be new entrants seeking for their first job. The labor force increase creates a huge opportunity for a demographic dividend, but even more so, it seems to be creating a challenge, since the youth unemployment rates are soaring, and currently it seems that many countries are not managing to use the demographic dividends in their favor. Increasing the demand for labor seems to be necessary. (Filmer and Fox, 2014).

### **Role of the “good jobs”**

Secondly, need for the so-called “good jobs” in Sub-Saharan Africa is dire. For a large part of people who have managed to climb out of poverty, an income secure wage job has been a primary stepping-stone. (Banerjee and Duflo, 2011). A key aspect of a good job is that it provides income security. This is crucially important for poor people, because it gives them food security, helps them to get out of the “poverty mind set” and enables them to start investing in their lives, families and future. (Banerjee and Duflo, 2011).

### **Informality of employment**

Thirdly, the role of informal employment in Sub-Saharan Africa is huge. In 2005, it was estimated to absorb about 60 percent of the urban labor force in Africa. It also generated more than 93 percent of all new jobs in the region in the 1990’s. There are several problems with the informal employment. It is typically biased towards employment growth at the expense of productivity growth and also heavily biased towards unskilled labor. Clearly a large informal economy is not a sign of favorable economic development. On the contrary, it points to the existence of a dual economy. (ILO, 2005). Manufacturing, on the other hand, is potentially a fast way to boost formal and modern employment (Filmer and Fox, 2014).

Consequently, creating more manufacturing employment could ease the unemployment situation, capitalize on the demographic dividend, and increase the amount of formal and “good” jobs needed for poverty reduction. Also many other beneficial effects exist. As Filmer and Fox (2014) conclude, (trade oriented) manufacturing can be an extremely fast way to create modern wage jobs.

### **Situation of the manufacturing employment**

Unfortunately, very low percentage of work force is currently employed in the manufacturing sector, only about 8-9% according to Rodrik (2014). According to Filmer and Fox (2014), on the *modern* manufacturing sector works only 3% of the labor in Sub-Saharan Africa and of the non-farm wage jobs, only 10% are in the manufacturing sector. When manufacturing employment is compared to other

countries, for example to Asian countries as Rodrik (2014) does, the manufacturing sector's share of employment is markedly lower in Sub-Saharan Africa compared to what it was in the Asian countries when they were on same GDP levels. To conclude, manufacturing employment seems to be on suboptimal levels.

## **2.2. Manufacturing productivity**

### **Importance of the manufacturing productivity**

The importance of productivity growth in manufacturing (and on other sectors as well) is huge in Sub-Saharan Africa. There are several reasons. Productivity has large effects on the general development of a country, its GDP, employment and also poverty reduction. The list of benefits goes on. Just a few examples will be given here, but more can be read in the report of ILO (2005).

### **Productivity's relation to GDP, development and poverty**

Productivity is a key factor defining the GDP in macroeconomics (Abel et al, 2008; Sørensen and Whitta-Jacobsen, 2010, etc.). Real GDP can also rise from employment growth (hours worked), but on long term and especially if population does not grow, productivity growth is typically the primary channel through which real GDP increases.

From the perspective of poverty reduction, for example ILO (2005) has stated that productivity growth is essential for it, finding that both productivity growth and levels are strongly, negatively associated with changes in poverty rates. They also found that low productivity was strongly related to long run underemployment.

According to standard macroeconomics (like Abel et al, 2008) the wage growth typically originates from productivity growth. Higher productivity allows higher wages, which in turn obviously allows higher standard of living and creates positive spillovers to the economy.

In long run, productivity is essential also for the employment. According to Filmer and Fox (2014), productivity growth is an important part of the solution to the

unemployment problem. They say that “a balanced approach focused on building skills, raising productivity, and increasing the demand for labor is necessary to tackle the unemployment problem.” Yusof (2007) argues, that the challenge for developing countries is to promote higher productivity growth for long-run sustainable growth, while at the same time providing short- and medium-term solutions for providing labor with decent employment opportunities.

### **Situation of the manufacturing productivity**

So what is the situation of manufacturing productivity in Sub-Saharan Africa? Simply put, productivity is low. According to UNECA (2014), from 1970 to 2000, the annual total factor productivity growth was actually negative in Sub-Saharan Africa. During recent years, the growth rate has finally turned positive. When comparing to U.S., the manufacturing productivity has turned worse and worse for decades, now being under 10% of U.S. productivity level. Productivity is also decreasing in comparison to other domestic sectors. According to the data of De Vries et al (2013), the productivity of manufacturing in Sub-Saharan Africa in 2010 was only 1,6 times higher than in the average productivity in the economy, whereas it used to be 2,8 times the average in 1975.

### **Why is manufacturing productivity so low?**

Several reasons for low manufacturing productivity exist. Filmer and Fox (2014) argue, that the productivity of an industry or sector can be divided into two components; productivity of an average company and the allocation of market share between productive and unproductive companies. In Sub-Saharan Africa, both measures are bad. When it comes to market shares of bad companies, they are astonishingly large. Unproductive companies fare way too well in Sub-Saharan Africa. Average productivity is good in a few countries, but the problem is that it doesn't translate into market share, due to political reasons, for example. (Filmer and Fox, 2014).

The level of management, incentives, processes, and R&D is also low in Sub-Saharan Africa. This constrains both total factor productivity and labor productivity. The low labor productivity in Sub-Saharan Africa is partly due to inadequate capital per worker,



too. Amount of domestic capital and access to international capital is very limited. (Filmer and Fox, 2014).

### **3. Productivity-Employment relationship in macroeconomic theory**

The relationship of productivity and employment is a very complex and multi-dimensional issue. The concentration is on the study of the short run relationship, but the long run relationship is also discussed very shortly.

The Classical and Real Business Cycle macroeconomic theories typically support the positive short run effect from productivity to employment. On the other hand, New Keynesian theories seem to be in favor of the negative short run effects. The negative short run effect is most often explained with sticky-price models, like the one of Gali (1999), but also found to be possible in dynamic general equilibrium models, like in the papers of Gali and Rabanal (2005) and Francis and Ramey (2005).

Thus, it is clear that no theoretical consensus exists. Because the frames of this thesis are limited, the short run effects of only one theory are studied. This is the Sørensen and Whitta-Jacobsen's (2010) textbook on advanced macroeconomics.

#### **3.1. Long run relationship**

This thesis does not concentrate on the long run relationship of productivity and employment, so the theoretical background of that relation will not be discussed in depth. There is more accord considering the long run relationship, than the short run relationship. Historical evidence has typically pointed to the direction of no long run relationship (Blanchard et al, 1995, for example). Whereas productivity growth and technological advancements have sometimes destroyed jobs on specific sectors, new sectors have typically emerged to absorb the labor (Blanchard et al, 1995). In economics, this is called as the creative destruction.

For example ILO (2005) argues that there is no necessary long run trade-off between the growth of productivity and employment; “Markets have historically compensated for these changes [meaning possible short run changes in employment], as higher rates of productivity growth have been accompanied by higher rates of employment growth.”

### **3.2. Introduction to Sørensen and Whitta-Jacobsen (2010)**

The examination of the short run relationship of productivity and employment will be based primarily on Sørensen and Whitta-Jacobsen’s (2010) textbook on advanced macroeconomics, because it properly presents the standard macro economic models. In the book they present a framework for Phillips curve and Wage-setting – Price-setting model (WS-PS model), explaining short run relation of inflation & unemployment and the long run equilibrium rate of unemployment. As this thesis is more interested in the effects of productivity shocks on employment, the analysis will concentrate more on the equations defining the demand of labor (price-setting curves), which in the models explain those effects.

Although the supply and demand equations of labor are not in the typical forms of price-setting and wage-setting curves (real wage as a function of unemployment), they are nevertheless referred to as price-setting and wage-setting curves. Equations that define these curves are referred to as price-setting and wage-setting equations.

The most important goal of the analysis is to find the direction of the effect of productivity on employment in short run (negative or positive), not the exact amount of the effect. Furthermore, the analysis concentrates on the sectoral rather than the aggregate level equations, as the thesis is concerned with the manufacturing sector. As Sørensen and Whitta-Jacobsen (2010) derive some of the models for aggregate economy level only, the sectoral equations for these models are derived in the analysis.

Sørensen and Whitta-Jacobsen (2010) induce three different WS-PS models, which will be described at first. To clarify the notation, the models will be here named as Models I, II, and III. The book also contains another model, which deals with unemployment, not the demand for labor. Consequently it is not included in the analysis.

Because none of the assumptions that separate the models (wage and price flexibility) are clearly wrong or right, analyzing each model is necessary. As will be seen in the Chapter 3.4, each of the wage and price flexibility combinations is probably valid in some Sub-Saharan African country and at some point of time. Thus, all of the models need to be analyzed.

The wage-setting curves will not be presented in detail in the analysis, because they are assumed fixed. Two different wage-setting curves are used in the Models I, II and III. Models I and II use a wage-setting curve, where wage is defined rigidly by trade unions in the beginning of each period. Model III uses a wage setting curve, for which wage is defined continuously and flexibly at the labor markets. The exact forms and details relating to the Wage-Setting curves can be found in the book of Sørensen and Whitta-Jacobsen's (2010).

In Chapter 3.3 the productivity-employment relationship of each model will be assessed and in Chapter 3.4 the assumptions behind the models will be considered in depth. Lastly, in Chapter 3.5 an attempt is made to build an optimal model for the Sub-Saharan African setting, combining the most realistic appearing assumptions from the models of Sørensen and Whitta-Jacobsen (2010). This will be called as the Model IV.

### **3.3. Models of Sørensen and Whitta-Jacobsen (2010)**

#### **Model I**

Model I assumes sticky nominal wages and flexible output prices. All workers of each sector are assumed to be organized in trade unions, which monopolize the supply of labor in each sector. Thus, the trade unions set the price of labor (the nominal wage) at each sector. Furthermore, the workers are assumed to be educated and trained to work

on one specific sector only. They are either employed on their sector or unemployed, which allows them to have a real income from an unemployment benefit  $b$ . At the beginning of each period, the trade union will set again a new nominal wage  $W_i$  for the sector  $i$ , targeting real wage  $w_i$ , so as to maximize its utility function  $\Omega$ . Hours per worker are assumed fixed. Employers are assumed to have the 'right to manage', meaning that they are always allowed to choose the amount of labor they hire, given the nominal wage.

In Model I, the price-setting equation of a specific sector is built on the assumption that an employer at the sector produces according to the production function  $Y_i = BL_i^{1-\alpha}$ , in which  $Y_i$  represents the output of the employer at sector  $i$ ,  $B$  represents the productivity parameter,  $L_i$  is the labor employed in the industry and  $1 - \alpha$  is the labor share of income. Sørensen and Whitta-Jacobsen (2010) don't specify the variable  $B$  in detail, but probably the best interpretation for it is total factor productivity. Capital  $K$  is omitted from the production function due to an assumption that capital is fixed in the short run.

The employer is assumed to produce a differentiated output, admitting it some monopoly power. Therefore, the employer faces a demand curve for the output according to equation  $Y_i = \left(\frac{P_i}{P}\right)^{-\sigma} \frac{Y}{n}$ , where  $P_i$  is the price of one unit of output at sector  $i$ ,  $P$  is the aggregate price level,  $Y$  is the output of all sectors and  $n$  is the amount of (equal sized) sectors. Price elasticity of demand  $\sigma$  can be interpreted as the strength of the product market competition in the sector. The assumption whether the sectors are of equal size does not matter for the analysis of productivity-employment relationship.

Based on the abovementioned equations, equations for marginal cost of production and marginal revenue of production can be derived. To calculate the marginal cost of production, diminishing marginal productivity of labor is assumed, as the capital stock is considered fixed in the short run. Finally, the company will then maximize its profits by setting a price that equates marginal cost to marginal revenue:

$$P_i = m^p \left( \frac{W_i}{(1-\alpha)BL_i^{-\alpha}} \right), \quad m^p \equiv \frac{\sigma}{\sigma-1} > 1 \quad (1)$$

This equation is in effect the price-setting equation of the sector  $i$ , defining the demand for labor in that sector. Term  $m^p$  is the mark-up cost, set by the employer on top of the marginal cost. It can be interpreted as the cost of capital and the economic rents.  $m^p > 1$  follows naturally from the assumption  $\sigma > 1$ .

Sørensen and Whitta-Jacobsen (2010) leave the equation (1) in the form presented above, but in this thesis it makes sense to continue the modification of the equation in order to arrive in a more easy-to-interpret form, that is also a more standard way of describing a price-setting curve. By dividing the equation with aggregate price level  $P$  and then rewriting it, the equation turns into form:

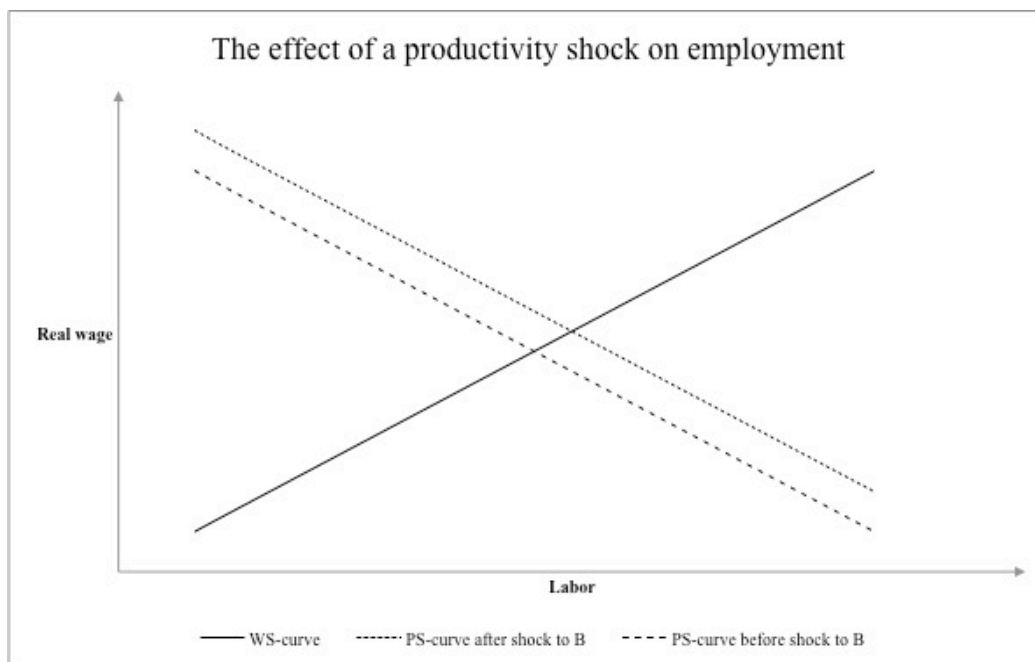
$$\frac{W_i}{P} = \frac{P_i (1-\alpha)BL_i^{-\alpha}}{P m^p} \quad (2)$$

In this equation, the term  $W_i/P$  represents the real wage  $w_i$  at the sector  $i$ . To analyze, how a productivity shock would affect the employment, let's first consider the right hand side of the equation. Firstly, it is easy to see that by itself, an increase in term  $B$  will also increase the value of the equation. However, effects on the other terms need to be assessed also. It is assumed that labor  $L_i$  is not directly affected by productivity  $B$ . On the other hand term  $P_i$ , which is the optimal (profit maximizing) output price at sector  $i$ , is directly affected. As the productivity term  $B$  is in the denominator of the equation (1), it is easy to see that an increase of the term  $B$  will decrease the value of  $P_i$ . The term  $P$  is a combination calculated from  $P_i$  and prices of other sectors (which are considered constant here). So if  $P_i$  declines, also  $P$  will decline. So productivity shock will directly change not only  $B$ , but also  $P_i$  and  $P$ . Therefore, it is difficult to say what is the aggregate effect on the right hand side of the equation.

By analyzing the left hand side of the equation (2), it is easier to see what happens. As the decline in  $P_i$  will lead to decline in  $P$ , and nominal wage  $W_i$  remains fixed in the short run, it is seen that the real wage  $W_i/P$  will increase. As the real wage of each

corresponding level of labor  $L_i$  thus increases, the price-setting curve (2) gets lifted upwards. So even if labor  $L_i$  is not directly affected by a productivity shock, indirectly it is.

To conclude, the price-setting curve gets lifted up, thus increasing the equilibrium levels of real wage and employment, which are defined by the intersection of the price-setting curve and the wage-setting curve. Hence, productivity affects employment positively in the short run. This is depicted in the graph below. Typically, the WS-PS Model is presented in coordinates of real wage and unemployment. In this case, using coordinates of real wage and employment is a more informative way of presenting the same thing, as the thesis is specifically interested in employment.



**GRAPH 1 - The effect of a productivity shock on employment.** A productivity shock lifts the Price Setting curve upwards. Consequently, the equilibrium point of Price Setting curve and Wage Setting curve (their intersection) also moves upwards, so that equilibrium values of real wage and labor increase.

## Model II

The Model II allows also prices to be sticky on the short run. In this model, Sørensen and Whitta-Jacobsen (2010) divide firms into two categories. First category consists of the firms that experience so high menu costs (the costs of updating price list of their

products), that they will keep their prices fixed in the short run, updating prices only at the beginning of each period. These are called firms with the sticky prices. Second group of firms experiences lower menu costs, thus keeping their prices flexible and continuously updating them. A labor demand equation is then derived as a weighted combination of the labor demand equations of these two types of firms. Because the effect of productivity shocks on employment for the flexible price firms with sticky wages was already defined with the Model I, it now suffices to examine how productivity shocks affect the labor demand equation of firms with sticky prices. Thus, to improve clarity, Model II is in this thesis defined as consisting of the sticky price firms only.

As Sørensen and Whitta-Jacobsen (2010) explain, the sticky price firms cannot know their marginal costs beforehand and will therefore try to minimize the expected marginal costs of production by assuming average, ‘natural’ rates of employment  $\bar{L}$ . Thus, their price-setting equation is a slight modification of the equation (1):

$$P_i^s = m^p \frac{W_i}{(1-\alpha)\bar{L}^{-\alpha}} \quad (3)$$

$P_i^s$  is the profit maximizing price, chosen by the sticky price firms in the beginning of each period. This equation differs from the equation (1) in at least one critical way. This is not a continuously adapting equality, like equation (1), but only used at the beginning of each period. However, the equation defines optimal proportions of price, nominal wage and productivity, so optimally the firms should adapt the nominal wage in response to a productivity shock. In this model it is not possible, as Sørensen and Whitta-Jacobsen (2010) continue to assume that trade unions set wages, which are thus fixed in the short run. As neither prices nor nominal wages adapt on short run, labor in the Model II will remain unaffected.

### **Model III**

The Model III, also called as the worker-misperception model, assumes that both wages and prices are flexible. In this sense, it is the opposite of the Model II. In this model, the wage-setting equation is not defined by trade unions, but by the individual workers

and firms, so that it is continuously and flexibly adapting to the circumstances. Keeping this in mind, also the wage-setting equation changes into another one, in which the wages are defined flexibly on the labor markets, not by trade unions.

Because the prices are assumed flexible, the equations (1) and (2) define the demand for labor. But for the reason that now also the nominal wage  $W_i$  is flexible in (1) and (2), the mechanism of adaptation is different. The profit maximizing firm can and will adapt to a productivity shock in two possible ways: by either decreasing prices  $P_i$  or by increasing nominal wage  $W_i$ . Either of these adaptations will increase real wage  $w_i$ , which in turn will lead to a movement of price-setting curve and increase of employment, as in Model I and Graph 1. Thus, the effect of a positive productivity shock on employment is positive.

### **3.4. Assumptions behind the models**

Now it is time to assess the assumptions behind the models and find out which of them might be realistic and which might be not, particularly in the context of Sub-Saharan Africa.

In regard to the models, one of the most important assessments is whether the prices and wages are flexible or fixed in the short run. To begin with the wages, let's consider the assumption of wage-setting trade unions, as in Models I and II. It seems, that on average, the assumption does not hold very well. According to Schillinger (2005), the trade unions in Sub-Saharan Africa were (at least in 2005) mostly weak across Africa, but not so weak as to be ignored. Their power to influence wages and working conditions and to defend workers has suffered after the 1980's, when the political connections of the unions were widely broken. Also the informalisation of the economies has decreased the power of the trade unions (Schillinger, 2005). In contrast to the general situation, in South Africa the trade unions are on the other hand an important economic and political force (Schultz and Mwabu, 1998). To conclude, it seems that on average the trade unions in Sub-Saharan Africa are quite weak and the assumption of flexible wages is more realistic than rigid wages. However, the findings



of Schillinger (2005) and Schultz and Mwabu (1998) clearly show that the assumption of wage setting trade unions cannot be totally rejected either.

In contrast, the prices seem to be rather rigid. Sørensen and Whitta-Jacobsen (2010) present a table where data is based on Hansen and Hansen (2006), that presents the frequency of price changes and the average duration of prices in Euro area and Denmark. On average, the duration of a price was quite long, 13 months in Euro area and 15,5 months in Denmark, signifying sticky prices. Moreover, on the non-energy manufacturing sector, the prices were considerably more rigid than the average. Even though the Sub-Saharan African countries have faced several high inflation periods during the past decades (World Bank, 2014), which has created an extra incentive to update prices more frequently, it is quite probable that to some extent the manufacturing prices have been sticky also in Sub-Saharan Africa. Consequently, it seems realistic to assume partially sticky prices, just like in the Sørensen and Whitta-Jacobsen's (2010) original Model II, where part of the firms face sticky prices.

To assess the assumptions behind the Model I, let's first consider the assumption that labor is fixed to the manufacturing sector and cannot work at other sectors. This is obviously incorrect. However, taking this into account won't probably affect the model very much. It is possible to interpret that the manufacturing unemployment  $u$  in this case simply means working at some other sectors. As in Sub-Saharan Africa the alternative sectors tend to be less modern on average (Filmer and Fox, 2014), it doesn't change the dynamics of the model (workers probably still prefer to be employed within manufacturing sector than on some other sector).

Assumption regarding the fixed hours per worker is naturally also incorrect, but it is a necessary assumption to keep the model simple enough. It allows one to use the number of workers as an approximation of labor. This should be 'good enough' for the model. Moreover, in reality (as in the data-analysis of this thesis), using hours worked can be impossible due to lack of data, making this an unavoidable assumption.

In contrast, the assumption of ‘right to manage’, meaning that the firms can flexibly choose the amount of labor they hire, is likely to be true in Sub-Saharan Africa. This is probably the case, because as explained the trade unions are on average weak.

Lastly, it is also important to notice that the forms of the production function and the demand curve faced by the firms are critical assumptions. Firstly, the Cobb-Douglas production function is used as a basis of the production function in all of the models, thus playing a part in defining the price-setting equation. Questioning this production function and researching alternative production functions does not fit in the scope of this thesis. However, omitting capital and human capital from the production function seem to be justifiable choices; it seems very likely that they are fixed in the short run.

The choice of demand function,  $Y_i = \left(\frac{P_i}{P}\right)^{-\sigma} \frac{Y}{n}$ , seems to be acceptable too. The shape of the curve, defined by  $(P_i/P)^{-\sigma}$  appears to be quite credible. Sørensen and Whitta-Jacobsen (2010) justify this mathematical form with the argument that the firm is assumed to produce a differentiated output, admitting it some monopoly power. In Sub-Saharan Africa the assumption of some monopoly power seems acceptable, because the competition there is on average low (Filmer and Fox, 2014). On the other hand, the assumption that sectoral demand is defined by  $Y/n$ , does not appear credible, since sectors are not likely to be evenly sized. But as mentioned, from the perspective of the analysis this is not a critical assumption, since it doesn’t affect the marginal revenue of the company  $(P_i(1 - 1/\sigma))$ , as defined by Sørensen and Whitta-Jacobsen, 2010).

In contrast, a critical assumption might be the one that  $\sigma > 1$ , as this excludes all (quite realistic) situations where the demand is inelastic in relation to price. The mathematical properties of the price-setting equations (1) and (3) make this assumption obligatory, since a situation where  $0 < \sigma < 1$  would imply negative prices in (1) and (3).

According to Nordhaus (2005), manufacturing demand is typically elastic in relation to price, but his comment is probably more related to developed countries, like U.S. As

mentioned by Sørensen and Whitta-Jacobsen (2010),  $\sigma$  can also be interpreted as a measure of competition, so that large value implies more and small value implies less competition. In this light,  $\sigma > 1$  might be a quite unrealistic assumption, because of the low competition in many markets in Sub-Saharan Africa (Filmer and Fox, 2014). Consequently, in the Sub-Saharan African setting the mathematical representation of the price-setting equations (1) and (3) might be a critical flaw, as it excludes the quite realistic inelastic values of  $\sigma$ .

### **3.5. Composing a model for the Sub-Saharan African setting**

As the analysis of assumptions is now conducted, it is possible to try to build a new model with optimal assumptions. The model attempts to mimic the circumstances of the manufacturing sector in Sub-Saharan Africa as realistically as possible. After arriving at the final model, the short run effects of productivity on employment will be researched again, to verify the effect of productivity shocks in the new model.

The results of the analysis seem to be supporting a model with assumptions of flexible wages and partially rigid prices, due to reasons presented below. According to the earlier deduction that trade unions are unlikely to play significant role in the wage-setting, it seems the most realistic option to assume that supply of labor is defined flexibly, like in the Model III.

Similarly, according to the previous arguments presented in favor of the sticky prices in manufacturing, partial sticky prices will be assumed. In this case, partial means that for some of the firms prices are still flexible, and continue to be defined by the Model III. For the rest of the firms, a new model is needed with flexible wages and sticky prices. This model will be named as the Model IV.

Composing of the Model IV can start from the price-setting equation of the sticky price firms, equation (3). Again, like with equation (1), by dividing the equation (3) with aggregate price level  $P$  and then rewriting it the equation turns into:

$$\frac{W_i}{P} = \frac{P_i^S (1-\alpha) B \bar{L}_i^{-\alpha}}{P m^p} \quad (4)$$

This is a more easy to interpret form of equation (3). Let's consider the effects of a productivity shock. What are the terms in the model that change directly as  $B$  increases? As the model has rigid prices, terms  $P$  and  $P_i^S$  cannot change in the short run, but in contrast to Model II, nominal wage  $W_i$  is now flexible. Consequently, when  $B$  changes it affects directly only the term  $W_i$  on the left side of the equation. Following a positive shock to  $B$ ,  $W_i$  and real wage  $w_i$  will grow. At this point, it is easy to see, that for each value of the equilibrium labor  $\bar{L}_i$ , the value of real wage  $w_i$  is now larger. In other words, the price-setting curve has moved upwards. Conversely, this also means, that for each value of real wage, the value of  $\bar{L}_i$  is higher. Thus, productivity affects employment positively in Model IV. Unlike in the Model I, it is not the prices but the nominal wage that reacts to productivity, causing the short run fluctuations in employment.

At this point it is possible to conclude the analysis of the Sørensen and Whitta-Jacobsen's (2010) models. In all models except the Model II (in which the rigidities prevent any short run effects), a positive productivity shock increases employment in short run. This result implicates, that the positive effect of the productivity shock should be quite robust to the assumptions differentiating the models.

According to the analysis conducted, the relationship of productivity and employment can probably be most realistically assessed with a combination of the Models III and IV, where wages are flexible and prices either flexible or rigid. Possibly the most critical shortcoming of the models was found to be the assumption that price elasticity of demand should always be bigger than one, i.e. flexible. Lastly, a collection of the results and characteristics of the models is presented in the Table 1.

<b>Model</b>	<b>PS-curve</b>	<b>Flexible wage</b>	<b>Flexible price</b>	<b><i>B to L</i> effect</b>
Model I	(2)	No	Yes	Positive
Model II	(4)	No	No	None
Model III	(2)	Yes	Yes	Positive
Model IV	(4)	Yes	No	Positive

**TABLE 1 – Assumptions and productivity effects of the models.** The numbers of WS-curves and PS-curves refer to the equation numbers. B to L effect refers to a total factor productivity shock’s short run effect on labor in the equations. Models I, II and III are derived from the equations of Sørensen and Whitta-Jacobsen (2010), and Model IV is constructed by combining their assumptions in a new way.

## **4. Research on Productivity-Employment relationship**

### **4.1. Research approaches, methods and data**

In this chapter, the various approaches commonly used for assessing productivity-employment relationship are introduced. For example, the different productivity measures are discussed. This is helpful for understanding how important the approach is for the end results, what needs to be taken into account when doing productivity-employment research and why seemingly contradictory results are not always contradictory.

#### **4.1.1. Measures of productivity**

According to OECD (2001), “productivity is commonly defined as a ratio of a volume measure of output to a volume measure of input use.” Despite of this widely accepted definition, no single measure or purpose of productivity measurement exist. Productivity can be measured for example to understand and gain knowledge of technology, efficiency, real cost savings, benchmarking or living standards (OECD, 2011). In this thesis, productivity is understood foremost as a measure of efficiency.

According to ILO (2005), productivity can be understood in terms of value as well as volume. When productivity is understood in terms of volume it can be seen as a measure of efficiency of production. This is also the reason for measuring productivity in real terms, such as will be done in this thesis. Price fluctuations don't affect a productivity measure that is in real terms. Two of the most common productivity measures will be discussed next: labor productivity and total factor productivity.

### **Labor Productivity**

Labor productivity is a factor productivity measure, because the output is measured in comparison to single factor of production, in this case labor. Labor productivity is quite an ambiguous concept and needs to be assessed to clarify what it actually means. A general form for labor productivity is as follows:

$$\text{Labor productivity} = \frac{\text{Production}}{\text{Work}} \quad (5)$$

In practice, labor productivity is usually defined in one of four different ways (OECD, 2001). Production is measured by either gross output (typically GDP) or gross value added and work is measured by either hours worked (H) or workers employed (L). The choice of definition somewhat depends on what the researcher is most interested in, but from the efficiency perspective 'hours worked' is a preferable denominator compared to 'workers employed', since it accurately measures the work executed. For example, when measuring work with 'workers employed' a change in hours per employee would increase the values of labor productivity, even if efficiency remains the same. On the other hand, in reality the choice of definition also depends on the available data; for example in the data-analysis of this thesis, data for 'hours worked' does not exist.

When using labor productivity as a measure for productivity, it is important to note that not only effectiveness of labor (how much can be produced with a given amount of labor) affect it, but also the amount of capital per labor and materials per labor. This is intuitive, because more capital per labor can buy more efficient machines for a given amount of workers, thus making these workers more productive. Chang and Hong

(2006), among others, see this as a shortcoming of labor productivity when it is used as a measure of efficiency. They even propose that the use of labor productivity is actually a key problem in a lot of the existing research that has found a negative relationship between productivity and employment.

However, there are more refined ways to use labor productivity, such as that of Blanchard et al (1995). In their method, the supply side shocks are isolated from demand side shocks. That is not further discussed in this thesis.

### **Total factor productivity**

Total factor productivity (or multifactor productivity) is often measured as a residual in production functions, such as the Cobb-Douglas production function:

$$Y = AK^\alpha L^{1-\alpha} \tag{6}$$

In the production function,  $A$  represents the total factor productivity. When all other variables are known, the value of  $A$  that equalizes the equation can be calculated, which then is the total factor productivity. OECD (2001) argues, that it reflects technical change, efficiency change, economies of scale and variations in capacity utilization and measurement errors.

Simply put, total factor productivity measures the efficiency of how much can be produced with a certain amount of inputs, like capital and labor. Also materials can be added to the production function. According to Mollick and Cabral (2009), total factor productivity measures the contribution of all other inputs than capital and labor (and materials, if it is included in the production function). As such, it is a purer measure of efficiency, than labor productivity.

### **Differences of total factor productivity and labor productivity**

Labor productivity can be considered to account the effects of total factor productivity, capital labor ratio and material labor ratio. Already Blanchard et al (1995) stress the need to sort out the component of productivity associated with exogenous

technological change from the component that varies in response to other shocks that may affect the capital-labor ratio. Many researchers, including Gali (1999) and Chang and Hong (2006) take this into account by disentangling the labor productivity. Chang and Hong (2006) present an illustrative decomposition of labor productivity. They show that total factor productivity growth is just one part of labor productivity growth. In their data for aggregate manufacturing in U.S. the average annual growth rate of labor productivity was 2,71%, of which 1,22% was due to increased material-labor ratio, 0,46% due to increased capital-labor ratio, and only 0,9% was due to actual total factor productivity increase. For this reason, Chang and Hong (2006) also argue, “TFP is a more natural measure of technology because labor productivity reflects shifts in the input mix as well as in technology.” On some of the industries they studied, the trends of total factor productivity and labor productivity were actually opposite; the other productivity measure increased while the other decreased or had no trend at all.

Also in empirics, it is important to distinguish between the productivity measures. Not very surprisingly, several studies in which effects of both labor productivity and total factor productivity have been studied, have found that these distinct measures give distinct results. For example, Mollick and Cabral (2009) found that productivity measured as total factor productivity had generally positive effects on employment, whereas measuring it with labor productivity had negative or insignificant results. Also Chang and Hong (2006) highlight the same thing.

## **Conclusion**

To conclude, it is important to make a distinction between the productivity measures. A big part of labor productivity consists of other factors than actual efficiency, which unfortunately creates some unnecessary noise. As the total factor productivity is not affected by such factors, it is often considered as a more suitable measure of efficiency or technology.



### **4.1.2. Multitude of research perspectives**

There are several ways to go about studying the relationship of productivity and employment. The interpretation and comparisons of the research results are hampered by the fact that so many different research approaches can be and have been utilized in the productivity-employment research. To make sense out of the wide spectrum of research and methodologies, some distinctions and categorization will be presented here. This is helpful for understanding the studies presented in Chapter 4.2. Overlooking the various approaches also shows us why so many seemingly contradicting research results considering productivity-employment relationship exist.

#### **The chosen direction of the causal relation studied**

Firstly, it is important to distinguish between the research that has been made to study the effect of productivity on employment, and the effect of employment on productivity. These two are obviously not the same thing. However, even as this thesis is interested in the former relationship, often also the results considering the latter relationship are very helpful, because they can tell a lot about the correlation of the variables. For the empirical study, it is also important to understand if the causation possibly runs in both directions, since it has consequences for the design of the research model and interpretation of its results.

#### **Choice of variables**

Secondly, the exact choice of variables matters a lot. As previously discussed, choice of productivity measure can radically change the results. Same applies to the measure of work. As explained, it can be measured in total hours and total workers, but also unemployment or employment shares of labor force can be utilized. There are also ways to refine the measures. Van der Horst et al (2009) use a method to refine the measurement of labor. They disentangle the hours worked ( $H$ ), which is used as a measure for labor, into the intensive and extensive margins of employment, where extensive margin means persons employed ( $L$ ), intensive margin means hours per worker ( $h$ ) and  $H = hL$ . This way it is possible to measure separately the relationship of persons employed and hours per worker to the productivity measure.

### **Absolute levels, natural logarithms, differences or growth rates**

Thirdly, how the variables are measured can also change the results. For example, variables can be measured either in absolute levels, logarithms, differences or growth rates. This is partly a choice of methodology, but also a choice of research priority. Using absolute levels or logarithms measures the same thing with different interpretation possibilities, so the correlation should not typically differ between these measures. Measuring growth rates of productivity and employment is a slightly different thing, due to which the results might also differ from research with level values.

Differencing, on the other hand, is a statistical method where the relationship of changes of variables is studied. Because it studies effect of changes on changes, it is viable for studying short run effects, but is not suitable for studying the long run effects (Van der Horst et al, 2009).

### **Sector, industry or total economy**

Fourth, the sectors and industries researched obviously matter too. Most of the studies presented here are conducted with manufacturing sector data, but possibly even more common are productivity-employment studies that cover the total economy. Such results cannot be directly applied to the manufacturing sector, but some important insights can be gained from them. It is also important to remember that the productivity-employment relationship varies between distinct industries of a given sector. This is also clear from the study of Mollick and Cabral (2009), who separately study the industries of the manufacturing sector.

### **Estimation methods**

Fifth, the choice of methodology can change the results too. Some of the common estimation methods of productivity-employment relation include Ordinary Least Squares (OLS), rolling and pooled regressions, Generalized Least Squares (GLS), Weighted Least Squares (WLS), (Structural) Vector Autoregressions (SVAR or VAR) and various instrument variable methodologies, like Two Stage Least Squares (2SLS).

These methodologies are not further introduced in this thesis, except for the methodology of choice in the data-analysis (OLS).

### **Other factors**

Obviously, the geographical location is an important factor. For example, the results from U.S. cannot be directly applied to Sub-Saharan Africa. Timeframe of the researched correlation varies hugely between studies, too. Both short run and long run effects are widely researched. Another dividing factor is the focus on either macro level (countries or sectors) or micro level (companies, for example). Also the goals of the research set various studies apart; for example, some study the elasticity of the variables, whereas some are just interested in the correlation or causation.

## **4.2. Empirical research and results**

In this chapter, a review of the research considering productivity-employment relationship is conducted. Unfortunately, not much research has been done in the Sub-Saharan African context, but what exists will be introduced herein. Most of the introduced research is implemented in U.S. or Europe. An attempt is made to find out especially what the typical short run relationships are according to empirical results, and what factors drive the relationship. Especially interesting are the relationship and the factors that might be important in the Sub-Saharan African manufacturing sector. Also some long run relation studies will be discussed shortly.

The research on the relationship of productivity and employment is vast and complex. At a glance, it seems that the results of most research are totally mixed and contradictory. When further studied, it rather seems that most of the studies are not necessarily contradictory, but just studying the same phenomenon from different angles, in different settings and with different tools.

Next, the most important studies will be explained in more detail. Analysis of results and methodologies is also included. The research will be here divided into three categories, according to the results of the research. Results are categorized according

to what is the relationship of productivity and employment – mostly negative, mostly positive or mixed.

#### **4.2.1. Research with positive productivity-employment relationship**

**Mollick and Cabral (2009)** conduct an empirical study on the effect of total factor productivity (plain and corrected for human capital) and labor productivity on employment. This study is potentially quite a useful point of comparison for Sub-Saharan Africa, since Mollick and Cabral (2009) study the manufacturing sector in Mexico, which can be also considered as a developing country.

Their methodology, model specifications and data considerations are also quite useful, and in part utilized in the data-analysis of this thesis too. Basically, they build a model in which the employment of a specific manufacturing industry depends on the productivity measure, capital and real wage (adding the control variables to the model one by one). The model is then estimated with a feasible generalized least squares (FGLS) method. Each model is estimated three times; for pre-NAFTA, post-NAFTA and total time periods. In the most controlled specification of the model, where real wage is added to the equation, a pooled IV method (2SEGLS) is used, because of endogeneity problems (the amount of labor also affects real wage). As instruments for real wage they use current exports and imports and lagged output.

Mollick and Cabral's (2009) results vary upon model specifications, time periods and productivity measures. Employment seems to react positively and significantly (at 1% or 5% levels) to TFP shocks in almost all model specifications and time periods. Especially with the most controlled model, the employment reaction is positive for all time periods and productivity measures.

Employment's reaction to labor productivity shocks is mixed. The results vary from significant and negative to positive and insignificant, depending on the model specification. Mollick and Cabral (2009) themselves comment on this, that using only labor productivity as a measure would lead to misleading results and thus recommend

more detailed datasets that allow the use of TFP, which is consistent with some other studies, like Chang and Hong's (2006).

Considering the capital variable, Mollick and Cabral (2009) find that in almost every specification it tends to increase employment, more so during the recent period. According to them, this implies that capital and labor are complements in manufacturing.

Mollick and Cabral's (2009) research also has weak points, some of which are related to their checks for serial correlation, unit roots, endogeneity and simultaneity. For testing unit roots, they use the tests LLC by Levin et al (2002) and IPS by Im et al (2003), with the Schwartz criterion for lag length selection. Maybe a bit surprisingly, they find that with both tests the null of unit root can be rejected for both employment and TFP time series at 1% significance level. For other time series, like labor productivity and capital, null of unit root can be rejected only partly. They conclude that the time series are stationary in most cases and take no action to correct for possible unit root. This could be a possible shortcoming in their study, as they don't show whether the results are robust for first-differencing, for example.

Serial correlation is tested with a test derived from Lagrange Multiplier Breusch-Godfrey test. Heteroskedasticity and serial correlation is found to be present in the standard errors, which seems realistic. However, it remains unclear how they treat the found heteroskedasticity and serial correlation or how it affects the credibility of the result.

In the simplest specification of the model (bivariate model), Mollick and Cabral use random effects estimation, since the Hausman specification test does not reject the null hypothesis of random effects model as the right choice. In the second model (where capital is added), fixed effects are employed due to Hausman test results. In the last model there are no random or fixed effects, because a pooled IV method is used. Using a random effects model is perhaps more efficient, but its underlying assumption that independent variables (productivity measures in this case) are uncorrelated with the

error terms might be unrealistic. Using fixed effects would be more conservative and secure, even if Hausman test says otherwise. Also this is a possible shortcoming in their research.

**Chang and Hong (2006)** studied the productivity-employment relationship in the U.S. manufacturing sector. Their results are not directly comparable, but offer some important insights. They found that the productivity affected employment generally positively. Their main result was that on average, a 1% increase in manufacturing TFP increased hours worked immediately by 0,35% percent. Hours worked continued to rise for two years, until it reached the new steady state at 1,3% higher than before.

When they researched the industries on a more detailed level (up to precision of four digits, meaning a division of manufacturing sector into 458 industries), they also found that technology's effect on employment varies greatly across manufacturing industries. In their research, some industries exhibited a temporary reduction in employment in response to a permanent increase in TFP, whereas far more industries exhibited an employment increase in response to a permanent TFP shock. Of the 20 2-digit manufacturing industries, 8 had a statistically significant positive response in hours worked to a TFP shock, whereas only 1 experienced a statistically significant negative response.

In contrast, they found a negative employment response to labor productivity shocks. But as explained in Chapter 4.1.1, they argue that labor productivity is somewhat biased and thus not as good measure for productivity as total factor productivity. They speculate, that disturbances affecting material-labor or capital-labor ratios (relative input price changes or sectoral reallocation of labor, for example) probably generate a negative correlation between labor productivity and hours along the downward sloping marginal product of labor.

Lastly, Chang and Hong (2006) also attempt to find explanations for the results. They find that sticky prices do not explain why the results differ across industries, as proposed by Gali (1999) and some others. However, Chang et al (2009) found in a later

paper an explaining factor for different results across industries; the storability of the product manufactured is an important explaining factor – the more it is storable, the more positive is the employment's reaction to productivity shocks.

**Van der Horst et al (2009)** study the long run causal effect from employment to productivity in 15 developed countries. They use 3SLS with 15-years rolling regression to uncover the causality and find a positive effect from employment on productivity. Again, the results are not directly comparable to the data-analysis of this thesis, but they have a few really interesting remarks and findings.

Van der Horst et al (2009) use an interesting way to disentangle the relation of productivity to total hours ( $H = hL$ ) into the intensive and extensive margins of employment, where extensive margin means persons employed ( $L$ ) and intensive margin means hours per worker ( $h$ ). This gives more detailed information considering the productivity-employment relation and results in a meaningful policy implication; even though employment in most situations affects productivity positively, the risk of a productivity slowdown seems to be stronger with stimulating hours per worker than with targeting on participation. This could quite likely be true in Sub-Saharan Africa as well, and should definitely be verified with research.

They also highlight that when employment explains productivity as an independent variable, it is important to consider it as endogenous. In other words, causality runs both ways. According to them the broader theoretical and empirical literature clearly points at a bi-causal relationship between employment and productivity, both in the short run and in the long run. This is an important result and also acknowledged in the data-analysis of this thesis.

Van der Horst et al (2009) find that employment can boost productivity, but that a productivity increase is not a guaranteed by-product of it. Most interesting finding probably comes from their regressions with rolling windows, which show how the elasticity between the variables is not stable. The 15-years rolling regression illustrates that elasticity of productivity to total hours is positive between 1970 and 2004, but

tends to fluctuate a lot (between 0,05 and 0,70). The result gives reason to expect that similar instability could be present also in the Sub-Saharan Africa. This would be an interesting path for further study.

**Nordhaus (2005)** studies the productivity growth to employment growth relation on U.S. manufacturing sector with pooled OLS and pooled 2SLS methods. He finds, like many others, that total factor productivity in manufacturing increases employment. Some of his remarks are interesting and helpful, but the study also has some major shortcomings. He uses several model specifications and datasets, finding similar results for them all; total factor productivity growth explains employment growth with a positive coefficient, many of which are significant at 5% or 1% levels.

Himself, he proposes that the main problem with the model and estimation is that errors in measuring output will lead to biased estimates of the coefficient of total factor productivity growth, as this causes downward bias in the estimates. However, he does not use any control variables, nor really explain how and why omitting all possible controls would not affect the credibility of the analysis. He also omits all time effects by pooling the data. These might be major problems in his analysis. For example in the research of Mollick and Cabral (2009), as well as in this thesis, the results changed and became more accurate after adding some relevant controls to the model.

Regardless of his results, possibly the key notion of Nordhaus (2005) is, that an important factor defining the manufacturing employment is its productivity growth compared to foreign competitors. It seems that this should be taken into account in the regressions and controlled for, because even if productivity would increase (and give a positive impact on employment), the employment would decline if the foreign competitors increased their productivity even faster. Actually, this is exactly what happened in the U.S. during the 1990's and early 2000's, according to Nordhaus (2005). The explanation is also intuitive; productivity lowers costs and it is rational to shift production into locations of lowest costs. In such situations, drawing a conclusion that productivity and employment affect each other negatively (due to negative correlation) would be misleading. Thus, not controlling for the foreign competitors



seems to be a shortcoming in almost all of the existing research, including the regressions of this thesis.

If Nordhaus' (2005) assessment that U.S. manufacturing employment has declined due to higher productivity growth abroad is true, that could also partly explain why manufacturing is growing so slowly in Sub-Saharan Africa. As seen from the data of UNECA (2014), the manufacturing productivity in Sub-Saharan Africa has declined for the past several decades compared to U.S. This means that compared to international competitors, productivity growth in Sub-Saharan Africa has fared even worse than that of U.S.

#### **4.2.2. Research with negative productivity-employment relationship**

**International Labor Organization's employment report 2004-2005 (ILO, 2005)** studies extensively the relationship of productivity, employment and poverty reduction. Although mostly qualitative, it also includes empirical research on the topic in developing country context. A key notion is, that productivity increases and jobs can be, and often are, inversely related. Considering Sub-Saharan Africa they report, that indeed an inverse relationship between employment and productivity exists. According to ILO (2005), the negative relation is due to high population growth and growing informal economic activity. The report also verifies that the relation seems to be very country and region specific – for example Asia and Pacific Rim experienced a clearly positive relationship.

The ILO (2005) report also raises the concern about the quality of productivity growth. The productivity growth is not very useful, if higher productivity is reflected solely in higher profits, rather than higher wages. They propose that this can happen for example if workers have little bargaining power. There is some evidence to support that this is the case in Sub-Saharan Africa. For example Wakeford (2004) reports, that in South-Africa the real wage growth has clearly lagged behind the productivity growth.

**Yusof (2007)** conducted another productivity-employment study in a developing country setting. He studies the member countries of Organization of Islamic Conference (OIC), most of which are developing countries, and many of which are in Africa. One of the studied OIC countries (Nigeria) is also within the data set of this thesis. Yusof (2007) finds that in the long run high levels of employment (or its growth) are linked with lower levels of productivity (or its growth) for 5 out of the 22 countries studied. For the rest of the countries (except Yemen) no long run relation between the variables exists.

Unfortunately, Yusof (2007) is quite vague considering the utilized methodologies. Apparently, he utilizes OLS, Vector Autoregression methodology and Vector Error Correction models. The vagueness obviously decreases the credibility of the results to some extent. Unfortunate is also the fact that the specific results of Nigeria are not presented.

**Gali (1999)** has made one of the most influential studies in the debate of short run relationship of productivity and employment. He studies the relation in U.S. with a structural vector autoregression method. He finds that productivity and employment are negatively correlated in the short run. In addition to conducting an empirical research, he constructs a theoretical framework and a model, which are in line with his research results. The model itself is simply a version of a sticky price labor market model.

According to the empirical study, positive technology shocks lead to a decline in hours, and tend to generate a negative co-movement between hours and productivity. On the other hand, non-technology shocks are shown to generate a positive co-movement between hours and productivity. Gali (1999) concentrates a lot on arguing why and how these results contradict Real Business Cycle models, but that is not essential for this thesis.

Like Chang and Hong (2006), Blanchard et al (1995) and some others, also Gali (1999) thinks that labor productivity as such is not a precise measure, and should be

disentangled into technology shocks and non-technology shocks. To do this, he uses a structural VAR model, identified by the restriction that only technology shocks may have a permanent effect on the level of productivity.

Gali's (1999) work is extended in a few papers. Firstly, the paper by Gali and Rabanal (2005) continue to build a dynamic general equilibrium model to explain why productivity-employment relation can be negative in the short term. Secondly, also Francis and Ramey (2005) test several theoretical models. They support the sticky price models, but also present two examples of modified dynamic general equilibrium models (with flexible prices) that allow negative short run relation of productivity and employment.

**Basu et al (2004)** study the effects of technology shocks on input use. They find, that when technology (and consequently productivity) improves, input use (including labor) and non-residential investment immediately fall sharply and output changes very little. Only with a lag of several years, labor returns to normal levels and output increases strongly. Like Gali (1999), they advance price stickiness as the major reason for the perverse short run employment effect of technical improvement.

#### **4.2.3. Research with mixed productivity-employment relationship**

**Wakeford (2004)** studied the relationship between productivity, real wages and unemployment on total economy level in South Africa. That makes his research paper valuable, because South Africa is also studied in the data-analysis of this thesis.

He found that a long run relationship existed between real wages and productivity for the period from 1983 to 2002, but not between unemployment and productivity. The results seem to suggest, that productivity is not an important defining factor of the employment in the long run in South Africa. Regarding the short run relation of productivity and employment, Wakeford (2004) says that not much can be said about it due to the construction of the data (lots of estimated values). The same problem is also taken into account in the data-analysis of this thesis.

An interesting finding is the evidence of a strong structural break in 1990, which seems to have affected the level of employment first, and other variables through that. After 1990, the productivity and unemployment have risen sharply, whereas the real wage growth has been left behind.

Importantly, Wakeford (2004) concludes that South Africa's productivity performance should not be looked at in isolation of the employment trend. Rather, he states that the two trends indicate that the economic growth has had a "job-shedding nature" in South Africa during the years 1990 to 2003. He also raises a concern considering the fact that labor's share of gross output has been shrinking during 1993 to 2003. According to him, the trend has been observed in many developing countries around the world, and reflects an increasing concentration of wealth among owners of capital. This is the same concern that is presented by Piketty (2014) and is currently a topic of debate in economics. If this is true in general in Sub-Saharan Africa, it is possibly a big problem also from the perspective of productivity-employment relationship, because it makes the demand for manufactures more insensitive to productivity growth, as productivity growth is not converted into purchasing power.

**Blanchard et al (1995)** study the long run and short run effects of labor productivity to unemployment in their quite theoretical paper. A study of the short run effects in U.S. and Germany reveals, that a productivity shock is likely to induce a small and temporary (only about one year) increase in unemployment, after which the unemployment seems to be slightly lower than it would have been without the productivity shock. They highlight the quite obvious, but important fact, that productivity shocks and technology advancements sometimes inflict extensive unemployment on some specific sectors. It takes some time for the freed labor to be absorbed on other sectors. Considering the methodology, also Blanchard et al (1995) highlight the need to isolate the supply and demand side labor productivity shocks from each other. This is important to study effects of autonomous supply shocks.

Blanchard et al (1995) also conduct a historical inspection of the long run effects on level of decades. In the aggregate economies of U.S. and France no significant relation between productivity growth and unemployment exist. If anything, they find that during decades of high productivity growth, the unemployment has been low. Another of their findings is that the key to high employment does not lie in the rate of productivity growth but in the demand for aggregate output that fully uses normal productive capacity.

They also make a very simple, yet insightful notion considering effects of a productivity shock. The effect on employment ultimately depends on the effect on production, which in turn depends on the demand. The effect on demand depends on the effect on price and its elasticity to demand. If price falls and the demand (and production) consequently increases more than the initial increase in productivity, the employment rises and vice versa.

When it comes to the data and how it is used, there seems to be critical shortcomings, as Blanchard et al (1995) don't provide the necessary background information. For example, they don't clearly tell what exact data they use. The paper of Blanchard et al (1995) is useful in terms of generally learning about the relationship of productivity and employment, but the results are less so.

**Cavelaars (2005)** studies the long run effects of employment on productivity with OLS and weighted least squares (WLS) estimation methods in OECD countries. Like Van der Horst et al (2009), Cavelaars (2005) also utilizes rolling windows method (for 10 and 20 year periods). The most important finding is, that the effect changed from negative to positive.

Interestingly, he finds that a statistically significant tradeoff between employment and productivity existed for the period from 1961 to 1980, but passed after that. During 1981 to 2000, the correlation has actually been positive, but not statistically significant with most model specifications. He proposes that during the latter period, possibly "the factors which positively affect both productivity and employment have become more

important.” Whatever the reason, the notion that the effect changes over time is important to keep in mind. So is also the key finding, that employment policies are less likely to have a negative impact on productivity at the macro level, than they used to. However, the result is obviously not directly applicable to Sub-Saharan Africa.

A useful remark that Cavelaars (2005) makes is the division of labor productivity’s effects on employment into direct and indirect effects. These effects work into opposite directions. Technological progress (productivity growth) enables producing the same amount of output with fewer workers, the *direct* effect of which is to reduce the demand for labor. However, *ceteris paribus*, technological progress decreases unit labor costs, which will increase demand for output, which *indirectly* increases demand for labor. The indirect effect is already familiar from the theory of Sørensen and Whitta-Jacobsen (2010), but this division is nonetheless a good way to clarify productivity’s effects on employment. Both of these effects are also taken into account by price elasticity of demand.

## **5. Data-analysis on Productivity-Employment relationship**

### **Goals of the data-analysis**

This data-analysis has one primary goal – it is to find out whether labor productivity affects employment positively or negatively in short run in Sub-Saharan Africa. Here, “affecting” is not necessarily meant as causation, but rather as co-movement. The goal is rather to find that if the labor productivity will change, what will happen to the employment? Is productivity or productivity growth negatively or positively associated with employment or employment growth in the short run? In practice, the goal is simply to find out the sign of the correlation coefficient of labor productivity to employment (in a regression that is as unbiased as possible, obviously).

For simplicity, the term ‘short run’ in this data-analysis often also refers to medium run effects (the second year after impact). Technically the correct way to refer to lags of the variables and the effects actualizing after the first year is the ‘long run’ or ‘medium

run'. However, the effects of productivity growth to employment often tend to actualize slowly, immediate effects lasting more than one year. Thus, in productivity-employment research, two years can still be considered 'short run'. On the contrary, 'long run' in many research papers refer to longer time periods, like three to ten years.

Uncovering an exact and fully unbiased correlation coefficient and credibly uncovering the causal relationship are also interesting things, but realistically beyond the reach of this data-analysis. Revealing the causality is always difficult, but even more so in the Sub-Saharan African context where lack of proper data is a serious issue. Furthermore, uncovering the causation is actually not invaluable for policy design. If it is known that productivity and employment are, say, negatively correlated, that information alone can already be helpful for the policy makers to design adaptive policies.

Finding evidence on the stated research question will not completely uncover the effects of productivity to employment in Sub-Saharan Africa. Because the interaction of these variables is very complex, this data-analysis just scratches the surface of the subject of productivity-employment relationship, by using one of many possible research approaches. The data-analysis serves the whole by giving one reference point.

For more complete answers, further research is needed with other productivity measures (total factor productivity), other approaches (studies of growth rates), other methodologies (e.g. structural vector autoregressions, generalized least squares, instrument variable methods) and also studies that are able to uncover the causal relations with more certainty.

### **Organization of the chapter**

The contents of the chapter are organized in the following way. Firstly, the datasets are introduced. Some of the data series are built as a combination of several data series, so the calculation procedure is explained in detail. Then the data is evaluated and tested for possible problems considering its stationarity, heterogeneity and serial correlation.

Secondly, methodology is chosen and scrutinized. Several models are used in this data-analysis to check whether the results are robust for different model specifications. The analysis begins from the simplest possible models, then adding more variables and more complex specifications. Meanwhile, the analysis attempts to find the optimal, most unbiased and most correctly specified model, where the model and methodology would depict reality as well as possible. Robustness of different model specifications is also tested with some methodology alterations. Lastly, the results are put together. Validity of the results is scrutinized and they are compared to other research results.

## **5.1. Variables and data**

### **5.1.1. Introduction to the dataset**

The data set used is a self-combined set of panel data for 11 Sub-Saharan African countries during years 1960-2010. The data is combined from De Vries et al (2013a), United Nations (2014), World Bank (2014) and Khan (2014). Key variables are manufacturing employment, manufacturing labor productivity and capital formation in the total economy.

The countries studied include Botswana, Ethiopia, Ghana, Kenya, Malawi, Mauritius, Nigeria, Senegal, South-Africa, Tanzania and Zambia. More countries would have been included, but the main data was available for these countries only. However, as De Vries et al (2013b) say, this set of countries is a reasonably comprehensive set of the variety of countries in Sub-Saharan Africa. The country set includes large and small countries, more and less developed countries, and so on. Thus, in terms of country size and level of development, no significant selection bias should exist. However, these countries are in the data set because the data exists for them only. Thus, the set of countries is not a totally random sample of Sub-Saharan African countries, and selection according to data availability exists. No apparent reasons arise that would make the regression results markedly different for other Sub-Saharan African countries, but because that is possible, caution must be applied when the results are generalized to the whole of Sub-Saharan Africa.



## 5.1.2. Data sources

### **Groningen Growth and Development Centre's Africa Sector Database**

The most important utilized data source is the Groningen Growth and Development Centre's (GGDC) Africa Sector Database (ASD) by De Vries et al (2013a). The database includes gross value added data, as well as data for total labor and manufacturing labor for the 11 mentioned Sub-Saharan African countries. The classification of sectors is done according to International Standard Industrial Classification (ISIC), Revision 3.1 (United Nations, 2002).

The statistics available for African countries are generally scarce and incomplete (De Vries et al, 2013b and Devarajan, 2013). The ASD data (De Vries et al, 2013a) seems to be one of the best that are available for the productivity calculations. According to De Vries et al (2013b), they "constructed data for each country separately and used methods to maximize the use of the available country-specific sources." They also continue to explain, that because there are sometimes reliability issues with African statistics, they crosschecked unusual bumps in the official series with other sources and corrected the data when necessary. Also United Nations (2014) database, for example, has gross value added data for some Sub-Saharan African countries, but on a less detailed level. Values of the gross value added statistics of the United Nations (2014) database are highly correlated with the ASD values (De Vries et al, 2013a).

The gross value added, employment and manufacturing employment data series are primarily collected from national statistical institutes of each country. As this official data is lacking for some countries and years, non-official data is used to bridge gaps in official data using growth trends. For example, in cases where official data for gross value added was not available, a bit less detailed African Statistical Yearbooks' data (African Statistical Coordination Committee, 2013) were used to fill in the gaps. When detailed sector data is missing, De Vries et al (2013a) use growth trends of aggregate sectors to calculate estimates of the data values.

In fact, the lack of “real” data is the primary concern with the ASD data set (as well as with other similar statistical sources that are known to the writer). It is quite obvious, that when two actual data points are connected by calculating estimates with trend growth values, the estimates can be very inaccurate. In the ASD document “Contents, Sources and Methods” (De Vries et al, 2013b) tables are presented, showing the source of each data point for the value added and employment series. Those tables illustrate that the problem is severe in some cases. The value added series are generally better than the employment series, but still periods of 6 to 8 years of estimated data exists for Ethiopia, Ghana and Malawi. In the employment series of Ethiopia, Ghana, Malawi, Nigeria, Senegal, Tanzania and Zambia, most of the data points are estimated. For Nigeria, which has the worst data of all, the employment data series contains no more than two real data points during the period 1970 to 2010.

There are a few statistical problems that the estimated data will probably cause. Firstly, it will cause a measurement error in manufacturing employment, which is the dependent variable, as well as in labor productivity, which is an independent variable. Measurement error in the independent variable typically causes an attenuation bias. This means, that the values of estimated coefficients in the regression are biased toward zero. This is very likely to be the case in the regressions of this thesis.

When it comes to consistency of the data, De Vries et al (2013b) say that the Africa Sector Database is constructed to be intertemporally, internationally and internally consistent. To assure intertemporal consistency, the series have been smoothed by repairing major breaks. When it comes to gross value added, the international consistency of the cross-country sectoral data follows from the application of the System of National Accounts 1993 framework (United Nations, 1993). Regarding the employment, a consistent employment concept of persons engaged is used, by employing a harmonized sector classification according to ISIC Revision 3.1 (United Nations, 2002).

According to De Vries et al (2013b), the African statistics are frequently considered as unreliable. Also Devarajan (2013) and Jerven (2013) have said that the statistical

foundations underlying GDP and employment estimates in Africa are subject to large measurement errors, weakening the fundamentals for statistical analysis. They have referred to this as 'Africa's statistical tragedy'. This is an unfortunate, but unavoidable fact. The problems that arise from the weak reliability of the data cannot be treated. Consequently, it is important to keep the problem in mind, when the credibility of the results is considered.

### **World Bank and United Nations**

Another important data sources are the United Nations' (2014) database for the GDP data and the World Bank's (2014) database for the capital formation per GDP data. These data sources are utilized to calculate the data series for capital formation variable, as explained soon.

A statistic "Gross capital formation per GDP" is received from the World Bank (2014). The data sources used by the World Bank (2014) include the World Bank National Accounts data and OECD National Accounts data files, which are also collected according to the System of National Accounts 1993 (United Nations, 1993).

The United Nations' (2014) database gives the "GDP" variable. Source of the United Nations (2014) data is the official data reported to United Nations Statistical Department through the annual National Accounts Questionnaire. Data is supplemented with estimates for any years and countries with incomplete or inconsistent information. The statistics for each country are presented according to classifications as recommended in the System of National Accounts 1993 (United Nations, 1993). Even though the source of the data is not exactly the same in these two data sets, the GDP figures are calculated with the same system of accounts in both data sources.

The "Gross capital formation per GDP" from the World Bank (2014) database is multiplied with the "GDP" variable from United Nations' (2014) database, which gives a variable "Gross capital formation" as a result. Because "GDP" in both data sets is calculated with the same system of accounts, the GDP figures should cancel each other

out quite nicely. The exact definition of the GDP figures does not matter here, because the definition in both data sources is the same.

The World Bank (2014) data for capital formation per GDP is unfortunately not available for the whole of the time period. However, it is much more extensive, than the corresponding data of the United Nations (2014) or other available data sources, and is consequently utilized. The United Nations (2014) data is available for all countries during 1970 to 2010, except for Ethiopia, for which the data is available for 1990 to 2010. For these reasons capital formation data for Ethiopia, Mauritius, Nigeria and Tanzania is partially lacking.

Similar reliability problems (Devarajan, 2013 and Jerven, 2013) apply to the World Bank (2014) database and United Nations (2014) database, as to the Africa Sector Database (De Vries et al, 2013a), lowering their credibility to some extent.

### **United Nations Industrial Development Organization's Databases**

Possibly a good source of data for the necessary variables in this data-analysis would also be included in the United Nations Industrial Development Organization's (UNIDO, 2014) INDSTAT2 and INDSTAT4 databases. For the reason that their database is not freely accessible and has a costly access, that data is not used in this thesis.

### **5.1.3. Variables**

For starters, it is useful to clarify the exact meaning of variables and terms used in this data-analysis. The key variables are total manufacturing employment (measured in total workers employed, not total hours), manufacturing labor productivity (gross value added per total workers employed) and capital formation in the total economy. It is important to note that employment in this text refers to the *number* of total workers, not to persons employed per total workforce. Other key variables include country dummies and trend growths of employment for each individual country. Also some other variables are considered and tested. Next, all of the important variables are discussed in detail and their composition is explained.

### **Total workers employed and other possible dependent variables**

The number of total workers in the manufacturing sector and its natural logarithm are used as the primary dependent variables in the data-analysis. The amount of total hours is not used, because total hours data does not simply exist for Sub-Saharan African countries. In contrast, total workers in manufacturing sector can be obtained directly from the data set of De Vries et al (2013a), so this is chosen as the dependent variable. The same variable is also utilized to calculate the labor productivity variable.

Also another approach to define the dependent variable was used. The manufacturing employment can be measured in relation to total employment. This approach would give more information on the relative size of the manufacturing sector as an employer. One benefit of the approach is, that it should control quite well the effects of the underlying population growth and employment growth. These effects shouldn't affect the share of manufacturing employment in any way, but will probably affect the amount of total workers in manufacturing, which could be problematic. However, building a model with a percentage share as a dependent variable is more difficult than a plain number. Furthermore, it complicates the interpretation of the results. The regression results with this dependent variable are also shortly introduced in the Chapter 5.2.

### **Labor productivity**

As stated, this thesis is most interested in productivity as a measure of efficiency. Total factor productivity is probably preferable measure of efficiency, when compared to pure labor productivity, for reasons like changes in labor productivity caused by capital-labor fluctuations (Chang and Hong, 2006). However, due to data constraints, instead of total factor productivity, labor productivity is used as an independent variable in the regression of this thesis.

To calculate the manufacturing sectors' labor productivities, two variables are needed. As explained in the Chapter 4.1.1, labor productivity can be calculated by taking either GDP or gross value added, and dividing it by either total hours worked or total

workers. Despite the fact that total hours worked is preferable to total workers, the latter has to be used in this thesis, because total hours worked data simply doesn't exist for the studied countries. When it comes to GDP or gross value added, the latter is preferable for reasons previously stated. Luckily, De Vries et al (2013a) provide the gross value added data. Thus, the labor productivity is defined along the following formula, where all values are for the manufacturing sector:

$$\text{Labor Productivity} = \frac{\text{Gross Value Added}}{\text{Total Workers}}, \quad (7)$$

### **Value added**

As shown, the value added time series are needed to calculate the labor productivity time series. However, also the value added time series needs to be calculated first, as De Vries et al (2013a) don't provide the value added data in a comparable form. They provide the gross value added data in both nominal local currencies and real currencies calculated with the base year 2005. The real gross value added series are utilized, because that excludes the effects of inflation. Then, to make the data comparable, the time series need to be converted into same currency, in this case U.S. Dollars. This is conducted by taking the U.S. Dollar exchange rates (Khan, 2014) for each local currency at 1<sup>st</sup> of January 2005 and using the exchange rates to calculate value added series in U.S. Dollars. Thus, real gross value added series are obtained for each country in a comparable currency.

### **Capital formation**

In this thesis, the capital is controlled with a variable "gross capital formation." It is not the total capital in the economy, but rather the increase of capital. Thus, it can also be interpreted as the total investments. Total capital is more commonly used as a control variable in productivity-employment regressions, but capital formation is expected to have very similar effects on employment as total capital would have. There is no apparent reason to believe that the regression results would be significantly different between these variables. The reason for using capital formation in this thesis instead of total capital is simply that capital formation data was better available.

Due to shortcomings in the data, capital formation can unfortunately be measured in aggregate economy data only. However, it seems reasonable to assume, that aggregate economy capital formation is quite a good proxy variable for manufacturing sector capital formation, and definitely better than nothing.

Including some sort of control variable for capital is important for a few reasons. A capital variable helps to control for the business cycles, because it is highly correlated with both output and amount of labor, as found by Mollick and Cabral (2009). Controlling for capital is also important because it crucially affects labor productivity. Because productivity is here understood in the sense of efficiency, including capital allows us to better control for the fluctuations in capital-labor ratio. Furthermore, in classical theories (Abel et al, 2008; Sørensen and Whitta-Jacobsen, 2010) capital is an important defining factor for employment.

The capital formation variable is provided by the World Bank (2014) in the form “gross capital formation of the total economy as a percentage of GDP”. This variable is converted into just “gross capital formation (in 2005 U.S. Dollars)”, as explained earlier in Chapter 5.1.2. According to the World Bank (2014), the capital formation variable consists of “outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and ‘work in progress’.”

It is also possible to not convert the variable and just use the “capital formation as a percentage of GDP” as an independent variable. However, “capital formation” is probably preferable, because the other variables in the model are in levels as well, not in shares of something. Regressing a share of something to a level of something makes the interpretation of results more difficult. On the other hand, “capital formation as a percentage of GDP” is likely to be more similar between total economy and

manufacturing, than capital formation. Consequently, to ensure robustness of the regressions, they will also be run with an independent variable “capital formation as a percentage of GDP.”

It is important that the real GDP is measured with the base year 2005, because also the real gross value added time series in Africa Sector Database (De Vries et al, 2013a) are calculated with the base year 2005. The real GDP values in 2005 U.S. Dollars are directly obtained from the United Nations (2014). This multiplication gives a total economy capital formation variable, which is measured in constant value 2005 U.S. Dollars, making the capital formation series of all countries comparable.

For Ethiopia, Mauritius, Nigeria and Tanzania only incomplete capital formation data exists. They lack 5 to 20 years of data for the period 1970 to 2010. Eliminating all years 1970 to 1990 from the regressions (i.e. balancing the data strongly) is not conducted, because elimination of 20 years from the regression would take a half of the data. This means that controlling for capital formation in the regressions makes the data unbalanced. Some risk of attrition bias exists, but considering the fact that all other data is actually available for these countries and time periods, the risk is probably not that high.

#### **5.1.4. Treating some problems with the data**

##### **Data balance and attrition bias**

The data set is unbalanced. This might cause attrition bias. For several countries, manufacturing labor productivity or manufacturing labor data is lacking for several years during the 1960's. For this reason, the regression is conducted both with all data, and with excluding 1960's. Excluding the 1960's helps to decrease the risk of attrition bias (as it is possible that the lack of data is correlated with the variables). Results of both regressions will be reported in Table 5. Some sparse data for the years 2011 to 2012 also exists for a few of the countries, but this data is excluded for all countries for the same reason. The issue with unbalanced capital formation data is discussed in the previous chapter.



## **Unit root**

The data series for the natural logarithms of manufacturing labor productivity, manufacturing employment and gross capital formation in total economy are tested for possible unit root. Unit root, if found, would give reason to expect that the regression results are spurious.

Two different unit root tests are chosen; the test by Levin et al (2002), which will be referred to as the LLC test, and the test by Im et al (2003), which will be referred to as the IPS test. These tests are widely used to test for unit root in panel data, for example by Mollick and Cabral (2009). Both tests are appropriate for a data set that has relatively few panels, such as the data of this thesis (Levin et al, 2002; Im et al, 2003). For example the LLC test statistic performs well when number of countries lies between 10 and 250 and time periods between 5 and 250 (Levin et al, 2002).

For the reason that the tested time series clearly have trends (as seen from non-reported visualizations of the data), the trend is controlled for in both LLC and IPS with the according command, as enabled by Stata.

To define the optimal number of lags in defining the test statistic, Bayesian Information Criterion (BIC) is applied for both models with the restriction that maximum amount of lags is five. Stata will thus choose the lag lengths separately for each panel (countries, in this case). Both unit root tests are also run with different maximum lag lengths to see if the results are robust for this restriction. Results with maximum lag length of five are reported in the Tables 2 to 4, because they represent the average results well.

Because LLC test requires strongly balanced data, appropriate year restrictions are used for the variables (1970-2010 for logarithms of labor productivity and employment, and 1990-2010 for capital formation). Same restrictions are also used for IPS to balance the data. But because balancing is not compulsory for the IPS test (Im et al, 2003), also results with no balancing or lags are reported.

The natural logarithm of manufacturing labor productivity is named as  $\ln LP^m$ , natural logarithm of manufacturing employment is  $\ln L^m$  and natural logarithm of gross capital formation in total economy is  $\ln K$ . Null hypothesis for both tests is that unit root is present. Here are the results:

<b>Variable</b>	<b>Test statistic</b>	<b>Average lag length</b>	<b>Observations</b>	<b>Years</b>
$\ln L^m$	-0.7673 (0.2215)	0.45	451	1970-2010
$\ln LP^m$	-5.3890*** (0.0000)	0.45	451	1970-2010
$\ln K$	-2.9152*** (0.0018)	1.73	231	1990-2010

**TABLE 2 – LLC test results.** The test statistic is Adjusted t-statistic. P-values of the test statistics are in parentheses. All results are for series in levels. To optimize the lag lengths, amounts of lags are chosen with BIC method and by restricting the maximum number of lags to 5. All statistics are calculated by using the trend option. Significance levels are marked according to \*\*\* for  $p < 0.01$ , \*\* for  $p < 0.05$  and \* for  $p < 0.1$ .

<b>Variable</b>	<b>Test statistic</b>	<b>Average lag length</b>	<b>Observations</b>	<b>Years</b>
$\ln L^m$	1.4628 (0.9282)	0.45	451	1970-2010
$\ln LP^m$	-3.4608*** (0.0003)	0.91	451	1970-2010
$\ln K$	-1.3643* (0.0862)	0.27	231	1990-2010

**TABLE 3 – IPS test results.** The test statistic is W-t-bar. P-values of the test statistics are in parentheses. All results are for series in levels. To optimize the lag lengths, amounts of lags are chosen with BIC method and by restricting the maximum number of lags to 5. All statistics are calculated by using the trend option. Significance levels are marked according to \*\*\* for  $p < 0.01$ , \*\* for  $p < 0.05$  and \* for  $p < 0.1$ .

Variable	Test statistic	Observations	Years
$\ln L^m$	-1.2812 (0.1001)	516	Depends on country
$\ln LP^m$	-3.3707*** (0.0004)	512	Depends on country
$\ln K$	-2.8059*** (0.0025)	394	Depends on country

**TABLE 4 – Unrestricted and unlagged IPS test results.** The test statistic is  $Z\text{-t-tilde-bar}$ . P-values of the test statistics are in parentheses. All results are for series in levels. To optimize the lag lengths, amounts of lags are chosen with BIC method and by restricting the maximum number of lags to 5. All statistics are calculated by using the trend option. Significance levels are marked according to \*\*\* for  $p < 0.01$ , \*\* for  $p < 0.05$  and \* for  $p < 0.1$ .

As seen on Table 2, in LLC test the null hypothesis of unit root cannot be discarded for the variable manufacturing employment. In contrast, the null hypothesis is clearly rejected for manufacturing labor productivity and capital formation on 1% significance level.

In the IPS test (Table 3), results are quite similar. The null hypothesis of unit root for manufacturing employment is not even close to rejection, whereas null of unit root is clearly rejected for manufacturing labor productivity on 1% significance level and on 10% significance level for capital formation. In the unrestricted and unlagged IPS test (Table 4), both manufacturing labor productivity and capital formation are significant on 1% level, and the manufacturing employment is very close to being significant on 10% level.

To check the robustness of the results, LLC and IPS tests are run for each variable with different maximum lag lengths as well. Detailed results are not presented here - suffice it to say that different maximum lag lengths don't change the results much. With LLC, the null of unit root cannot be rejected with any maximum lag lengths for manufacturing employment. In contrast, for capital formation the unit root can be rejected on 1% or 5% significance levels with the exception that with maximum lag lengths of seven or more, the p-values explode for some reason and unit root cannot be rejected. For manufacturing labor productivity the p-values of LLC test are always

0,0000 and consequently unit root can always be rejected with a good certainty. With IPS, the null of unit root cannot be rejected for manufacturing employment for any maximum lags at all. For manufacturing labor productivity, unit root can always be rejected on 1% significance level, and for capital formation on 1% to 10% levels.

Because both the dependent variable and one independent variable are suspected to possibly have unit roots, the regressions are subject to a risk of spurious regression results. At this point, it would be possible to continue testing, by using an appropriate test to check if the variables are cointegrated, but in this thesis that is not conducted. Instead, the analysis applies first-differencing to the data and the model, which will remove unit root if it exists. It is probably best to do regressions with both models (non-differenced and first-differenced) and compare whether the results are in line with each other. If the results are same from both models, it allows exclusion of the possibility that the result of the original model is subject to spurious regression.

The first-differencing of the data only removes one degree of unit root. Consequently, the first-differenced data series are tested for unit root as well to ensure that no unit root of second degree exists. The LLC and IPS tests are specified in the same way as before, except that no trend option is used (because first-differencing already eliminated it). Detailed results will not be presented here, but with both tests the null hypothesis of unit root can now be easily rejected for all time series on 1% significance level. This result clearly shows that no unit root of second degree exists and that at least the first-differenced model is stationary and valid.

To conclude the results, there is a serious risk of unit root of first degree in the employment time series and to some extent in the capital formation time series. The time series of manufacturing labor productivity can quite confidently be declared as stationary (i.e. no unit root).

## **5.2. Methodology, model specifications and results**

### **5.2.1. Methodology**

#### **OLS – the chosen methodology**

The estimation methodology chosen for this data-analysis is Ordinary Least Squares regression (OLS). It is not quite certain, if OLS is the most optimal possible methodology for the given data. However, many researchers (Bourles and Cette, 2005; Bettendorf et al, 2009; Cavelaars, 2005) have used OLS in defining the productivity-employment relationship. The attempt in this data-analysis is to obtain credible results with OLS, simultaneously keeping in mind the shortcomings of the methodology.

#### **OLS assumptions**

Let's shortly review the underlying assumptions of OLS. Firstly, OLS assumes that the variables are linearly related. The linearity is not explicitly tested, but at least no clear indications arise to suspect nonlinearity. Nonlinear models were not used in any of the statistical research reviewed and cited in this thesis. Secondly, OLS assumes that the independent variables are uncorrelated with the error terms (exogeneity) and with each other (no multicollinearity). Unfortunately, these assumptions are likely to be violated. This problem is discussed in more detail in the Chapter 5.3.3. Thirdly, OLS assumes that the sample is randomly assigned from the underlying population. In this case, the set of countries in the data-analysis is not totally randomly assigned from all Sub-Saharan African countries, because the countries are actually chosen according to availability of data. Ramifications of this fact are discussed in the Chapter 5.1.1. Assumptions of homoscedasticity and no serial correlation are discussed in detail in the end of this chapter.

#### **Fixed effects or random effects**

Whether the model should include fixed effects or random effects is an important choice to assess. In this case, the choice seems to be quite clear. Fixed effects are used, because it seems quite certain, that the utilized variables are correlated with the error terms. This is due to the fact that in real world countless factors affect and are

correlated with the employment and labor productivity variables. Thus, the model omits a large amount of possible variables that affect the dependent variable and the independent variables in the model. The effects of these omitted factors will show up in the error term and make the errors non-random and correlated with the variables. The heteroskedasticity test and serial correlation test conducted later in this chapter also support this view. For many of the omitted factors, data is unavailable or difficult to measure. Utilizing fixed country effects can control those of them, which are time invariant.

Also a Hausman specification test could be conducted to verify the use of fixed effects or random effects, such as done by Mollick and Cabral (2009). They found that the test strongly suggested fixed effects for every model specification except the simplest model (Model 1 in this thesis). Here, the Hausman specification test is not conducted, because it does not seem necessary.

Adding controls for the fixed effects will decrease the unobserved part of the error term, if the fixed effects are statistically significant. This will likely decrease the possible bias of the correlation coefficient of the independent variable of interest. In this sense, causal inferring is on a stronger basis than without the fixed effects. However, problems like multicollinearity and endogeneity could in some cases be avoided even better with a well-specified instrument variable approach. Unfortunately, instrument variable approaches have the downside that good instruments are really difficult to find, even more so in the Sub-Saharan African context, where available data is scarce and relatively unreliable.

### **5.2.2. Model specifications**

The model specification follows several steps, where the model is enhanced step by step. The most important phases of the specification will be reported and named as Model (1), Model (2), and so on. Their results will be presented in the Tables 5 to 8. The different model specifications and the effects of changes in the model will be analyzed. The goal is to arrive at as good model as possible, given the chosen

methodology and the data and variables that are available. Some of the named models are similar to each other but may have different methodologies or data restrictions. They are named as separate models to enable reporting of distinct results.

### **Improving the model step by step**

Building of the model begins from a simple relationship of productivity and employment. The model is similar to that of Mollick and Cabral's (2009) simplest specification:

$$L_{it}^m = \alpha + \beta_{LP} LP_{it}^m + \varepsilon_{it} , \quad \text{Model (1)}$$

$L_{it}^m$  presents here the total workers in the manufacturing sector of country  $i$  at time  $t$ .  $LP_{it}^m$  is the labor productivity in country  $i$  at time  $t$  at the manufacturing sector and  $\beta_{LP}$  is its regression coefficient.  $\alpha$  is the constant term and  $\varepsilon_{it}$  is the error term.

More interesting than to study the effects of absolute levels of labor productivity to absolute levels of total workers, is to study how percentage changes in labor productivity affect percentage changes in total workers. For this reason, natural logarithms are taken from all series. Taking natural logarithms from the series allows one to approximately see this; when labor productivity changes, the expected percentage change of the total workers is given approximately by  $\Delta L(\%) \approx \beta_{LP} \Delta LP(\%)$ . The model now looks like this:

$$\ln L_{it}^m = \alpha + \beta_{LP} \ln LP_{it}^m + \varepsilon_{it} , \quad \text{Model (2)}$$

As such, the regression is suspect to heteroskedasticity and serial correlation problems. In the end of this chapter, both heteroskedasticity and serial correlation tests are conducted and they are verified to be present in the regressions. Thus, the next thing to optimize the model is to treat these problems by clustering the standard errors, as enabled by Stata. The standard errors are clustered according to country. The actual model is otherwise the same as before, but the results are reported under the name Model (3). All models from now on will have the clustered standard errors.

In a dataset like this, where the number of countries (clusters) is relatively small, it is worthwhile to remember that the cluster-robust estimator might produce estimates of standard errors that are too small on average. Consequently, the clustered standard errors might still be somewhat downward biased (Woolridge, 2003).

The next thing to optimize the regression results is to deal with the balance issues of the data. As mentioned, the data is quite unbalanced in the beginning of the period, as labor productivity and employment figures lack for several countries in the 1960's. The unbalanced time periods expose the regression to the risk of attrition bias. Attrition would be a problem especially if the lack of data is correlated with some of the variables. Hence, the regression is conducted by restricting the data so that it becomes strongly balanced. Regressing the data only for years 1970 to 2010 does this. This leads us to Model (4), which is similar to the Model (3), except that it has the restriction on years.

Next thing is to control for the effects of capital formation variable. Capital is accounted in the model as gross capital formation of the total economy in 2005 U.S. Dollars. Arguments for adding capital formation in the model are presented earlier in the Chapter 5.1.3. By adding a term  $\beta_K \ln K_{it}$ , where  $K_{it}$  is the gross capital formation in the total economy in country  $i$  at time  $t$  and  $\beta_K$  is the regression coefficient of its natural logarithm, the model turns into:

$$\ln L_{it}^m = \alpha + \beta_{LP} \ln LP_{it}^m + \beta_K \ln K_{it} + \varepsilon_{it}, \quad \text{Model (5)}$$

The next step in the analysis is to include fixed effects into the model by adding dummy variables. It is possible to incorporate dummy variables for example in the two following ways. Firstly, dummies (fixed effects) can be set for each individual country. This takes into account the country-specific, time-invariant differences in the manufacturing employment levels of the countries. Secondly, fixed effects can be set for each year of the research period. This will be tested soon. For now, fixed effects are



added for each country with a term  $\sum_{i=1}^{11} \beta_i D_i$ , where  $D_i$  is the dummy for country  $i$  and  $\beta_i$  is its regression coefficient. This leads us to the Model (6):

$$\ln L_{it}^m = \alpha + \beta_{LP} \ln LP_{it}^m + \beta_K \ln K_{it} + \sum_{i=1}^{11} \beta_i D_i + \varepsilon_{it}, \quad \text{Model (6)}$$

Up to this point, six distinct regression models have been specified, labeled as Models (1) to (6). The regression results of these specifications are displayed in the Table 5:

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Addition to model	-	Logarithms	Clustering	Data balancing	Capital	Fixed Effects
Dependent variable	$L^m$	$\ln L^m$	$\ln L^m$	$\ln L^m$	$\ln L^m$	$\ln L^m$
$\ln LP^m$		-0.591*** (0.050)	-0.591 (0.438)	-0.654 (0.461)	-0.901*** (0.168)	-0.880*** (0.188)
$\ln K$					0.984*** (0.118)	0.645*** (0.149)
$LP^m$	-8.809 (5.546)					
$\alpha$ (Constant)	703.477*** (55.365)	17.175*** (0.412)	17.175*** (3.320)	17.746*** (3.535)	-1.172 (2.564)	7.344 (4.358)
Observations	516	512	512	451	394	394
R-squared	0.005	0.214	0.214	0.246	0.864	0.966
Country Fixed Effects	No	No	No	No	No	Yes

**TABLE 5 – Building the model.** The reported values are the correlation coefficients of the variables and their standard errors in the parentheses. Significance levels are marked according to \*\*\* for  $p < 0.01$ , \*\* for  $p < 0.05$  and \* for  $p < 0.1$ . The coefficients of the country dummies ( $D_i$ ) are not reported in the table.

### Comparing the results of Models (1) to (6)

From the table, it is clear that adding the controls has improved the model. For example, the R-squared values improved from 0,005 of the Model (1) to 0,966 of the Model (6). This implies, that the added variables do matter, and that without them the model would suffer from a larger omitted variable bias.

Quite expectedly, the regression results of Model (1) are quite poor, and no significant relation between labor productivity and employment appears. R-squared value is poor, signifying that labor productivity as such does not explain a lot of the variation in

employment. Taking the natural logarithms in the Model (2) clearly enhances the model, because it makes the coefficient of labor productivity significant at 1% level and also enhances the significance of the constant and increases the R-squared value.

Clustering of the standard errors in Model (3) quite expectedly increases the values of standard errors a lot, making the coefficient of labor productivity again statistically insignificant. This proves the error clustering necessary, since it indicates that the errors in the Model (2) were actually artificially small.

Restricting the years in Model (4) on the other hand actually increases the R-squared value and statistical significance of coefficients slightly, regardless of the fact that the number of observations decreases. The improved statistical significance could be a sign of a structural change that happened in the productivity-employment relationship at some point within the studied time period. This would mean that in the 1960's the relation was on average different than later in the period. Whatever the reason, it seems that restricting the 1960's out of the regressions is a good idea.

Inclusion of capital formation in Model (5) greatly enhances the results. The coefficients of labor productivity and capital formation are both significant at 1% level. In Model (6), the added country dummies further enhance the R-squared value of the model. All but a few of the country dummies are significant at 1% to 10% levels.

### **Adding trend variables**

Trends are clearly visible in the plotted (non-reported) manufacturing employment data. Trends can be accounted for in at least three distinct ways. Firstly, a single, mutual trend variable can be added in the model. A mutual trend variable assumes that the manufacturing employment is changing in every research country along a similar trend. This is obviously quite a big assumption and does not properly account for distinct development paths of the countries. However, such a variable is tested by adding a term  $\beta_T Year$  into Model (6). As the name states, the value of this trend variable is the year of the observation. This new model specification is called as Model (7).

Secondly, the trends can be accounted for by adding fixed effects for each separate year of the research period. When the years are restricted to 1970 to 2010, this means adding 41 dummy variables for the years. The upside of this approach is that yearly fluctuations caused by global business cycles, for example, are probably very well controlled. On the other hand, the downside is that it forces the effect of a given year to be same in every research country, still not accounting for differences between the countries. Another downside is that this approach takes a lot of degrees of freedom. The model with year dummies is same as Model (6), but with dummy variables added for each year;  $\sum_{j=1970}^{2010} \beta_Y Year_j$ . This is called as the Model (8).

Thirdly, the trends can be accounted for by adding separate trend variables for each country. Mathematically, this can be done by a multiplication of the year variable with the dummy variables of each country:  $Trend_i = Year * D_i$ . Thus, the term  $\sum_{i=1}^{11} \beta_{T_i} Trend_i$  is added to the Model (6) to get to Model (9). Separate trend variables take 11 degrees of freedom, but compensate this by controlling for the differences in the employment growth in different countries. Model (9) looks like:

$$\ln L_{it}^m = \alpha + \beta_{LP} \ln LP_{it}^m + \beta_K \ln K_{it} + \sum_{i=1}^{11} \beta_{T_i} Trend_i + \sum_{i=1}^{11} \beta_i D_i + \varepsilon_{it}, \quad Model (9)$$

In the following table, the results of Models (7), (8) and (9) are presented:

	<b>Model (7)</b>	<b>Model (8)</b>	<b>Model (9)</b>
Time variables	Mutual trend	Year dummies	Country trends
Dependent variable	$\ln L^m$	$\ln L^m$	$\ln L^m$
$\ln LP^m$	-0.838*** (0.104)	-0.822*** (0.125)	-0.459*** (0.0654)
$\ln K$	0.338** (0.127)	0.390* (0.176)	0.173*** (0.0451)
$\alpha$ (Constant)	-32.08*** (6.698)	9.687** (4.208)	31.96*** (8.088)
Observations	394	394	394
R-squared	0.980	0.982	0.993
Country Fixed Effects	Yes	Yes	Yes

**TABLE 6 – Models with different time variables.** The reported values are the correlation coefficients of the variables and their robust standard errors in the parentheses. Significance levels are marked according to \*\*\* for  $p < 0.01$ , \*\* for  $p < 0.05$  and \* for  $p < 0.1$ . The coefficients of the mutual trend ( $Year$ ), year dummies ( $Year_j$ ), country trends ( $Trend_i$ ) and country dummies ( $D_i$ ) are commented, but not reported in the table.

### Comparing the results of Models (7) to (9)

Detailed results regarding the various time variables will not be presented. However, all of the tested time variables in the Models (7) to (9) are generally very significant and positive. The mutual trend variable in Model (7) is positive and significant at 1% level. Most of the year dummies in Model (8) are significant at 1% level and all of them positive. The regression results presented in the Table 6 reveal, that in terms of explanatory power, Model (9) is better than the others. This is seen from the R-squared values. Also the coefficients of Labor productivity and Capital formation are most significant in the Model (9). Of the other variables, every coefficient is easily significant at 1% level, except for two country trend variables, which are significant at 5% and 10% levels. All country trend variables have a positive coefficient, except the least significant of them, which has a slightly negative value (Nigeria). Thus, Model (9) is so far the best of the tested model specifications.

### **Lagging the independent variables**

So far, the Model (9) seems to be the best specification. However, the model can possibly be improved further, by lagging the variables. Intuitively, lagging of the independent variables seems to be a good idea, because it seems very realistic that the effects of, say, a labor productivity shock will not hit the employment immediately and then cease. It seems more realistic that the effects last at least for a few years, before dying out. Lags can take this into account.

A natural place to begin studying how lagging might affect the model is to lag the independent variable of interest: the manufacturing labor productivity. The optimal amount of lags must be of course tested. To test for the optimal lag amount, the regression is run adding lags one by one, meanwhile testing the regression models with Bayesian Information Criteria (BIC). The model specification with the smallest value of BIC is theoretically optimal. However, it is also good to confirm that the coefficients of lags make sense – so that the coefficients of lags don't jump from negative to positive, but affect to the same direction. In addition to adding lags to the labor productivity, the model is also run with a specification of one lag but no unlagged labor productivity. This is likewise tested with BIC.

The detailed results of the lag testing are not presented here. Suffice it to say that the model with one lag of manufacturing labor productivity (plus the original unlagged labor productivity term) is optimal according to BIC. This model is named as the Model (10), in which the term  $\beta_{l,LP}$  is the regression coefficient of the first lag of labor productivity. It looks like this:

$$\ln L_{it}^m = \alpha + \beta_{LP} \ln LP_{it}^m + \beta_{l,LP} \ln LP_{it-1}^m + \beta_K \ln K_{it} + \sum_{i=1}^{11} \beta_{T_i} Trend_i + \sum_{i=1}^{11} \beta_i D_i + \varepsilon_{it} ,$$

*Model (10)*

The delay of effects probably applies to the capital formation variable as well, so lags for that are tested too. Regressions are run with different amounts of lags for capital formation. Similarly as with labor productivity, a regression is also run with the lag only, i.e. without the unlagged capital formation variable. According to F-test results,

the capital formation variable was most significant, when measured only with the first lag. However, according to BIC, the optimal model is again the unlagged capital formation variable plus the first lag of capital formation variable. The regression coefficient of the first lag of capital formation is named as  $\beta_{l,K}$  and the new model, chosen by BIC, is named as Model (11).

$$\ln L_{it}^m = \alpha + \beta_{LP} \ln LP_{it}^m + \beta_{L,LP} \ln LP_{it-1}^m + \beta_K \ln K_{it} + \beta_{l,K} \ln K_{it-1} + \sum_{i=1}^{11} \beta_{T_i} Trend_i + \sum_{i=1}^{11} \beta_i D_i + \varepsilon_{it} , \quad \text{Model (11)}$$

To conclude the lagging of the models, Table 7 collects the results of the lagged Models (10) and (11), also adding the Model (9) for comparison.

	<b>Model (9)</b>	<b>Model (10)</b>	<b>Model (11)</b>
Model description	Unlagged	Lagged $LP$	Lagged $LP$ & $K$
Dependent variable	$\ln L^m$	$\ln L^m$	$\ln L^m$
$\ln LP^m$	-0.459*** (0.0654)	-0.187 (0.250)	-0.200 (0.248)
$\ln LP_{t-1}^m$		-0.315 (0.289)	-0.348 (0.279)
F-stat ( $\ln LP^m$ & $\ln LP_{t-1}^m$ )	49.25***	66.75***	106.07***
$\ln K$	0.173*** (0.0451)	0.181*** (0.0446)	0.111** (0.0384)
$\ln K_{t-1}$			0.0933*** (0.0287)
F-stat ( $\ln K$ & $\ln K_{t-1}$ )	14.78***	16.38***	9.12***
$\alpha$ (Constant)	31.96*** (8.088)	-111.8*** (8.881)	-108.9*** (10.04)
Observations	394	393	383
R-squared	0.993	0.994	0.994
Country Fixed Effects	Yes	Yes	Yes

**TABLE 7 - Lagged models.** The reported values are the correlation coefficients of the variables and their robust standard errors in the parentheses. Significance levels are marked according to \*\*\* for  $p < 0.01$ , \*\* for  $p < 0.05$  and \* for  $p < 0.1$ . The coefficients of the country trends ( $Trend_i$ ) and country dummies ( $D_i$ ) are not reported in the table. The F-stats are calculated for joint significance, if lags of a variable are included in the model.

### **Comparing the results of Models (9) to (11)**

As the results show, lagging the model turns the coefficient of labor productivity statistically insignificant. The same applies to the added lag. However, this is not a problem, since more important is their significance as a group. F-test is utilized to measure the significance of the single labor productivity term in Model (9), and then the joint significance of the labor productivity term and its lag term in Models (10) and (11). The increase in F-statistic (which has null hypothesis that the tested coefficients are zero) clearly shows that adding the lag term of labor productivity made labor productivity (as a group of variables) even more significant than it was.

Same effect does not apply for the capital formation variable. Adding a lag term to it actually makes it less significant as a variable group. However, as a group it is still clearly significant at 1% level, and also the separate terms are significant. As chosen by BIC, Model (11) is the best model so far.

### **First-differencing the model**

As defined by the LLC and IPS unit root tests, the possibility of unit root cannot be excluded. Hence, the data and the model should be first-differenced to remove risk of spurious regression results. First-differencing removes unit root of first degree from the model, but also all time-invariant explanatory variables. However, this is not a concern, because first-differenced model still controls for the country specific fixed effects and other time-invariant variables.

The first-differenced model measures how a change in the logarithm of, say, labor productivity will affect the change in the logarithm of employment. So instead of measuring effects from levels to levels, the first-differenced model measures effects from changes to changes. The interpretation of the coefficients of labor productivity and capital formation doesn't change.

Because Model (11) is so far the best model specification, that is the one to be first-differenced. First-differencing procedure goes as follows. The Model (11) at time point  $t-1$  is subtracted from the Model (11) at time point  $t$ . The procedure cancels out the

constant and the country specific fixed effects. The  $Trend_i$  variable is reduced into a dummy variable, because after differencing the time variant individual specific effects ( $Trend_i$ ), the remainder is a country specific dummy ( $D_i$ ). Thus, the first-differenced model, which is named as Model (12), looks like:

$$\Delta \ln L_{it}^m = \beta_{d.LP} \Delta \ln LP_{it}^m + \beta_{l.d.LP} \Delta \ln LP_{it-1}^m + \beta_{d.K} \Delta \ln K_{it} + \beta_{l.d.K} \Delta \ln K_{it-1} + \sum_{i=1}^{11} \beta_{T_i} D_i + \Delta \varepsilon_{it},$$

*Model (12)*

The first-differenced model is regressed twice: with normal standard errors (Model 12) and again with clustered standard errors (Model 13).

	<b>Model 12</b>	<b>Model 13</b>
Model description	Normal std. errors	Clustered std. errors
Dependent variable	$\Delta \ln L^m$	$\Delta \ln L^m$
$\Delta \ln LP^m$	-0.182*** (0.0348)	-0.182 (0.104)
$\Delta \ln LP_{t-1}^m$	-0.114** (0.0513)	-0.114 (0.0643)
F-stat ( $\Delta \ln LP^m$ & $\Delta \ln LP_{t-1}^m$ )	17.33***	4.49**
$\Delta \ln K$	0.0931*** (0.0177)	0.0931*** (0.0178)
$\Delta \ln K_{t-1}$	0.0629*** (0.0177)	0.0629** (0.0209)
F-stat ( $\Delta \ln K$ & $\Delta \ln K_{t-1}$ )	18.17***	14.01***
Observations	372	372
R-squared	0.404	0.404
Control of Country Fixed Effects	Yes	Yes

**TABLE 8 – The first-differenced models.** The reported values are the correlation coefficients of the variables and their standard errors in the parentheses. Significance levels are marked according to \*\*\* for  $p < 0.01$ , \*\* for  $p < 0.05$  and \* for  $p < 0.1$ . The coefficients of the country trends ( $D_i$ ) are not reported in the table. The F-stats are calculated for joint significance of the lagged and unlagged term of the variable.

### Comparing the results of Models (12) and (13)

As seen from the table, all coefficients of labor productivity and capital formation are significant individually as well as in groups in Model (12). Expectedly, the significance



levels somewhat decrease in the Model (13), which has the clustered errors. However, still after error clustering, the labor productivity variables are jointly significant on 5% level and capital formation variables on 1% level. Results of the Model (13) are especially important, because Model (13) is probably the most controlled in this thesis. It doesn't have unit root, as tested. Clustering of the errors has also decreased heteroskedasticity and serial correlation.

### **Other tested model specifications**

In addition to the model specifications presented above, also several other model specifications were tested. The results of those are not reported in detail, but were generally very similar to those presented. The labor productivity affected employment negatively in all model specifications, while the statistical significance and R-squared values varied. Below, the most important ones of the tested model specifications are shortly described.

One of the tested model specifications was using employment share of manufacturing as the dependent variable. A linear-log regression was conducted to make the model measure the effects of percentages to percentages. This model was then controlled with capital formation, various trend variables, fixed effects, lags, clustering, etc. Due to the variable types, the effects of labor productivity or capital formation on employment share of manufacturing are not very straightforward to interpret, but the directions of the effects are still clear – labor productivity was negatively correlated and capital formation positively correlated with employment share of manufacturing. In the end, employment share of manufacturing was not used as a dependent variable in the final regression models because the model is more difficult to interpret and the coefficients were not as statistically significant as with natural logarithm of employment as a dependent variable.

Another tested specification was to include capital formation variable in the form (natural logarithm of) capital formation per labor. To be precise, this was measured as capital formation in the total economy per workers in the total economy. This specification of capital formation didn't change the results. The reason to use the pure

capital formation measure, instead of capital formation per labor in the final regression models (with logarithms taken) is, that the former gives a more natural and useful interpretation of results. Furthermore, pure capital formation measure explained employment more significantly than capital formation per workers.

Also capital formation as a percentage of GDP was tested. It was included in regressions as a control variable as such and with a natural logarithm taken. Both specifications gave similar results. Capital formation as a percentage of GDP (and its lag) always had positive correlation coefficients, and the coefficients of labor productivity remained negative. The statistical significance of these capital formation variables was not nearly as good as with plain capital formation.

Lagging of the dependent variable (manufacturing employment) is conducted as well. A few potential problems arise with this approach. According to Achen (2000), while using an autoregressive term as a control variable it often acquires large and very significant coefficients and dramatically improves the fit of the model, but simultaneously makes the other coefficients collapse into small and insignificant values. More importantly, the result is very likely biased, because OLS is not able to produce unbiased estimates with such models. Dynamic panel data models with a lagged dependent variable should preferably be estimated with a Generalized Method of Moments (GMM). GMM estimation is not conducted in this thesis.

Regardless of the problems, OLS estimation with lagged dependent variable was conducted for the Model (9). As expected, the R-squared value was very large (0,9982) and the lagged dependent variable was positive and statistically very significant. Importantly, the directions of effects of labor productivity and capital formation remained unchanged (negative for labor productivity and positive for capital formation). Labor productivity was statistically significant at 5% level and capital formation at 1% level.

### 5.2.3. Post-regression tests

#### **Heteroskedasticity test**

The regression results are tested for possible heteroskedasticity. If heteroskedasticity is found, it should be treated somehow, so that it will not interfere too much with the regression results. Heteroskedasticity testing is implemented with a Breusch-Pagan (or Cook-Weisberg) Lagrange-Multiplier test. The test is done for the Model (11), with the exception that no error clustering is utilized, because the goal is to find if heteroskedasticity is originally present.

The residuals of the regression of Model (11) are squared. The Breusch-Pagan test conducts a new regression, where the squared residuals of the original regression are regressed with all independent variables of the original regression. The Breusch-Pagan test could also be done more precisely, by including also additional variables that could be correlated with the residuals. However, given the results presented next, that is not necessary.

The test calculates a Chi-squared test statistic with a null hypothesis that variance of the dependent variable in the original regression is constant. Rejection of the null hypothesis means that heteroskedasticity is likely present. For the regression of Model (11) the result is clear; the Chi-squared test statistic is 60,84 and the according p-value is 0,0000. This indicates that heteroskedasticity is clearly present in Model (11), and that the conducted Breusch-Pagan test does not need additional variables.

The found heteroskedasticity could be controlled with at least a few ways. One option would be to utilize (Feasible) Generalized Least Squares estimation methodology, but that cannot be done within the limits of this thesis. In stead, clustering the standard errors (according to country), as conducted in this thesis, controls heteroskedasticity.

#### **Serial correlation test**

Another common and persistent problem in the macroeconomic panel data is the one of serial correlation. Serial correlation doesn't affect the unbiasedness or consistency of OLS estimators, but it does affect their efficiency. With positive serial correlation, the

OLS estimates of the standard errors will be smaller than the true standard errors. (Pindyck and Rubinfeld, 1998).

In this thesis, a similar serial correlation test is conducted as is done by Mollick and Cabral (2009). They conduct a test that is derived from Lagrange Multiplier Breusch-Godfrey test. It is quite simple; the residuals of the tested regression are regressed with all independent variables of the regression and the lag(s) of the residual itself. If the lag(s) of the residual explain the residual on statistically significant levels, serial correlation is present. The test is here conducted only for the most advanced fixed effects model specification (Model 11), because if that contains serial correlation, it is quite evident that all other model specifications contain serial correlation as well. The results are clear; first lag of the residual explains the residual with a t-value of 27,16 and according p-value of 0,0000. Thus, the lag of the residual is significant on 1% level and serial correlation is very clearly present in the regression.

As mentioned, clustering of the standard errors according to countries is utilized, because it can also fix the serial correlation problem. However, although clustering of the errors should address the problem with errors correlated within a country, they don't necessarily fix the rest of serial correlation.

One simple way to confirm that the error clustering is effective in treating the serial correlation is to see if the clustering increases the size of the standard errors and makes the regression results less significant. That is a sign that the clustering was useful. This is exactly what happens with the regressions of this thesis. It is present in the differences in the regression results of Models (2) & (3) and Models (12) & (13).

### **5.3. Interpretation of results**

#### **5.3.1. Summary of the goals and results**

As stated, the goal of this data-analysis was not to uncover the effects of productivity to employment in Sub-Saharan Africa completely. This data-analysis serves the whole by

giving a partial answer – it simply studies the labor productivity's correlation coefficient to employment in Sub-Saharan Africa. Primarily, the data-analysis attempts to find a credible answer to the question; how does employment change if labor productivity changes in Sub-Saharan African manufacturing sector?

In short, the result of the data-analysis is as follows; in Sub-Saharan African manufacturing sector, labor productivity affects employment negatively in the short and medium run (2 years). Causation is not verified. The results are very clear and robust in the sense that all model and methodology specifications point to the same direction.

Thus, the result suggests that in short and medium run, productivity is negatively associated with employment. However, this cannot be concluded with certainty without further research. The next step would be to continue research with different approaches, for example with total factor productivity as a productivity measure. It is also important to verify to what extent the effect of labor productivity is due to capital intensity fluctuations. If further research seems to confirm the negative effects, policy attention is needed to mitigate the short run effects. On the other hand, if further research proves that the results of this thesis were incorrect, the side effects of productivity shocks do not require that much attention in policy design.

A causal relation from productivity to employment is probable, but not totally certain. The negative correlation coefficients found in the data-analysis don't necessarily mean that a negative causal effect exists. There are a few key problems with the causality. Firstly, there are several omitted variables (some of which are discussed in this thesis) that affect both labor productivity and employment. Consequently, it is totally possible that these variables actually cause the correlation (or part of it) between labor productivity and employment.

Secondly, as the theories (Sørensen and Whitta-Jacobsen (2010), among others) and research of Cavelaars (2005), Van der Horst et al (2009) and many others suggest, a causal relationship is endogenous and very probably also runs into the other direction

– from employment to productivity. In other words, it is possible that the negative relation is caused more by a causal effect from employment to productivity, than vice versa.

### **5.3.2. Comparison of the results to existing research and theories**

Several studies have found similar results as this data-analysis. One of the most comparable studies is the one of Wakeford (2004), who studied the long run productivity-employment relationship in South Africa, although not in manufacturing sector explicitly. He found, that the economic growth in South Africa had a “job-shedding nature” during the years 1990 to 2003. The results of the data-analysis do not contradict with the result of Wakeford (2004). In fact, the results seem to be loosely consistent.

Also Yusof (2007) studied the productivity-employment relation in a developing country context, but he concentrated in the long run effects. Similarly to South Africa in Wakeford’s research (2004), for most countries the long run relation did not exist. However, he found a negative relation for some of the countries. Unfortunately, the research does not exactly overlap with this data-analysis.

Mollick and Cabral (2009) found that labor productivity affected employment negatively in short run in the Mexican manufacturing sector. The data-analysis of this thesis can be quite well compared to the results of Mollick and Cabral’s (2009) model specification with a control for capital (but real wages excluded). Both studies have the same definition of labor productivity, value added per persons employed. Both models have fixed effects, almost the same variables and use natural logarithms. The models in this thesis have additionally included trend variables. Comparison reveals that the results are consistent; in both studies, the effect of labor productivity on employment is negative and statistically significant.

Many others have also found the negative short run relationship between labor productivity and employment, but with less comparable sets of countries. These

include for example Chang and Hong (2006), Cavelaars (2005), Basu and Fernald (2006), Gali (1999), Francis and Ramey (2005), Bourles and Cette (2005) and Dew-Becker and Gordon (2008).

No clear contradictions were found between this data-analysis and existing research. Many studies, like those of Nordhaus (2005), Mollick and Cabral (2009) and Chang and Hong (2006) have found, that in the short run total factor productivity is positively correlated with employment. However, the results of this data-analysis do not contradict those results, because the utilized productivity measure is different. Furthermore, these studies are not conducted in Sub-Saharan Africa.

When the results are compared to theory, in this case especially to the theory of Sørensen and Whitta-Jacobsen (2010), no clear contradictions are found. Sørensen and Whitta-Jacobsen (2010) use a productivity parameter  $B$ , which in their models is total factor productivity. In their models, term  $B$  affects employment positively, as was explained in the Chapter 3.3. Unfortunately, the data-analysis results cannot be directly compared with the models of Sørensen and Whitta-Jacobsen (2010), because the productivity measure is different.

Even though not many direct contradictions exist, in the end it is difficult to form practical interpretation of the results. This is due to the fact that it remains unclear why labor productivity and total factor productivity tend to give contradicting results and which one is more important from the viewpoint of actual policy design.

### **5.3.3. Robustness and credibility**

The results of the data-analysis are very robust in some ways, but quite weak in others. In terms of *tested* model and methodology specifications they are robust. These included OLS regressions with a host of different controls: country dummies, years, mutual trend and country specific trends. The results were also robust for taking logarithms, error clustering and removal of unit roots.

### **Robustness to unit roots**

The removal of unit roots with first-differencing was successful. As tested, no unit root remained after the first-differencing. The results of regressions with first-differenced models did not significantly change the results – regression coefficients of the labor productivity remained negative. However, the coefficients were closer to zero. The sum of the correlation coefficients (first lag and non-lagged) of labor productivity was only -0,296 in the first-differenced Model (13), whereas it was -0,548 in the Model (11). This could imply that part of the regression results in Models (1) to (11) might arise from spurious regression. However, because the first-differencing did not change the direction of the relation, at least the main regression result (negative short run relation) is robust for unit root and spurious regressions.

### **Problems with endogeneity and multicollinearity**

Unfortunately, there are also some ways in which the results are weak. One of the biggest weaknesses arises from the nature of the macroeconomic variables. Macroeconomic variables, including the ones that were studied in this data-analysis, are typically related to each other in very complex ways and the causal relations run into both directions (everything affects everything). In other words, the variables are endogenous and multicollinear. As Van der Horst et al (2009) propose, given the endogeneity problem, OLS will likely produce biased coefficient estimates.

### **Problems with omitted variables**

Another weakness of the data-analysis relates to the non-tested model specifications, or in other words to omitted variables. There are several potentially important factors that could be controlled for. For example some additional variables could include real wages, formality of employment, domestic competition, productivity in comparison to international competitors and human capital. Also all factors that affect international competitiveness and trade would very likely somehow affect the results. These include for example development of the governance, infrastructure, institutions, openness of the markets, trade policy, macroeconomic stability, inflation and so on. These variables can be broadly labeled under the quite general term “business climate.” The “business climate” is potentially very important for the reason that it is very likely the bottleneck



of competitiveness and growth of manufacturing sector in many Sub-Saharan African countries (Rodrik, 2014). Productivity gains in a context of bad “business climate” might not result in growth of production or employment, if productivity is not the bottleneck.

### **Problems with the choice of productivity measure**

The choice of labor productivity to be the measure of productivity is another potential weakness. As Chang and Hong (2006) note, labor productivity is not as natural measure of productivity as total factor productivity, and the results might even be opposite. After all, labor productivity as a measure takes into account much more than just productivity in the sense of efficiency. For example, as noted earlier, disturbances affecting material-labor or capital-labor ratios affect labor productivity. For example, Chang and Hong (2006) show that in U.S. significant permanent shifts in input mix have occurred on manufacturing sector and that they are associated with short run reduction of hours (i.e. negative relation of labor productivity and employment). Similar reasons might explain the negative correlation on the researched period in Sub-Saharan Africa as well. The capital formation variable in this data-analysis helps to control part of the changes in input-mix, but they are not controlled to full extent. A potential weakness also arises from the unavoidable fact that labor productivity is measured as “total workers per gross value added”, instead of the more accurate “total hours per gross value added.”

### **Problems with data quality**

Another significant problem arises from the data itself. The problem is, as explained earlier, that a large proportion of the gross value added data and employment data is not genuine, but estimated. The consequent measurement error in the independent variable is very likely to cause attenuation bias. This results in regression coefficients that are biased towards zero. If that is the case, it will luckily not affect the direction of the correlation. The correlation coefficients were found to be negative. Removing attenuation bias would thus make the correlation coefficients even more negative. However, unfortunately in the cases in which the data is estimated, the short run effects from labor productivity to employment are likely to be wiped out (Wakeford,

2004). This is obviously a hindrance, when the regression results are utilized to assess the short run effects. Luckily, all of the data is not evaluated and the results have also value for assessing short run effects.

Another unavoidable issue with the data arises from the weak reliability of the African statistics, which decreases the credibility of the results to some extent. This is discussed with more depth in the Chapter 5.1.3.

### **Problems with remaining serial correlation**

When it comes to serial correlation, all of it is not likely to be fixed with clustered standard errors. This would imply, that the regression results might be too precise, i.e. that the standard errors are smaller than they should be. However, the result of the data-analysis is also robust to this effect, because remaining serial correlation affects only the size of the standard errors, not the values of coefficients.

### **Robustness to other methodologies and research approaches**

Finally, it also remains unknown if the results are robust for different choices of methodologies and different research approaches. That is unavoidable. Only further research can tell if the result is robust to other methodologies. The review of credibility can be concluded as follows; to some extent, the results of this regression are feeble, and have to be regarded with caution.

## **6. Conclusions**

### **Goal of the thesis**

The goal of this thesis is to find answers to the question; how does productivity affect manufacturing employment in Sub-Saharan Africa? The focus is especially in the short run effects of productivity growth. The question is approached with analysis of macroeconomic theory, existing research and data.

## **Review of the chapters and their key findings**

In the Chapter 2, the Sub-Saharan African manufacturing sector was introduced, concentrating on the productivity and employment situation. The findings were clear – manufacturing has not developed optimally. The sector's share of GDP, value added, exports and employment have diminished for decades. Additionally, the productivity growth in the manufacturing sector has lagged behind the productivity growth of the total economy. To address the problems, productivity growth seems to be the most important policy goal, but boosting manufacturing employment is important too. If a short run tradeoff between the two goals exists, it is important to maintain good employment possibilities with adjustment strategies, while advancing the productivity growth.

The analysis of theory in Chapter 3 gives quite clear results: in the theory of Sørensen and Whitta-Jacobsen (2010), total factor productivity shocks affect employment positively in the short run. All models had positive productivity effects, except one in which no effects existed due to rigidity of variables. Except for the rigid model, the productivity effect was found to be robust for various assumptions of price and wage flexibility. However, especially the assumption that demand is necessarily elastic in relation to price, was found to be dubious for reasons especially related to Sub-Saharan African circumstances (low competition, for example). This might be a critical flaw, but more research is needed to confirm any conclusions.

Chapter 4 sheds light on the existing research on productivity-employment relationship, focusing on the short run relation in manufacturing sector in contexts that are as relevant for Sub-Saharan Africa as possible. The chapter also introduces some common approaches to productivity-employment research to improve the understanding and interpretation of the existing research. Depending on the approach and setting, positive, negative and mixed effects were found. For example, the effect of labor productivity on employment was mainly negative, whereas the effect of total factor productivity was positive. Making practical conclusions according to the existing research is difficult, because it remains unclear what causes the differences in results

for labor productivity and total factor productivity and which results are more relevant for policy. Several research papers had some shortcomings, affecting their credibility.

Finally, the Chapter 5 conducted a data-analysis to research the labor productivity-employment relationship in Sub-Saharan Africa. An empirical study is conducted to evaluate the short run relation with a data set of 11 Sub-Saharan African countries during a 41-year period. OLS methodology with fixed effects is conducted for several model specifications, including a first-differenced model. Data and results are tested for unit root, serial correlation and heteroskedasticity. Data-analysis finds a negative relationship of labor productivity and employment, which is robust for the tested specifications. However, this result is also subject to some credibility issues, including estimated data values, reliability of data, omitted variables, shortcomings of the methodology and a few others. Consequently, the results must be viewed with caution.

### **The need for further research**

It is clear that this thesis alone does not give final answers – more research is obviously needed. Nevertheless, this thesis gives some initial perspectives, which the further research can possibly utilize. Several interesting paths for further research emerge. Firstly, further analysis of macroeconomic theories and the validity of their assumptions in Sub-Saharan Africa would be useful to assess if they explain the productivity-employment relation correctly there. A relevant topic for analysis would also be the price elasticity of demand of Sub-Saharan African manufactures.

Secondly, more data-analysis is needed with different approaches. Regarding the data-analysis of this thesis, a more detailed approach dividing the labor productivity term into productivity, capital-labor ratio and material-labor ratio would be useful. Additionally, a similar study with instrument variable methodology would possibly help to better understand the causalities between the variables. It would also be essential to know what is the relation of total factor productivity and employment. Analyzing the reasons for the differences of results with labor productivity and total factor productivity, and their comparative relevance, is also crucial. If possible, a research with a wider set of countries and better data would also be welcome.

## **Speculations**

To conclude, when combining all of the evidence, the balance seems to be supporting a view, that the short run relation of productivity and employment might be negative in Sub-Saharan Africa. All existing research that was conducted in Sub-Saharan Africa (ILO, 2005; Wakeford, 2004; Yusof, 2007) and the data-analysis in this thesis seem to be supporting this view. According to ILO (2005) the most important reasons for negative short run relationship in Sub-Saharan Africa are high population growth and the large share of informal employment.

Nevertheless, there is also another intuitive explanation, shortly discussed in Chapter 3.4, which supports the existence of negative relationship. As Blanchard et al (1995) highlight, the productivity-employment relationship critically depends on the price elasticity of demand. Given that productivity increases decrease the prices, if demand is elastic (inelastic) it increases more (less) than the productivity initially increased. Consequently, if the demand is inelastic towards productivity increases, employment will decrease, because the new demand can be satisfied with less labor.

There are several possible reasons why this might be the case in Sub-Saharan Africa. As discussed in Chapter 2, the competition and domestic market for manufactures is on average really low in the Sub-Saharan African manufacturing sector. Furthermore, the sector is not exporting enough because it is not very competitive, and in many countries the demand consequently relies on the tiny, domestic markets. Thus, the market size is on average very limited. Yet another problem probably arises from the low competition, as it gives the firms so much market power that productivity increases don't decrease the prices of manufactures as much as they would in more competed markets.

As discussed in Chapter 4.2, the situation is probably worsened by the development, that the labor share of income in Sub-Saharan Africa is relatively small and that the labor in general has little negotiation power. The real wages have lagged behind the productivity growth (at least in South Africa). This means, that productivity increases

don't turn into wage increases and domestic purchasing power as much as they should, which in turn probably makes the demand for consumer manufactures inelastic in relation to productivity growth. This is obviously quite speculative and should therefore be verified with further research.

### **Policy implications**

The topic of policy recommendations is interesting, but a discussion that goes beyond the limits of this thesis. However, it is useful to shortly discuss how the results of this thesis might relate to policy making in practice. The results of this thesis and its data-analysis are alone not sufficient to draw detailed policy recommendations. The data-analysis gives results of just one research with a limited approach. As mentioned, policy recommendations would depend on the results of further research with other methodologies and approaches, because the basis for policy recommendations should probably be stronger than one limited research. Furthermore, policy recommendations would probably need to be tailored separately for each country and thus based on an assessment of the country's situation. Depending on the results of further research and situation assessments, the governments in Sub-Saharan Africa should be prepared to utilize measures to support employment when positive productivity shocks occur.

Regardless of the exact effect of productivity to employment in each country, there seems to be some recommendable policies and policy goals (e.g. improving formality of employment, increasing competition, removing entry barriers, etc.), which usually seem to mitigate the adverse short run effects from productivity shocks, if they exist. More information on this subject can be found from the report of ILO (2005). Lastly, it remains very important to improve the productivity in long run, because it is obligatory in order to improve the competitiveness and long-term employment prospects of the manufacturing sector in Sub-Saharan Africa.

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