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International Trade and Mobile Telecommunication in Africa

Effects on trade between EU and Africa

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Abstract: This study investigates if the access to mobile telecommunication in African countries has an effect on export flows between countries in Africa and EU countries. Countries in Africa have the last decade experienced an immense growth of available mobile cellular subscriptions. The effect of this increase has not been studied before in an international trade context. This study also investigates if the effect of access to mobile telecommunication changes over time. These effects are estimated by using the gravity model. The mobile telecommunication is measured with the penetration rate of mobile cellular subscription in each of the countries in Africa. The study found that a one percent improvement in access to mobile telecommunication is associated with a 0.25 increase in international trade. This study also found that the effect on export flows of the access to mobile telecommunication increases over time.

Keywords: International Trade, Mobile Telecommunication, Africa, EU, Gravity model

Acknowledgement

Humour. A teacher once said that, humour is something that too long have been lacking in academic research. This teacher used humour frequently in papers and research which made the text personal and perhaps a bit easier to capture. Even though one's words made impression on me, this bachelor thesis also lack humorous element. But, a big but, this thesis has been really fun to work with and actually made me laugh a lot of times to periods of very confusing thoughts and confusing actions. I welcome these feelings and actions, since I consider them as a sign of being caught up in something which is a good sign when writing a thesis.

This thesis is finished thanks to my excellent advisor Maria Persson. She has been helpful and constructive in her approach and never taken long time to answer my mail and phone calls. And I can assure you that there have been a lot of them. Another person that has played a major role in this thesis is my highly loved friend, Lina Lundén. She has taken her time to thoroughly read trough this study and provided me with comments on contents and use of grammar. All remaining faults are mine. Family and friends, you all know that you give and gave me energy to end this study.

I sincerely hope that my findings in this thesis will make an impact on decisions' made regarding how to improve living conditions for the population of countries in Africa.

Best regards,
Angelica Holmgren
Lund, 2012

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1. Introduction

Mobile telecommunication has recent years expanded on the African market. Many countries in Africa are experiencing an increased access to the technology. The uncertainty regarding the impact of this technology on the African society has given rise to plenty of research and speculation among researchers, politicians and policymakers. Many studies are investigating the social effects of mobile telecommunication, the usage of the technology on a national level and also potential areas of technology expansion.

In an op-ed article written by the Swedish Minister of Foreign Affairs, Carl Bildt, Minister of Commerce, Ewa Björling, and, Minister for Development Assistance, Gunilla Carlsson, (2011) it is argued that a transformation is ongoing in many countries in Africa, a transformation that is beneficial for the countries themselves, as well as for partner countries. They mean that economic growth, new technology and increased international trade are three factors that are greatly improved due to the development of the mobile telecommunication industry (Bildt et al, 2011, and, Economist, 2011). On the global market EU is one of the biggest trade partners while, countries in Africa are upcoming and potential trading partners. Therefore, it is interesting to study whether or not mobile telecommunication has any effect on export flows from a *new* market to the biggest trading union.

Mobile communication is to be considered as a quite new communication channel in some countries in Africa and the technology continuously expands on the market. Does this access to mobile communication have an effect on exports from countries in Africa to EU countries? The main hypothesis of this study is that the access to mobile telecommunication has a positive effect on trade flows. Since international trade is thought of as an important factor to reach economic growth in a country, the expected positive relation between access to mobile telecommunication and trade flows is important to examine. Furthermore, the effect of access to mobile telecommunication on exports from countries in Africa to EU countries has been examined over time. Expected result is that technology becomes more important over time. This would denote that the technology needs to be considered in a long-run context. For example, development of aid assistance actions and governmental policies to advantage of mobile telecommunication technology could be beneficial for export flows.

The gravity model is used to investigate these hypotheses. The dependent variable is bilateral export flows between countries in Africa, as the exporters, and EU countries, as the importers. Explanatory variables are gathered but the variables of main interest are those estimating the impact of mobile cellular subscriptions in countries in Africa during the year 2000 and 2009. Since this time period is chosen the EU15-country group is examined together with all countries in Africa. There are two available measures of mobile cellular subscription on the World Bank's *World Development Indicators* and in this study I have chosen to use the measure mobile cellular subscription per 100 people.

In a study by Jungmittag and Welfens (2009) they found that if international telecommunication in European countries increases by one percent it has an impact on the volume of trade with 0.2 percent. They emphasize that a liberalization of international telecommunication results in trade creation. Furthermore, they stress that an increase in output and real income will be attained. To the best of my knowledge, this study is the one closest to my field of research. However, my contribution to the research field is isolated to mobile telecommunication, as opposed to all telecommunication, and bilateral trade between countries in Africa and EU countries, which is the first in its category.

The results show that access to mobile telecommunication has an effect on international trade between countries in Africa and EU countries. My finding does correspond well to the result found by Jungmittag and Welfens. This study also found that the access to mobile telecommunication has become more important over time.

The disposition of this study is as follows. Section 2 illustrates the link of mobile telecommunication to international trade. A discussion about trade costs and its impact on trade flows is conducted. Furthermore, the hypotheses are here presented. The following section, section 3, pictures the current access of mobile telecommunication in countries in Africa. In section 4 the gravity equation is presented, along with estimation strategies and data sample. This study's empirical findings are presented in section 5. Finally, this study's main results are summarized in section 6.

2. Linking Mobile Telecommunication and International Trade

This chapter will define the costs that firms and individuals encounter when engaging in international business and trade. First will costs and benefits occurring with mobile telecommunication be examined, thereafter, the role of trade costs in an international trade context is studied, and finally, my research questions are presented.

2.1. Costs Associated with Mobile Telecommunication

International trade is associated with higher trade costs¹ than trade within country borders. From a theoretical point of view this means that high trade costs will prevent firms and individuals with fewer resources to take place on the international trade arena. Economic growth connected to increased international trade will therefore not be possible in these cases. The rate of export flows will remain at same levels and economic gains will be lost or never even accessible for these firms and for these individuals.

Included in trade costs are the costs of communication and information exchange. Possibility to communicate is a fundamental factor to enable international trade to take place between two or more parts. The choice of communication channel depends on the level of costs associated with the different alternatives. As suggested above, high trade costs prevent some firms and individuals from engaging in international trade, hence, the communication channel with lowest costs will be used by potential trade partners. Mobile telecommunication is one possible communication channel and the link between this technology and international trade is explored in this study.

A definition of trade costs is all costs, except for the marginal cost of producing the actual good, which become liable when transferring goods to a final user. For example, transportation costs, as trade and policy barriers, information costs and contract enforcement costs, furthermore, costs linked to different valuation of currencies, legal and regulatory costs and local distribution costs. Important to note, there are often several and more costly trade

¹ The costs of communication will be investigated deeper due to the purpose of this paper. The concept trade costs will be used in this study rather than transaction costs. The first one mention covers a wider range of costs and is therefore more suitable for this study. Communication costs or information costs will be used when referring to the costs associated with telecommunication or mobile telecommunication but also other potential communication channels. These costs are covered in the umbrella concept - trade costs.

barriers in developing countries than in developed countries, due to for example lacking infrastructure, non-functional political systems or less beneficial trade agreements (Anderson & van Wincoop, 2004, and Butter & Mosch, 2003).

Theories of communication say that facilitated opportunities to communicate when engaging in international trade will raise the levels of business, as well as trade flows. With reduced international communication costs and more efficient telecommunication system possible effects to expect are increases in trade concerning both exchanges of traditional goods and trade associated with more specialized goods. By being able to use mobile telecommunication, firms and smaller businesses can more easily than before access information about current prices, lucrative markets and best available supply chains (Jungmittag & Welfens, 2009, Aker et al, 2010, and, Fink et al, 2002).

Reduced trade costs are beneficial for the growth of business and usually have a strong impact on the possibilities to make more economically viable deals in an international context. Taking the case of countries in Africa, which generally suffer from low levels of infrastructure, a well functioning telecommunication is important since it allows individuals and firms to both send and receive information quickly and at a low cost (Aker et al, 2010). In countries in Africa the development of mobile telecommunication is considered to decrease trade costs and make exports markets more accessible for people and firms located in these areas (Carmody, 2009).

The development of mobile telecommunication technology in African countries is likely to decrease the costs associated with the use of this technology. Along with decreased costs and a better functioning mobile telecommunication network, people are more prone to use the technology. By using it, firms and individuals can easily do business both on a national and international level. They can, for example, more easily and at lowered costs² access lucrative markets, gain information about current prices of goods and raw material and manage the supply chain of goods. Next section will further examine if the decrease of trade costs have an impact on international trade flows.

² I here assume that the use of mobile telecommunication is considered to be the easiest way to access information. However, this may not mean that it is the cheapest communication channel in absolute numbers in countries in Africa. The assumption relies on that mobile telecommunication technology demands less effort by the user than landline telecommunication, in relation to the gain of same amount of information. Intuitively, I find this likely since a mobile phone can be used anywhere which a regular phone cannot.

2.2. The Effects of Communication on International Trade

So, poorly functioning or non-available telecommunication can be argued to lead to increased trade costs. Does this mean that it also affects international trade volumes? Theoretical models by Melitz (2003) and Chaney (2008) have used the heterogeneous firms framework to illustrate how fixed and variable costs of trading have an impact on both the level of traded volumes (the so-called intensive margin) and the number of firms that can participate in the international market (the so-called extensive margin). For the purposes of this paper, it is interesting to note that regardless of whether the costs associated with lack of telecommunication should be regarded as fixed or variable, these theoretical models predict that they should have an effect on the value of international trade. In other words, higher costs due to poorly functioning or non-available telecommunication should lead to lower values of trade.

The latest generation of trade theories predict that countries with low levels of mobile telecommunication penetration should tend to experience low levels of trade with other countries. Can this be confirmed by the existing empirical research? Fink et al. (2002) contributes to the study of international trade by examining whether trade costs have any effect on trade flows or choice of trade partner. By using the gravity model they examine the impact of communication costs on international trade and found a significant influence on trade patterns. Furthermore, communication costs seemed to have bigger impact on differentiated products than on homogenous products in international trade. Harris (1995) means that differentiated products that require a greater amount of information flows demand a communication network that can transmit that amount of information, therefore, communication costs increase while trading with these kinds of products.

Jungmittag and Welfens (2009) examine the effects of EU's liberalization of the telecommunication system and its impact on international trade values. They find that high communication costs have the same negative impact on export flows as tariffs. They investigate this by using the gravity model and the numbers of minutes called from the exporters to the importers. Their result shows that if international telecommunication increases by one percent, the volume of trade rises by 0.2 percent. However, they argue for more research within the area, both to increase the reliability of their results and to gain a deeper understanding of the impact of telecommunication in an international trade context.

More research with similar result will help to motivate the need of a functional telecommunication network in order to receive economic growth through trade within a country.

To summarize the two above theoretical sections, previous research argues that the level of trade costs matter for the value of international trade flows. It is argued that a well-functional communication channel affect trade flows positively, for that reason, the area is important to examine in an international trade context. Furthermore, previous studies state that especially countries with low levels of infrastructure will gain from increase access to telecommunication. This study will from these theories and hypotheses investigate how access to *mobile* telecommunication has affected trade flows between EU and countries in Africa. My hypotheses are presented in next section.

2.2.2. Hypotheses

From previous research and theories presented above it is concluded that a lack of a functional telecommunication increase trade costs which in turn negatively affects export flows. Therefore, this study seeks to examine the effects of the relatively new communication channel, mobile telecommunication, in countries in Africa, on export flows.

This first and main hypothesis of this study is to investigate if the access to mobile communication has a positive effect on exports from countries in Africa to EU countries. The effect of access to this technology is examined during the year 2000 and 2009. The investigation will reveal if mobile telecommunication has been important for exports from countries in Africa to EU countries. If the result is positive, this would imply that the access to mobile telecommunication has an increasing effect on international trade flows. This means that improvements of the mobile telecommunication technology should increase firms and individuals possibilities to engage and succeed in international trade, which could bring forth economic growth.

The second hypothesis is that the effect on exports of the access to mobile telecommunication increases from 2000 to 2009. If a positive effect over time is estimated this would reinforce arguments for improvements or changes of policies and development concerning the mobile

telecommunication area. Potential policies and areas to develop could be aid assistance actions, development of infrastructure and governmental policies.

These are the hypotheses that are going to be investigated, analyzed and discussed throughout this study.

3. Mobile Telecommunication in Africa

This chapter depicts the current situation mobile telecommunication in countries in Africa. A discussion about landline and mobile telecommunication in African countries is first presented. Following section deals with the usage and development of this technology.

3.1. Landline to Mobile Telecommunication

Landline telecommunication technology is expensive and time demanding to build in rural areas. Therefore, the development of mobile telecommunication has represented the first modern telecommunication in some rural areas of countries in Africa. Many regions³ in African countries lack functional infrastructure such as roads, railways and landline telecommunication (Aker et al, 2010).

McCormick (2005) argues that the costs of building mobile telecommunication networks are in most cases below the costs of landline telecommunication. These costs are considered in relation to the amount people living in the areas subject to development of telecommunication technology. However, the costs to *access* the mobile telecommunication network could still be too high for the rural population to manage and the technology could be beyond reach for them.

Djiofack-Zebaze and Keck (2008) present how the liberalization of telecommunication network has affected countries in Africa at a regional and national level. They conclude that improved conditions for competition within the telecommunication sector and other reforms contribute to decreased costs of using the technology. Yet, in comparison with rest of the world, prices of using mobile telecommunication in African countries are still at high levels, but the study identifies a trend of decreasing prices. This study found that a one percent increase in access to mobile telecommunication networks in countries in Africa increases real

³ The authors stress that this has been the case especially for rural regions with a low population density.

GDP per capita with 0.5 percent. These findings imply that investments and developments of the mobile telecommunication network have, if not at an international level, an economic beneficial impact on a national level within countries in Africa.

3.1.1. Usage and Development of Mobile Telecommunication

According to Aker et al. (2010) the penetration of the mobile telecommunication reduces communication costs extensively and improves access to information regarding, for example, lucrative markets and current good prices on the market. The mobile telecommunications help firms to manage their supply chains and create more efficient production and trade. Some mobile phones even offer a possibility to access the Internet⁴.

A way to measure the increase of mobile telecommunication is to study the amount of mobile cellular subscriptions available in one country during a time period. At the WDI there are two measures of this variable available. The first one, called *mobile cellular subscriptions*, presents in absolute numbers how many subscriptions that are in use in one country. The other one, called *mobile cellular subscription (per 100 people)*, presents how many subscriptions that can be found per 100 inhabitants in one country. Since, the last measure reveals information about the distribution and penetration rate in society this is the one that will be used throughout this study. From 2000 to 2009 all countries in Africa have experienced an increase in the rate of this variable which is shown in Figure 1.

From Figure 1, it is clear that all countries in Africa have experienced an increase in the amount of mobile cellular subscriptions per 100 people. However, the data do not tell how many people that are the main users of the numbers of mobile cellular subscription in use. For example, there are 39 subscriptions per 100 people in Guinea-Bissau (GNB), does this mean that there is one person using all 39 subscriptions for herself, or are there 39 people having one mobile cellular subscription each? This measure does not reveal if there is an unequal distribution of the total amount of available mobile cellular subscription between the people in one country. Nevertheless, this data provide an intuition and the best picture available⁵ of what the mobile telecommunication situation looks like in the specific African countries.

4 The access and usage of smart phones, phones that access Internet, are in this study not considered.

5 See 4.2.2. *Criticism of Data* for further motivation for the use of the measure.

Figure 1. Change of mobile cellular subscription from 2000 to 2009

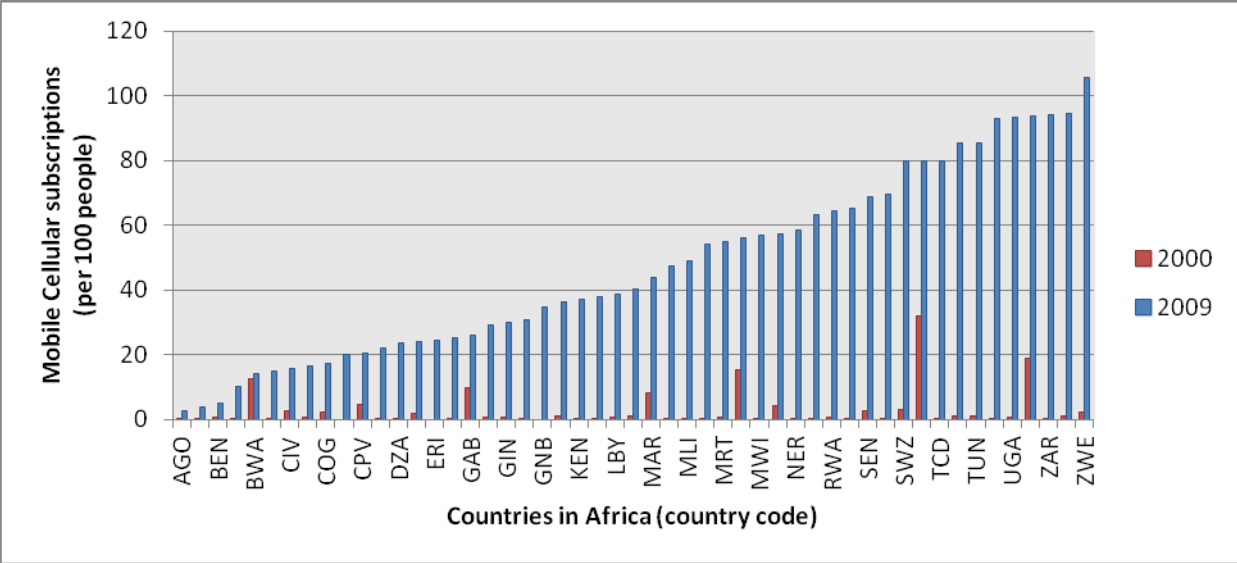


Figure 1: The diagram show how many mobile cellular subscription that were present in each of Africa’s countries (except from Sao Tome and Principe and Somalia) during the year 2000 respectively 2009. *Source:* Data from World Bank (2011).

Some regional differences within this figure is hard to discover, but the countries with most mobile cellular subscription in 2009 are, in subsequent order with the highest rate first, Zimbabwe, Zambia, Democratic Republic of the Congo and South Africa. They are all geographically placed in the Southern part of Africa, except from Democratic Republic of the Congo which is found in Central Africa. Zimbabwe shows a penetration rate of 106 subscriptions per 100 people, while South Africa has a rate of 94 subscriptions per 100 people. The four countries found with least mobile cellular subscriptions in 2009 are, in subsequent order with the lowest rate first, Angola, Burundi, Benin and Burkina Faso. These countries are found in the Central and West part of Africa. Angola has a penetration rate of 3 subscriptions per 100 people and Burkina Faso shows a rate of 10 subscriptions per 100 people. Almost all countries have experienced a huge increase in the amount of mobile cellular subscriptions, except from Botswana that shows an almost constant penetration rate from 2000 to 2009.

Almost all countries in Africa have experienced a growth in the penetration rate of mobile cellular subscriptions presented in Figure 1 by data from the World Bank. The mobile telecommunication technology has become more accessible in most areas of Africa and even, for some rural areas, represented the first telecommunication. This increased access has facilitated communication between individuals and business. However, in some areas the

penetration rates are still low. The difference between the country with highest penetration rate (Zimbabwe) and the country with the lowest penetration rate (Angola) is 103 subscriptions per 100 people. If this study suggests that access to mobile telecommunication has a positive effect on export flows, this difference could be considered as an incentive for further developments.

4. Empirical Methodology

In this chapter the methodology used in this study is presented. A definition of the model and data used is discussed, as well as expected outcome of the variables and strategy of estimation.

4.1. Background on the Gravity Model

The gravity model is widely used within the research field of international trade and economic integration. The model relies on the gravity theory of international trade that determines bilateral trade as a result of attracting and opposing forces. The idea of the gravity model is borrowed from Newton's theory of gravity in physics that explains how physical bodies attract in relation to their mass. Bilateral trade is the dependent variable in the gravity model and is determined by countries' economic and demographic size and their geographic situation. GDP (economic mass) is the major attracting force in the model and the main opposing force is distance (economic resistance).

Kepaptsoglo et al. (2010) presents a selection of 55 research studies using the gravity model during the last decade. According to the authors there have been some adjustments to the model since its introduction by Tinbergen (1962) and Linneman (1966). The model is today recognized as a major instrument to analyze trade flows and explain effects of changes related to trade within society (Kepaptsoglo et al. 2010, Anderson & van Wincoop, 2003, and, Helpman & Krugman, 1985).

Keum (2008) mentions Frankel et al. (1995) and Deardorff (1984), two papers that argued for the shallow theoretical foundations of the gravity model. However, these economist have found theoretical grounds within modern trade theory that well explain bilateral trade and related trade arrangements. This is also stated by Fink et al. (2002) which declare that the

gravity model can be derived from trade models as the Ricardian and Heckscher-Ohlin and models that assume increasing returns to scale and monopolistic competition.

The gravity model has been used in papers aiming to evaluate bilateral trade effects of, to mention some, intra-industry trade, facilitation of trade procedures, free trade agreements and determinants of trade between developed and developing countries (Shelburne, 2002, Bourdet & Persson, 2011, Kepaptsoglo et al. 2010, and, Subhani et al. 2011). The gravity model allows for additional variables to be included in the equation. This study seeks to analyze the effect that access to mobile telecommunication has on export flows between countries in Africa and EU countries.

4.1.2. Empirical Specification

The gravity model explains the variation in bilateral trade between countries in Africa and EU countries. The model explains this variation as a function of the country's economic size and the distance between the country pairs. To be able to examine this study's questions, additional variables need to be included and estimated in the gravity equation. To interpret the gravity model as a linear equation it is logged on both sides. My specification of the first gravity equation is shown in equation (1).

$$\begin{aligned} \ln X_{jit} = & \beta_1 + \beta_2 \ln GDP_{it} + \beta_3 \ln GDP_{jt} + \beta_4 \ln GDPcap_{it} + \beta_5 \ln GDPcap_{jt} + \\ & \beta_6 \ln Dist_{ij} + \beta_7 Language_{ij} + \beta_8 Colony_{ij} + \beta_9 Year2009_t \\ & + \beta_{10} \ln Mobile_{jt} + \mu_{ijt} \end{aligned} \quad (1)$$

The dependent variable, $\ln X_{jit}$, is the value of export flows from countries in Africa j to EU countries i at time t . The real GDP measured in constant US dollars for both the importing and the exporting country is denoted by $\ln GDP$. The real GDP per capita measure in constant US dollar for both the importing and exporting country is measured by $\ln GDPcap$. These variables are included to measure the economic and demographical size of a country. The measure also reveals the level of development in one country. A relatively high number could be interpreted as if the country has received a high level of development in relation to other

countries. It is empirically established that larger economies trade more than smaller economies, hence the *lnGDP* is expected to have a positive impact on bilateral export flows.

The distance between the most important cities in each country pair is measured in kilometres and symbolized with *lnDist*. The intuition of the distance variable is that a longer distance between the country pair will increase trade costs, due to the costs of transportation; therefore a longer distance is expected to have a negative impact on international trade. Trade values will decrease.

The three following variables are dummy variables. The first one, *Language*, takes the value of 1 if the country pair shares a common language, if they do not, the variable takes the value of 0. Common language is expected to have a positive impact on bilateral trade since it facilitates communication between the trading countries. The second one, *Colony*, takes the value of 1 if the country pair ever colonized the other, if they have not shared a colonial history, the variable takes the value of 0. Similar for this variable is that it is thought to have a positive impact on export flows since it indicates that the countries share a common cultural background. The third and last one, *Year2009*, takes the value of 1 if the data of the country pair originates from the year 2009, otherwise, it takes the value of 0 if the data originates from 2000. This variable grasps how much export flows change from 2000 to 2009 *ceteris paribus*. If it is positive this implies that export flows change positive from 2000 to 2009 if all other variables remain the same.

Next variable is the one of main interest in this study. It is called *lnMobile* and shows if the access to mobile telecommunication in countries in Africa has any effect on export flows between countries in Africa and EU countries. If the coefficient is statistically significant it implies that the access to mobile telecommunication has an effect on bilateral trade flows between countries in Africa and EU countries. The expected outcome of this variable is an increasing and positive effect on trade values since theories argue that functional communications systems decrease trade costs. Therefore, by assuming that increased access to mobile telecommunication decreases trade costs, the expected outcome would be that access has a positive effect on export flows between, in this case, countries in Africa and EU countries.

The equation ends with μ_{ijt} which is an error term.

This study also aims to investigate if the effect of access to mobile telecommunication on export flows from countries in Africa to EU countries has changed over time. To test that effect an interacted variable is needed. This variable is named $Mobile2009_{jt}$ and created by using following equation:

$$Year2009_t \times lnMobile_{jt} = Mobile2009_{jt}$$

This variable is added the gravity equation and the specification of the second gravity equation is as followed:

$$\begin{aligned} ln X_{jit} = & \beta_1 + \beta_2 ln GDP_{it} + \beta_3 ln GDP_{jt} + \beta_4 ln GDPcap_{it} + \beta_5 ln GDPcap_{jt} \\ & + \beta_6 ln Dist_{ij} + \beta_7 Language_{ij} + \beta_8 Colony_{ij} + \beta_9 Year2009_t \\ & + \beta_{10} ln Mobile_{jt} + \beta_{11} Mobile2009_{jt} + \varphi_{ijt} \end{aligned} \quad (2)$$

Definitions and expected outcome of the earlier presented variables are as explain above. The new variable $Mobile2009$ is integrated in equation (2) to denote if the effect of access to mobile telecommunication has changed from 2000 to 2009. If the variable is positive and statistically significant it means that the role of mobile telecommunication has become more important to export flows over time between countries in Africa and EU countries. As previously argued I expected to find that mobile telecommunication has a positive effect on export flows. Furthermore, I expect the effect of access to mobile telecommunication to increase over time. With other words, that access to the technology for firms and individuals is increasingly important over time to engaging in international trade.

φ_{ijt} is the new error term for equation (2).

4.2. Data

4.2.1. Sample

In this study the effects on exports from countries in Africa to EU countries due to increased access to mobile telecommunication in Africa is examined. To perform this investigation, I have collected relevant cross-section data for the gravity model during the years 2000 and 2009.

Since the mobile telecommunication has taken ground in countries in Africa during the last decade, these two years were chosen to capture this development of the telecommunication industry in African countries and to avoid the risk of lacking reliable data. During this period EU has expanded from 15 member countries into 27 members. To avoid capturing enlargement effects, I restricted my data selection to the group called EU-15. It includes following countries: Austria, Belgium, Germany, Denmark, Spain, Finland, France, Great Britain, Greece, Ireland, Italy, Luxembourg, Netherland, Portugal and Sweden. Furthermore, Africa consisted during this period of 53 countries⁶ which have all, except from Sao Tome and Principe and Somalia because of lack of information, been considered in the gravity equation. The EU countries group are used as reporters, in other words the importers, and the countries in Africa used as partners, exporters to EU countries.

Data⁷ of bilateral trade flows, X_{jit} , is gathered from United Nations COMTRADE database.

Some of the country pairs lack data, denoted with a zero, which creates a problem when estimating the log-linear gravity model. The reasons to the zero could be that the importing country has not reported its imports properly to COMTRADE, that there exists rounding errors or simply that trade does not occur between the two countries. I manage this lack of data in two different ways which are further discussed in 4.3. *Strategy of Estimation*.

GDP and *GDPcap* for the importers and the exporters, are explanatory variables in the gravity model. Data of these variables was collected from the World Bank's *World Development Indicators*. Data is available for all EU countries and countries in Africa, except from Somalia and Sao Tome and Principe. Due to inadequate data concerning these two countries, they

6 See Table 2 in Appendix for further information of the sample.

7 See Table 3 for further information of data collection.

were not taken into consideration within my regression. From the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) database the data for the following variable's were found: *Dist*, *Language*, and, *Colony*. All data collected from this database is bilateral.

Finally, data on available mobile cellular subscription in countries in Africa was gathered from the World Bank's *World Development Indicators (WDI)*. This database consists of two different measures of this variable. One of the variables presents the absolute number of active mobile cellular subscriptions in each country, and the other variable presents the amount of mobile cellular subscriptions per 100 inhabitants. As mention in previous chapter, the last variable mention is used in this study. The aim of this study is to discover if the access to mobile telecommunication helps the population within a country to engage in international trade, if the access has an effect on trade values. Therefore, the variable last mention is more valid since it considers the size of the population and the distribution of the technology among them.

4.2.2. Criticism of Data

There is a lack of available data concerning mobile telecommunication in countries in Africa. The data of the amount of minutes called between the exporters and importers, used by Jungmittag and Welfens (2009), is not available for all countries of Africa. Therefore, the variable provided by the WDI is used. Data from the World Bank is considered to be a trustful and reliable source which is also the reason to why this data is used. The database provides two variables of mobile telecommunication, number of mobile cellular subscription available, and, the amount of mobile cellular subscription distributed per 100 people. As mention above, the variable showing the penetration rate is used in this paper and I claimed in chapter 3 that this variable provides the best picture of the current mobile telecommunication situation in countries in Africa.

The concept *best* refers not to the most desirable measure but to the best available measure on the market. Improvements of mobile telecommunication data are wanted. For instance, a measure similar to the one used by Jungmittag and Welfens (2009) would be to prefer, both to gain more reliable results, but also to have a second variable to compare the results with.

4.3. Strategy of Estimation

The log-linear gravity models are estimated with Ordinary Least Square (OLS). A problem with data of cross-section character is heteroscedasticity. This means that the variance for the error term is different for different observations and may lead to incorrect inference (Westerlund 2005, p. 173). A White's heteroscedasticity test showed that the data suffered from heteroscedasticity, and therefore the model has been estimated using White's consistent standard errors and covariance that can be used even though the residuals are heteroscedastic (Westerlund 2005, p.176).

The gravity model is multiplicative in its basic form. In order to interpret the coefficients as elasticities, the gravity equations are log-linearized. This gives rise to a problem, since the log of zero is not defined. As mentioned in previous part some of the country pairs lack data from the COMTRADE database. These zeros could be a source to measurements errors and therefore the zeros are managed in two different ways and estimated in two separate gravity regressions in order to secure the trustfulness of my results. This action is made to run a sensitivity analysis of the results.

As a first adjustment of the data available, I put in the value 0.0001 where the bilateral trade values shows a zero. This action enables the observations of this particular country pair to be estimated in the log-linearized regression. Consequently, by managing the potential measuring faults like this all observations become observed within the gravity regression.

Further, another approach to the zeros is also taken. All zero observations available are removed and the gravity regression is estimated once again which results in new estimations of the variables. This reduces the amount of observations from the number of 1530 to 1438, but this sample is still large enough to be significant and reliable. Estimations of the same coefficients in the two different gravity regressions are subsequently compared. The coefficients are expected to show similar effects.

My estimations did not show any remarkable differences as shown in Table 1 and therefore I consider my gravity equations with results as reliable and valid.

However, some estimation problems could still exist. Santos Silva and Tenreyro (2006) argue that the gravity model estimated with OLS is inadequate to examine international trade flows. They mean that the major problem with this methodology emerge when the empirical model is log-linearized and the presence of heteroskedasticity leads to inconsistent estimates. Furthermore, they denote the problem of the existence of zeros in the data, which demands certain management, which they call “several unsatisfactory solutions”. They conclude that using Poisson pseudo-maximum-likelihood estimation is a good solution. However, using such an advanced methodology is beyond the scope of this bachelor’s thesis.

Further problems could be omitted variable bias. This means that the estimated model leaves out variables estimating causal factors. The model becomes biased and compensate for the missing factor. This could make the OLS-estimator inconsistent and biased.

Since there is no previous research in this particular field, I am using a parsimonious model to investigate the impact of my variables. Thus, some factors as, for example, trade policies, quality of institutions, bad physical infrastructure and politics of commerce are not covered in my model. Nevertheless, my initial results in this unexplored field establish a starting point and a basis for further research. The following chapter presents my empirical results for this paper.

5. Empirical Results

This chapter will present my empirical findings from the methodology and data used for answer this study’s question. The outline of this chapter is as following: first will a short summary of the estimation strategy be presented and after that follows a presentation of the empirical results with short comments of actual meaning.

When zeros are included, analysis is made on 1530 observation, and when zeros are deleted there are 1438 observations analyzed for the years 2000 and 2009. The gravity equation is estimated with OLS-estimator (Ordinary Least Square). The regressions are tested for heteroskedasticity with Whites test which establishes the error term’s variance. My results are presented in Table 1. The dependent variable is the natural logarithm of bilateral trade flows in all columns (a)-(d).

Results from gravity equation (1) which are shown in columns (a) and (b) are first analyzed. The core of the gravity model is the economic size of the trading economies and the bilateral distances between them which are thought of as determinants of trade flows. The gravity model measures the economic size in GDP of the trading countries. The interpretation of GDP in this model is that a larger economy will trade more than a small country. Received results of the *GDP* variables for both importers and exporters turned out to correlate well with this theory. The *GDP per capita* variables for importers and exporters are sought to capture the level of development in the particular country. The results show a negative impact on trade flows. The *Distance* variable shows the expected sign in column (b) meaning that a longer distance between the trading economies will have a negative impact on trade flows. In column (a), the result is not statistically significant which could be a result the inclusion of zero observations.

Table 1. Estimation results

Estimator:	OLS (a)	OLS (b)	OLS (c)	OLS (d)
In importer's GDP	1.920*** (0.000)	1.292*** (0.000)	1.921*** (0.000)	1.292*** (0.000)
In exporter's GDP	1.614*** (0.000)	1.249*** (0.000)	1.594*** (0.000)	1.240*** (0.000)
In importer's GDP per capita	-2.477*** (0.000)	-2.053*** (0.000)	-2.481*** (0.000)	-2.049*** (0.000)
In exporter's GDP per capita	-0.249** (0.045)	0.0426 (0.546)	-0.386*** (0.001)	-0.019 (0.804)
In distance	-0.179 (0.308)	-0.417*** (0.001)	-0.162 (0.360)	-0.408*** (0.003)
Language dummy	1.810*** (0.000)	0.960*** (0.000)	1.810*** (0.000)	0.961*** (0.000)
Colony dummy	0.514* (0.063)	1.084*** (0.000)	0.510** (0.063)	1.083*** (0.000)
Year2009 dummy	-1.043*** (0.002)	-0.713*** (0.001)	-3.025*** (0.002)	-1.601*** (0.002)
In Mobile	0.245*** (0.000)	0.125*** (0.001)	0.247*** (0.000)	0.125*** (0.002)
In Mobile2009	-	-	0.559** (0.021)	0.250* (0.053)
N Observations	1530	1438	1530	1438

Dependent variable: Logarithm of trade flows.

Source: Author's own calculations.

Note: Column (a) and (b) shows the results from equation (1). Column (c) and (d) presents the results from the gravity equation (2). Column (b) and (d) both show results from equation (1) respective (2) but all bilateral trade flows equal to zero is removed, together with additional observations to that particular country pair. Notice the fewer observations in these two columns. All four equations are corrected with Whites cross-section standard errors. P-value in brackets. Asterisk denote significance at 1% (***), 5% (**) and 10%(*).

The dummy variables, *Language* and *Colony*, show in both columns expected impact on trade values. The results are significant and show a positive impact on export flows. This is a logical result because common spoken languages facilitate communication and shared colonial history speaks for an understanding for each other's culture among the trading countries. The variable *Year2009* shows that when effects of the other variables are erased the export flows decreases from 2000 to 2009 between countries in Africa and EU countries. This means that other explanations and variables are needed to explain the actual increase in trade values.

Main result for this study is the *Mobile* variable. This variable presents if the access to mobile telecommunication has any effect on export flows. The results are highly statistical significant and show a positive impact. The access of mobile telecommunication affect trade flows with 0.245 in column (a) and 0.125 in column (b). This means that if the mobile telecommunication would increase by one percent this would increase export flows by 0.25 and 0.13 percent, respectively.

New estimations are made with gravity equation (2) and the interaction variable. Since, another explanatory variable is added, the results of gravity equation (1) becomes affected. Results from gravity equation (2) are presented in column (c) and (d). The control variables, *GDP*, *GDP per capita*, *Distance*, *Language*, *Colony* and *Year2009* show the same pattern and statistical significance as discussed earlier. Also the main variable, *Mobile*, shows the same effect as with equation (1). The results are highly significant and present an effect of 0.247 and 0.125, respectively, on trade flows. This implies that access to mobile telecommunication is important for the value of export flows.

The interaction variable, *Mobile2009*, does show statistically significant and positive results. It evaluates if the effect of access to mobile telecommunication has changed over time, and the results speaks for an increases of 0.554, when all observations are included, and 0.25, when zeros are removed. This means that access to mobile telecommunication has become more important over time and has a bigger effect on international trade between EU countries and countries in Africa in 2009 than it did in 2000.

To summarize, the results show that the access to mobile telecommunication has an effect on international trade flows and that the effect of the access has increased over time. The results

presented are statistically significant and correspond well with Jungmittag and Welfens's (2009) findings that if international telecommunication increases by one percent, the volume of trade increases by 0.2 percent. Their result is considered suitable for comparison with the findings of this study. These empirical results suggest that the importance of mobile telecommunication to international trade increases over time and that this effect should be considered by governments and policy makers. A discussion concerning this issue is found in the next part, chapter 6.

6. Summary and Conclusion

The main purpose of this study has been to investigate if the access to mobile telecommunication in Africa has any effect on export flows from countries in Africa to EU countries. Furthermore, this study also examines if this effect has changed over time. This is a current topic considering that many countries in Africa are experiencing an increase in access to mobile telecommunication and the effects of this is not widely explored. The technology's effect on international trade is important to examine, since international trade is thought of as an important factor to enhance economic growth in countries.

To the best of my knowledge this kind of research has never been performed before. Jungmittag and Welfens (2009) have performed a similar research with international landline telecommunication, its liberalization and its impact on European countries. Their approach differs to my research since mine concerns mobile telecommunication and its impact on countries in Africa and exports to EU countries. However, their findings function as a control result to my findings. On the basis of this, I have used a parsimonious model to estimate the effect of mobile telecommunication and my result can be a starting point for further research within the subject.

The gravity model is well-known and very much used in international trade. Therefore, I chose to carry out my investigation with this methodology. My results show that access to mobile telecommunication affect international trade flows between countries in Africa and EU countries with 0.25 percent. This means that the value of export flows would change 0.25 percentage if access to mobile telecommunication increased by one percent. These results correspond well with Jungmittag and Welfens (2009) findings that if international

telecommunication increases by one percent, the volume of trade increases by 0.2 percent. Furthermore, my results show that the importance of access to mobile telecommunication increases from 2000 to 2009. This means that access to mobile telecommunication becomes more important for international trade over time.

What do my results suggest and how to apply them in a bigger context? International trade is important for countries to gain economic growth. My results indicate that mobile telecommunication has a positive impact on international trade. Moreover, my findings suggest that a greater access to mobile telecommunication will positively impact exports and the importance of access to the technology to trade flows increases over time. Governments and policy makers should take these results into account when considering areas to develop in order to receive economic growth. Other institutions and organisation that could consider these results are aid donors and aid development programmes. This study's findings could function as proposal for how to develop their aid strategies but also as push for further research within this area.

To make my initial results in this area more reliable I suggest that more research needs to be done within this subject with both quantitative and qualitative methods. Furthermore, more advanced methods, as suggested by Santos Silva and Tenreyro (2006), need to be used to ensure that estimated models do not contain any estimation problems such as heteroskedasticity, omitted variable bias or other statistical issues.

In summary, the results speak for a development of the mobile telecommunication technology in countries in Africa to increase international trade. Access to mobile telecommunication positively affect international trade, furthermore, it is argued that access to the technology turns out to be of greater importance over time to trade flows. Since international trade is considered to increase a country's economy, this could contribute to a greater economic growth of countries in Africa and hopefully after further research, improved living conditions for the population.

7. Reference list

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8. Appendix.

8.1 Countries in Africa

Table 2. List of countries in Africa considered in this study

Angola	Mauritania
Burundi	Mauritius
Benin	Malawi
Burkina Faso	Namibia
Botswana	Niger
Central African Republic	Nigeria
Cote d'Ivoire	Rwanda
Cameroon	Sudan
Congo, Rep.	Senegal
Comoros	Sierra Leone
Cape Verde	(Somalia)
Djibouti	(Sao Tome and Principe)
Algeria	Swaziland
Egypt, Arab Rep.	Seychelles
Eritrea	Chad
Ethiopia	Togo
Gabon	Tunisia
Ghana	Tanzania
Guinea	Uganda
Gambia, The	South Africa
Guinea-Bissau	Congo, Dem. Rep.
Equatorial Guinea	Zambia
Kenya	Zimbabwe
Liberia	
Libya	
Lesotho	
Morocco	
Madagascar	
Mali	
Mozambique	

Note: Somalia and Sao Tome and Principe in brackets since they are not considered in the gravity equations.

8.2. Variables and data source

Table 3. Definition of data source for estimated variables

<i>Variable</i>	<i>Definition</i>	<i>Data source</i>
GDP	Gross Domestic Product.	World Data Bank 2010
GDP per capita	Gross Domestic Product per capita.	World Data Bank 2010
Distance	The bilateral distance in kilometer between two trading countries economical centre	CEPII 2011
Language dummy	Takes the value of one if the importer and exporter share a common language.	CEPII 2011
Colony dummy	Takes the value of one if the importer and exporter share a common colonial history.	CEPII 2011
Year2009 dummy	Takes the value of one if the data origins from year 2009.	Author's own calculations.
Mobile	The penetration rate of mobile cellular subscriptions available in each country in Africa.	World Data Bank 2011
Mobile2009 (Year2009*Mobile)	Shows if the effect of access to mobile telecommunication changes over time.	Author's own calculations.